

The role of Energy Economics in Economic Development: An overview

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Abstract

Energy is also known as oxygen of the economy and energy economics or the economics of energy deals with the study of the supply and use of the energy in the societies with the help of economic tools and concerns. A branch of applied economics where economics principles and tools are applied to 'ask the right questions' is called Energy Economics. Therefore the paper begins with the introduction of the concept of energy economics, which is mainly concerned with the basic economic issue of fulfilling unlimited wants by allocating scarce resources of the economy. Hence, energy economics gives complete sight of all aspects of the energy sector i.e. demand, supply, energy-economy interaction and its equilibrium or government policy toward energy sector issues and their solutions and so on. The main aim of the paper is to study the importance of energy economics, its scope and its primacy in the process of development. Through this paper we have also tried to throw light on the important factors which determine the demand for energy. A qualitative methodology has been used in this study. A systematic

literature review was conducted and an attempt has been made to address the questions related to energy economics.

KEYWORDS: Energy Economics, Economic Development, Energy Demand.

1.1 Introduction

Energy Term: The ability to do work or produce heat is called Energy. The ability of doing work can either be in the form of capability i.e. potential of any substance which can produce heat or energy or it can be in the form of converted energy to motive power i.e. kinetic energy.

1.2 Energy Economics

A branch of applied economics where economics principles and tools are applied to ‘ask the right questions’ is called Energy Economics. It is concerned with the basic economic issue of fulfilling unlimited wants by allocating scarce resources of the economy. Hence, energy economics gives complete sight of all aspects of the energy sector i.e. demand, supply, energy-economy interaction and its equilibrium or government policy toward energy sector issues and their solutions and so on (Fontes&Freires, 2018).

Importance of energy economics:

The field that studies the process of human utilization of energy resources and energy commodities and what are the consequences of its utilization is called Energy economics. In the terminology of physical science, the ability to do work is called energy, for instance, accelerating, lifting, or heating material. In economic terms, “energy” comprises of all energy commodities and energy resources that embody significant amounts of physical energy and thus provide the capacity to perform work. Energy commodities - e.g., gasoline, diesel fuel, natural gas, propane, coal, or electricity –endow energy services for human activities, which can be lighting, space heating, water heating, cooking, motive power, electronic activity. Energy resources - e.g., crude oil, natural gas, coal, biomass, hydro, uranium, wind, sunlight, or geothermal deposits – can be harvested to generate energy commodities.

Energy economics studies forces that guide economic agents – (firms, individuals, governments) – to provide energy resources, to convert these resources into other useful energy forms, to transport them to the users, to use them and to dispose of the residuals. It also studies the role of alternative markets and regulatory structures on these activities, their economic distributional impacts, and environmental consequences. It focuses on economically efficient provision and use of those energy commodities and resources and pay importance to the factors that lead away from economic efficiency (Sweeney, 2002). Like any other branch of economics, energy economics is mainly concerned with the basic economic problem of allocating scarce resources in the economy. Thus, the microeconomic concerns of energy supply and demand and the macroeconomic concerns of investment, financing and economic linkages with the rest of the economy form an essential part of this subject (Bhattacharyya, (2019).

Energy economics recognizes the fundamental physical realities that

1. Energy can neither be created nor be destroyed but can only be converted among its various forms,
2. Energy comes from the physical environment and ultimately is released back into the physical environment.

Thus, the study of human activities using energy resources from naturally available forms is known as energy economics, through often complex conversion processes, to forms providing energy services (Sweeney, 2002).

1.3 Literature review

Energy is also known as oxygen of the economy (Voser, 2011) and energy economics or the economics of energy deals with the study of the supply and use of the energy in the societies with the help of economic tools and concerns. Energy economics received a big push in the economic literature after the oil crises of 1973. However, it has its genesis in the history from 1865, when Jevons wrote about the eventual depletion of the coal reserves in the book “the coal question”. H. Hotelling was one of the early researchers who worked on the economics of exhaustible resources including fossil fuels and framed a price path for non-renewable resources.

Study of the energy issues with the help of economic tools relates to the abundant use of the energy resources and competition among the main fuels which are used as sources of energy, the part which public policy plays in shaping the consumption and process of extraction of these fuels, the impact of the usage of these fuels have on environment. It simultaneously studies the market forces as well as the state forces which have a lasting impact on the prices and distribution of the energy sources and services. A major part of the energy economics is devoted to the concerns related to the long-term availability of the energy resources and their judicious, efficient utilization (Barnett and Morse 1963). Because of the physical constraints and exhaustible nature of the majority of the energy resources it becomes imperative to find ways with the help of which less and less fuel can be put to produce more and more output. Energy economics also focuses on the harmful effects of the blind usage of the energy resources on physical environment. The environment gets degraded with the increasing extraction and usage of energy resources in quantity as well as quality. This environmental concern of the energy economics has given rise to the notion of sustainable development where in the resources are used in a reasonable and responsible manner without compromising the future of forth coming generations.

Energy economics works on the principle of “energy can neither be created nor be destroyed but can only be transformed from one type to another”. Amid global market uncertainty to build a strong economy having high standard of living, quality of life, education and health we need energy in an unprecedented amount as energy is the life-blood of economic growth and development (Voser 2011). A high usage of energy guarantees social progress. Using the energy in an enormous amount also bestows the society with the responsibility of its efficient use and judicious use. The supply of energy sources must meet the demand for energy sources both from

developing as well as developed world. Inexhaustible resources won't be able to match the growing demand for energy implying that there would be a higher demand for the exhaustible sources of energy because of the very importance these energy resources have in the economic growth and development of a society.

Economic development has a strong connection with the consumption of energy resources. A higher usage and consumption of energy resources is highly positively associated with a higher level of economic development (Michael and Barbona 2003). Developed countries consumption of energy per unit of economic output is higher than of less developed countries. The per capita consumption of energy in developed countries is far more in comparison to the less developed countries. It is worth mentioning here that in the more advanced stages of industrial development due to the application of more efficient techniques for consumption and production of energy, the energy used per unit economic output has decreased drastically (Nakicenovic 1996). Schurr's study of 1984 is one of the most satisfactory guiding examples for considering the positive relationship between energy development and broader economic development of economically advanced societies. The fact of economic theory that behind of some imaginary saturation level, an increase in any factor of production is an increase in output *ceteris paribus*. The use of the types of sources of energy varies with the level of economic development along with the other inputs of production in an economy. Some economists call it as energy ladder. At the lowest level of income organic sources of energy (wood, dung, sunshine for drying) are consumed including human effort. Animal power, charcoal a processed biofuel and some marketable fossil fuels become the sources of energy in the intermediate stage. Ultimately more advanced fossil fuels and electricity become the main sources of energy in the advanced stages of development (Barnes and Floor 1994).

The linkage between energy consumption and economic development is also discussed broadly by WB report 1994 which focuses on the investment in energy infrastructure and increasing returns in the output. This study proves both theoretically and empirically the increasing rates of return to the investment in energy services and infrastructure. OTA mentioned in 1991 and 1992 that traditional energy sources require huge investment in the form of labor time and can be less efficient in comparison to even ordinary machines powered by external sources.

Jorgensen (1981, 1984) analyzed energy-economy relationship econometrically for both pre-1973 and post 1973 periods. He used a five input (capital, labor, electricity and non-electrical energy and materials) model and concludes the increased use of the electricity as a source of energy increased the productivity industrial sectors of the advanced economies. Another world bank study about the rural population of Philippines shows that the educational, economical, income and health levels of the population increased when they shifted from traditional use energy sources to electricity as a source of energy. These studies prove the important role the energy consumption plays in economic and social development of a society.

Energy sector also contributes to the job creation moto. Energy sector contributes directly and indirectly to job creation in a society as well as to the GDP. Direct jobs are created when positions are held by the people working in the energy industry and indirect jobs are created in the industries which supply inputs and other raw materials to the energy industry. There are also induced jobs which are created when the salaried people in the first two industries mentioned above spend their incomes in the unrelated sectors of the economy causing a employment multiplier effect in unrelated industries. In 2009 the oil and gas extraction sector contributed about 7% of the total investment and created approximately 150, 000 jobs in 2011 which is about 9% of the total jobs created in the US during that particular year (WEF 2012). In US, the American Petroleum Institute at most produce more than 9 million jobs directly and indirectly which accounts approximately for 5% of the economy's total employment. In Norway, energy and allied sectors contribute almost 20% of the total business GDP owing to its large supply chain in energy industry.

Demand for energy and the factors which govern the demand for energy in a particular society is one of the main component studies in energy economics. The demand for energy is classified in to direct demand and derived demand. In the former case it is used as a final good mostly in households' activities and in the latter case it is used as an input for producing final products because of its use in industrial activities. In the industrial sector energy is used for the purpose of transformation of various inputs into a final products and services. The sectors which demand energy in huge amount are agriculture, industry, transportation and commercial activities and electrical activities (Pagoulatos, 1975).The largest share of energy demand originates from the transportation sector and then space heating followed by process steaming. There are several factors which determine the demand for energy in a particular economy. Starting from the population size to the cultural habits of a society determine the level of energy demanded in an economy. Economists have also focused on the population size as a major source of energy demand for the purpose of commercial agricultural activities. Latter after the advent of globalization the major consumer of energy is the industrial sector followed by the transportation which is directly or indirectly related to industrial sector. The demand for energy in a society depends also on the technological level and modernization of the institutions. The more advanced and sophisticated are the institutions, the greater is the demand for energy. The phase of the economic activity also in an economy also determines the consumption of energy. Energy is demanded increasingly during the phase of boom and less in the phases of recession or depression. The level of the economic activity is one of the major determinants of demand for energy resources and services. Countries experiencing high growth rates of GDP and GDP per capita would be consuming a higher level of energy as compared to the low growth economies.

1.4 Objectives

1. To study the concept of Energy Economics, its scope and importance.
2. To understand the role of energy in the process of economic development.

3. To throw light on the various factors which determine the demand for energy.

1.5 Methodology

A qualitative methodology has been used in this study. The source of the data is various journals, books, articles and research material related to the topic. A systematic literature review was conducted and an attempt has been made to address the questions of what is energy economics, its scope and its primacy in the process of economic development. Different criteria were used for selecting articles, journals, papers and documents for the study.

1.6 Scope of Energy Economics

a. In the beginning, the scope of energy economics is linked with energy-economy contraction. In 1970's with the oil price hike there emerged a need for resolving these energy issues and developing the concept of energy economics. In 1980's, economists diverge the analysis to environmental concerns of energy use and economic development and in 1990's, the focus was shifted on liberalization and reconstruction added to energy issues. Now, 'Energy Trilemma', i.e. Energy Security, Equitable energy access and ecological impact mitigation, are the most important concerns of all energy economists (Fontes&Freires, 2018).

Energy economics also deals with several related issues which include:

- Roles of alternative market and regulatory structures on activities related to energy distribution and use, economic distributional impacts, and environmental consequences.
- Economically efficient provision and use of energy commodities and resources and the factors that lead away from economic efficiency.

Thus energy economics is a broad scientific subject area that includes topics related to supply and use of energy in societies (Wikipedia, 2008).

1.7 Basic principles of energy economics

The important fundamental principles which forms the base of Energy economics and some of which are based on scientific theory, while others are based on economic theory are as under:

a) **Law of thermodynamics:** Energy economics identifies two important postulates of thermodynamics, which are:

- Energy can be neither created nor destroyed
- Energy can be converted among its various forms.

b) **Source and end of energy:** Energy economics believes in the fact that energy comes from the physical environment and eventually is released back into the physical environment.

c) **Energy demand:** Energy demand is a derived demand which is derived from wishes to use energy for obtaining desired services. It depends primarily on demand for desired services, their availability. It also depends upon the properties of energy conversion technologies and the costs of energy and technologies used for conversion.

d) **Is Energy as an essential good?:** In economics, an essential good is one for which the demand never turns negative even if its prices increase. In the theoretical limit, in case of high prices of essential goods, the consumers would allocate their income in such a way so that they can purchase these essential goods. Energy is considered an essential good because human activity would be impossible without the use of energy. Although energy is essential to humans, neither particular energy commodities nor any purchased energy commodities are essential goods. Particular energy commodities are not essential because consumers can convert one form of energy into another. Even the aggregate of all purchased energy cannot be viewed as an essential good.

e) **Net energy gain:** Net energy gain is defined as:

$$NEG = EnergyConsumable - EnergyExpended$$

Currently, several resources in the world can provide energy. Though, the cost or the energy required to tap this resource is very high, which leads to $NEG < 0$.

f) **Market mechanism and energy usage:** Market forces are the ultimate guiding mechanism behind the usage of various energy commodities. The decision for using renewable or non-renewable resources will be determined by the market prices. Market forces would guide commodity prices upward, when the depletable resources were approaching depletion, so that commodity prices of depleting resources would rise so high that the remaining demands would be satisfied by the renewable substitutes.

g) **Hidden environmental costs:** There are numerous hidden costs involved in the use of energy resources. One of the most prominent hidden costs is the environmental impact. Recently environmental impacts that are receiving the most attention are associated with the release of greenhouse gases into the atmosphere, primarily carbon dioxide, from the combustion of fossil fuels. Persistent environmental impacts of energy use and the absence of governmental intervention indicate that significant costs of energy use are not included in the price energy user's face. These are called externalities, which lead to the overuse of energy and provide strong motivation for interventions designed to reduce energy use (Sivakumar, 2012).

1.8 Primacy of energy in the process of economic development:

Energy and economic development

Introduction:

Energy is a necessary input used in all productive activities. The process of economic development is closely associated with higher levels of energy consumption, especially commercial energy (viz., coal, oil and electricity) and this trend is expected to increase in the future also. Without energy the existence of mankind is almost impossible, as it is the basic natural resource. It plays a crucial role in human welfare, as all essential economic activities of present development are dependent on the use of energy. The availability of easy and cheap energy may serve to fuel industrial development and insufficient energy supplies can result in lower industrial and agricultural production and decelerate rate of economic development

1.8.1 Economic Development –A Conceptual Approach

Economic development is a 'process' of increasing the real national income of a country over a long period of time. It aims at improving the quality of life of people. (Feldman & Hadjimichael, 2016) argue that 'economic development in a country calls for certain fundamental changes in the structure of economy'. (Spolaore & Wacziarg, 2013) is of the view that 'Economic development has much to do with human endowments, social attitudes, political conditions and historical accidents; capital is a necessary but not a sufficient condition of economic progress'. (Arthur Lewis) opines that 'natural resources determine the course of development and constitute a challenge, which may or may not be accepted by the human mind'. The provision of social overheads has an important bearing on economic development. (Hirschman) has shown priority for social overheads like electricity and other forms of energy in promoting the economic development of a country. Economic progress comprehends the advancement of a community along the line of evolving new and better methods of production and raising the levels of output through the development of human skill and energy, better organisation and the acquisition of capital resources.

We can conclude that economic growth is a quantitative sustained increase in the country's per capita output or income, which should be accompanied by expansion in its labour force, consumption, capital and volume of trade. But economic development is a much wider term which is related to qualitative changes in the economy. It describes the underlying determinants of growth such as technological and structural changes. An economy may grow but it may not develop because of prevailing poverty, unemployment and inequality in the economy, which may continue to persist due to the absence of technological and structural changes.

1.8.2 Energy Consumption and Economic Development - Views and Empirical Evidences

Several empirical evidences and many experts have confirmed a high degree of correlations between energy consumption and economic development. (Guru and Ahsan) have shown that 'world energy demand has been on the increase at almost the same rate as the gross world

product over the past fifty years'. (Culp) has observed that 'those countries that have had the profuse supply of energy available have observed substantial higher rates of industrial growth and a corresponding increase in gross national product'. The close relationship between the consumption of energy and growth of economy and improvement in living standards of people has also been highlighted by (Chaman). 'The high standard of living of an industrial society, the growth of its economy and its power to affect the course of events in other countries are to a great extent due to the large amount of energy which it consumes.'

In the next section we will discuss the important role of energy in economic development with the help of several examples where we have shown a correlation between Electricity (one of the most important form of energy) and Economic development.

1.8.3 Electricity and Economic Development

Electricity is one of the most convenient and versatile forms of energy providing simultaneously motive power, heat and light and it meets both intermediate demand and final demand. There exists a positive correlation between energy consumption and economic development and it also holds well concerning electric power consumption and economic development. Today electricity is considered the most versatile form of energy servicing mankind. It possesses the greatest advantage in its adaptability and possibility of transmitting across hundreds of kilometers, for distributing to a variety of consumers at all times at their doorstep, according to their requirements. For sustaining economic activities of a country, electric power is considered as a crucial input. Thus, electricity has rightly been called the fifth factor of production next to land, labour, capital and organization. It is considered as the prime mover of economic growth and development. The development of electricity has a deep influence on economic development as well as the development of society since it enriches the quality of life. Today electricity is no longer considered as a luxury, but it has become an economic necessity, not only for affording living comforts, but also in promoting agriculture growth and industrial development.

Electricity and Sectoral Growth Economy is a multi-sectoral organism consisting of agriculture, industry, services and the social sector. Electricity can transform all these sectors into modern and viable ones and help them to promote the society to become a dynamic force. The use of electricity in all these sectors puts them on a high growth path by raising their productivity. Rostow's concept of stages of economic growth is basically related to the thesis that how a traditional society transforms itself into a take-off and self sustained growth. In this process of transition, electricity plays a vital role, as all the sectoral components of the economy have not only to become highly productive but have also become complementary to each other's growth.

1.8.4 Electricity and Agriculture

We are observing the commercialization of modern agriculture by using qualitatively highly improved inputs and using electricity in its various operations. Even in countries like India, where agriculture was considered as a way of living in the early period has made incredible progress in recent years with the adoption of modern methods of cultivation and farm

management. In this process, the use of electricity has been very extensive in the different operations of farming. Now progressive farmers are using electricity for tilling, irrigation, harvesting and cold storage of their products before marketing the same. There has been an intensive use of electricity by farmers mostly in the area of using pump sets for lifting water for irrigation purposes thereby ensuring proper growth of the crops. Most of the farmers use advanced machinery for tilling and harvesting where power is used. Similarly, during the period of falling prices, farmers resort to cold storing of perishable agricultural commodities. Similarly allied occupations like dairying, hatchery, floriculture, veterinary, forestry and horticulture are also massively benefited by the use of electricity in raising the productivity and quality of their operations. The rural communication system based on electricity has been a great help to the agriculture sector in various ways.

1.8.5 Electricity and Industry

There is a massive dependence of the industrial sector on electricity as an important input in its various operations of manufacture, transporting, assembling, storing, grading and other different areas of management. The increased use of the latest equipment like, computers/Internet and modern means of communications like Fax machines, Satellite communications, and e-mail, etc., is due to electricity. In those countries where labour is scarce, automation of work through the use of electricity has come as boon to industrial activities. The use of electricity by railways has been very helpful in transporting bulky goods [raw materials or finished products] to distant places. Electricity has completely transformed the industrial sector in the mass production of capital and consumer goods for the ever-expanding domestic and foreign markets.

1.8.6 Electricity - Services and Social Sector

The use of electricity has enabled the service sectors like surface transport, communication, aviation, shipping, etc., to provide quick and prompt services to the people. The society has been enormously benefited by the use of electricity. Now the rural masses have access to modern amenities like electric lighting, refrigerators, fans, TV and radios due to the use of electricity. Their outlook has changed and they have been able to widen their vision about the fast-changing standards of people in advanced countries. There is a transformation of the traditional bound society into a dynamic one through exposing the rural masses to modern developments in science and technology. Rural people can obtain better tools and equipment in their occupations of agriculture and cottage and small-scale industries with the help of electricity. These modern tools and equipment are the result of modern technology, which in turn is the result of the use of electricity.

1.8.7 Electricity and Employment

Electricity creates employment both directly and indirectly. Direct employment is created through the network of electric projects, the transmission of the power and maintenance of the various components of the electricity undertaking. The indirect employment is generated by way

of helping industrial, agricultural and tertiary sector by providing the input in the form of electrical energy (Lloyd, 2017).

1.9 Factors determining the demand for energy

Introduction to energy demand:

The term “energy demand” is referred to any type of energy which is required to fulfill individual or sectoral energy needs. Individual energy demand is relate to the individual energy requirements to fulfill different purposes like cooking, heating, cooling, etc. Sectoral energy demand is related to the energy requirements of different sectors such as industrial, residential, and transportation. Energy demand can correspond to:

- (1) Primary energy demand- this is the amount of energy required by a country, or
- (2) Final energy demand -this is the amount of energy supplied to consumers.

Energy demand shows the relationship between the price and quantity of energy in the form of electricity or fuel. It normally demonstrates that at a given cost what amount of energy will be bought and how price changes will influence that amount. The whole energy system of a country is derived according to energy demand. The overall worldwide energy demand not only depends on total energy use but also its location, available energy resources, resource types and properties, characteristics of end-user technology, etc.

1.9.1 Energy demand analysis in different sectors:

The demand of energy can be classified into various sectors by end-users. As said by the International Energy Agency (IEA, 2017), various classifications of the energy demand sector are as follows:

- Residential
- Commercial and public services
- Industrial
- Transport
- Nonenergy
- Other*

Note *,: other sector includes agriculture, fishing, and non-specified other (IEA, 2017).

In accordance with the Malaysian Energy Commission (MESH, 2015), the most important classifications by sector are as follows:

- Residential
- Commercial
- Industrial
- Transport
- Agricultural
- Fishery
- Non energy

From the above classifications,

Sectoral energy demand analysis can be grouped as follows:

- Building (residential and commercial)
- Industrial
- Transport

1.9.1(a) Building sector energy demand analysis

The major portion of energy demand is consumed by building sector; as said by the US Energy Information Association, the building sector consumes 20.1% energy out of total worldwide energy consumption (EIA, 2016). There are several factors on which Energy use intensity (EUI) depends (Ouf&Issa, 2017). A building's system energy consumption mainly depends on its

- Structural condition
- Building materials
- Weather
- operating condition

1.9.1 (a)i Structural condition

Structural conditions and building materials are important factors influencing energy consumption. Energy consumption varies based on - building structure/type

- Apartment
- Condominium
- Flat
- Bungalow
- Duplex
- Townhouse

1.9.1 (a)ii Building materials

Structural building materials are important factors in energy consumption. Energy consumption varies based on

- Material types
- Thermal properties
- Dimensions
- Operating behaviours

Energy consumption in the building sector depends on the equipment used by households, including energy used for heating, cooling, lighting, cooking, and other electrical equipment:

- Type of building
- Number of inhabitants
- Usage of the building
- Amount of equipment
- Power rating
- Operating hours
- Equipment efficiency

1.9.1 (a)iii Energy consumption in buildings also depends on weather conditions:

- building location (hot or cold region)
- Duration of each season

- Temperature
- wind speed
- Duration of day and night

The building sectors are commonly classified based on the purpose and usage of buildings as follows:

- **Residential buildings**

There is a significant difference in the consumption of energy in residential buildings depending upon the provinces and countries. There can be several factors which influence building energy consumption, for example building type and household characteristics, energy source availability and energy policies, homeowner income, and type of energy equipment used.

- **Commercial buildings**

Commercial buildings are generally profit-seeking businesses or those which are providing various services. The commercial buildings consume energy by heating, lighting, cooling, computer and information system operating, etc. Commercial buildings include hospitals, offices, education institutions, police stations, warehouses, hotels and restaurants, shopping malls, retail stores, and places of worship. Some other on-building energy use in the commercial sector contributes to public services such as traffic lights and water and sewer systems.

1.9.1(b) Industrial Sector:

The one of the largest energy-consuming sectors is the industrial sector and it consumes about 54% of total world energy in 2012; and it is expected that the energy consumption of this sector will grow 1.2% per year between 2012 and 2040 (EIA, 2016; Hasanuzzaman et al., 2012). The sector can be divided by 3 different industry categories:

- Energy-intensive manufacturing,
- Non-energy intensive manufacturing, and
- Nonmanufacturing

1.9.1 (b)i Energy-intensive manufacturing (IEO, 2016)

Most industries are energy-intensive and major energy end-users of each country. The following industries are commonly considered energy-intensive:

- Food: food, tobacco goods manufacturing, and beverages
- Chemicals: organic chemicals, inorganic chemicals, agricultural chemicals, and resins, including chemical feed stocks
- Steel and iron: steel and iron manufacturing including coke over
- Pulp- and paper-based: printing and interrelated support activities and paper manufacturing
- Nonferrous metals: mostly aluminum and other metals such as zinc, copper, and tin

- Refining: coal products and petroleum refinery manufacturing including natural gas and coal used as feed stocks
- Nonmetallic minerals: mainly cement and other nonmetallic minerals such as lime, glass, clay, and gypsum products

1.9.1 (b)ii Non-energy intensive manufacturing

- Other chemical industries: pharmaceutical (botanical and medicinal), coatings and paint, detergents, adhesives, and other miscellaneous chemical yields
- Other industries: the entire other industrial manufacturing including metal-based durables (machinery, fabricated metal items, electronic and computer products, electrical equipment, and transportation equipment)

1.9.1(b)iii Non-manufacturing

- Forestry, agriculture, fishing: forestry, agriculture, and fishing
- Construction: industrial construction, civil and heavy engineering construction, building construction (commercial and residential), and specialty skill contractors
- Mining: natural gas and oil extraction, coal mining, and mining of nonmetallic and metallic minerals. The fuel mix and intensity consumed in the industrial sector vary according to the country and region and it also depends on the mix of technological development and economic activity. There can be variety of purposes for which Industrial sector energy is used - for example, assembly and processing, cogeneration and steam, process cooling and heating, air conditioning for buildings, and heating. The industrial sector energy consumption also includes chemical feed stocks. Besides, the feed stocks of natural gas are applied to produce agriculture chemicals. For the manufacture of plastics and organic chemicals, and among several other uses both petroleum products (i.e., naphtha) and natural gas liquids are used.

1.9.1 (c) Transport sector

Transportation is an important part of a country's economy and its purposes as a foundation, service provider, and support. In addition, energy use in the transport sector contains the energy consumed in moving goods and people by air, rail, water, road, and pipeline. The transportation sector comprises two major modes:

- Passenger
- Freight

Passenger types include buses, trucks and light-duty cars, two- and three-wheel vehicles, passenger trains, and airplanes.

Freight types are used in the movement of finished, intermediate, and raw goods to consumers and include light-duty, medium, and heavy trucks; international marine vessels and domestic marine vessels; pipelines; and rail (Hasanuzzaman&Abd Rahim, 2019).

1.10 Summary and Conclusion

In this lesson, we have discussed the concept of energy economics, its scope and importance. We begin the chapter by giving a brief introduction about the definition of energy i.e. the ability to do work or produce heat is called Energy. The ability of doing work can either be in the form of capability i.e. potential of any substance which can produce heat or energy or it can be in the form of converted energy to motive power i.e. kinetic energy. Then we proceed with explaining what is energy economics and its significance. We tried to explain the scope and importance of energy economics and also throw light on some of its basic principles. Then in the next section of the lesson we draw our attention towards the primacy of energy in the process of economic development. We tried to explain a positive correlation between the growing energy requirements and the increasing pace of economic development. With a special reference to electricity, we through various examples have made an attempt to discuss an interrelation between energy and various sectors of the economy, as we know that the electricity is one of the most crucial and versatile source of energy and has a significant role in the economic development of the country. Then at the last section of the chapter, we focused on various factors that determine the demand for energy.

1.11 Glossary:

Energy Trilemma: In order to build a strong basis for prosperity and competitiveness, individual countries must balance the three core dimensions of what Oliver Wyman and the World Energy Council have defined as the energy trilemma: affordability and access, energy security and environmental sustainability.

Energy Security: The ability of a nation to secure sufficient, affordable and consistent energy supplies for its domestic, industrial, transport and military requirements is termed Energy Security. It means that current and future energy needs have a high probability of being met, irrespective of economic or political instability.

Economic efficiency: Economic efficiency is when all goods and factors of production in an economy are distributed or allocated to their most valuable uses and waste is eliminated or minimized.

Externalities: An externality is an economic term referring to a cost or benefit incurred or received by a third party. However, the third party has no control over the creation of that cost or benefit. An externality can be both positive and negative and can stem from either the production or consumption of a good or service.

9.13 References

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