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Environmental Sustainability, Energy Use and Economic Growth:

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ABSTRACT:- Manufacturing and trading concentration, elevated economic activities and rise in urban population are the driving forces of city growths in the central part of Japan. Toyohashi city, locating between Tokyo and Nagoya, Osaka, is facing rapid growth for its industrial and port related economic concentration. As a result, use of natural resources and energy in the city is increasing. Recent trends show that to ensure economic growth, the City level energy use increased significantly. On the other hand, after the great disaster of 2011, Japan is concentrating more on natural resources to produce energy. The outcome would end in a higher use of natural resources like fossil fuels and natural gas. Finding an optimum solution to address energy-economy interactions is, therefore, becoming complex and difficult. Under the circumstances, this paper attempts to study the growth of Toyohashi city over time and resultant increase in consumption level of electricity and gas. Another objective of the paper is to find features of effect of technological yield in use of energy. The results of the study show that manufacturing and trading sector of the economy are causing expansionary pressure on use of combustion energy. The study also finds that contribution of technology to reduce use of energy in production side of the economy yet a dormant factor. Hence, introduction of technology to ensure improved and efficient use of energy has been recommended by the findings of the paper. The limitation of the study can be described as the limitation in research sample and data influence on the results coming out from market orientation. Difference in technology and direction toward the energy use was not taken care of by the study too.

KEYWORDS:- Economic growth of city, energy use, Environmental Kuznets Curve, Toyohashi city.

I. INTRODUCTION

Faster urbanization and increasing economic activities in city areas are causing greater challenges to address better energy- technology -environmental management. Cities are emerging as the driving factor for economic activities and are supplying essential knowledge of production and innovation. The future cities are therefore a significant element of the global future. The typical structure, size and scope of city economic development are creating undesired impact on the protection of the natural resources. Therefore, understanding the relationship between city development and environmental collision is critical. Cities are the main user of world's energy. Since cities are vibrant and essential element of global development in terms of social, economic and technology, they need to offer their populations several services. Ensuring services need energy and, source of such energy is mainly based on fossil fuel. For example, Tokyo metropolitan area for her 12 million people consumes approximately 20Mtoe annually –which is equivalent to the total annual energy consumption of Bulgaria (IEE, Japan, 2008).

The relationship between energy consumption and economic growth has been described in several literatures. The general framework for determining the growth lies in the extended account of neoclassical approach represented by Dy= f(y, y*), where Dy: growth rate of per capita output, y: current level of per capita output, and y*: long run per capita output. The growth rate is diminishing for a possible output y and rising in y* for given y. Economic growth y* depends on choices of environmental and economic variables of the economy (Hwang, 2008). Nevertheless the directions of causation of the relationship remain controversial when relationship between natural environment and economic growth is taken into account. Other studies suggest that different orders of causality exist between GDP and energy consumption. Kahn (2007) found pollution as emergent byproduct of three factors in a city: (1) scale, (2) composition, and (3) technology. He advocates that in developing the concept of ''Green City'', establishing local and global level benchmark for air, water quality, and greenhouse gas emissions are necessary. Sansoni, et al. (2010) decomposed transform in the environmental pollution by city growth into three effects: (1) demand composition shift effects, (2) output growth effects, (3) eco-efficiency change effects. They imply that the first effect can be positive or negative in the sense that the continued use of natural environment are increased or reduced. The second effect is negative, because more output means generally increased use of the natural environment. The third effect is positive, owing to

technological progress. Overall ability of Japan's energy conversion (usually measured as the amount of primary energy used to generate a unit of GDP) was high before the first oil price crisis of 1973-74. During the early 1970s it took as much as twice energy to produce a dollar of GDP both in the US and in Japan. But by 1990 the US required about 30% less energy to produce a dollar of GDP than it did in 1974 and Japan had lowered the average energy to its economy by 35% (Zachariadis, 2007). Moreover, despite the appreciation of its currency, Japan was even more forward of the US in energy conservation than it had been before the first oil price crises of the early 1970s. After that an unexpected setback took place and between 1990 and 2005, the energy intensity of the US economy (inflation-adjusted) fell by 12%, but the energy intensity of the Japanese economy first stood still and then, by the year 2000, was actually about 6% above the 1990 level. By the year 2005 it was about 3% higher (Smil, 2007). Two factors can be recognized as the reasons for this reversal state: first, rising of demand for higher industrial energy and second, energy intensities of all major industries, after falling by 20-50% between 1973 and the late 1980s, had reached their lowest levels between 1988 and 1990, and had risen and became flat subsequently. By the year 2000, the energy intensity for the iron and steel industry, manufacturing, and ceramics were about 12%, 15%, and 17% above the 1989 level respectively (Roney, 2011).

II. STATE OF ENERGY USE IN JAPAN AND TOYOHASHI CITY

Japanese cities are experiencing rapid population growth causing graying of rural areas. Regional concentration of certain economic activities is contributing growth of certain regions. In the presence of shrinking population, declining 12.5 million by 2030 and 25 million by 2050, Japanese cities are growing in population. Data of Statistics Bureau, Japan, 2011, show that between 2005 and 2010 city population in Japan increased by 0.6% against national increase of by 0.2% leaving a decrease of 3% in the rural areas. Japanese success to achieve efficient use of industrial energy keeps the nation over any other developed country. Japanese manufacturers reduced energy consumption per unit of output by 40% between 1973 and 2003 (Agency for Natural Resources and Energy, 2005). France and Germany burn up nearly 50 %t more energy than Japan to produce equivalent level of economic output. By the same scale, Britain's energy use is nearly double, the United States nearly triple, and China's almost eight times of Japan's level. Japan also ranks near the bottom among developed countries in CO2 emission per capita and GDP ratio. In the OECD, only Sweden has lower CO2 emissions to GDP ratio than Japan (Agency for Natural Resources and Energy, 2008).

III. OBJECTIVE, RESEARCH QUESTION, AND METHODOLOGY OF THE STUDY:

The purpose of this paper is to find out the relationship between technological contribution on the energy using sectors of an economy and consequent effect on the level of energy use. The broad objective of the paper is to find the links between urban economic growth or the scale of economy and environmental sustainability. The broad purpose of this paper thereby is to:

1. Outline city economy- energy use pattern,
2. Investigate technological contribution on efficient use of energy, and
3. Design potential plan for future energy use.

The present study aims to focus on following research questions:

1. Which production sector of the economy play pivotal role in using energy?
2. What is the effect on the use of energy when city economy grows?
3. How could Toyohashi city manage city growth and energy use dilemma?

Multiple regression models have been considered for the purpose of research. The relationship among the variables has been considered as linear. The basic idea of model formation comes from Grossman and Krueger's (1995). Consumption of energy has been considered as a function of manufacturing output, trade volume and population of Toyohashi city. The study pursues following hypotheses:

Hypothesis 1: *With the growing concern of energy efficient production system, level of energy use in manufacturing and trading sector of a city in Japan is falling.*

IV. EMPIRICAL RESULTS AND DISCUSSION:

The model OLS regression analysis results are provided in **table 1**. The regression coefficients estimated from the panel data are statistically significant, as indicated by the *t*-statistics. The results of table 1 show that level of electricity and gas use can be explained by the growth of manufacturing and trade volume. The effect of EKC hypothesis has been confirmed squared coefficient of ln_M of equation (2). The squared coefficients of ln_T and ln_M of equation (3) and (5) do not confirm EKC hypothesis.

V. CONCLUSION

In the path of recovering and rebuilding from the disastrous earthquake and tsunami, Japan will have to decide whether to rely more heavily on inherently risky nuclear power and imported fossil fuels. Turning to renewable energy source instead of fossil fuels and nuclear power, would lead to healthier energy security, and economic well-being of its people (Roney, 2011). Our study suggests that even a city in Japan could play significant role in rearranging energy consumption level. Firstly, even the manufacturing and trading sectors of city grows, better innovation could contribute to improved energy input- output ratio. Since future direction of Japan's energy use remains fundamentally uncertain, our findings are suggestive. The inverse U-shape EKC of manufacturing output and electricity usage confirm that technological improvement is able to reduce use of energy usage and/or energy-output efficiency can be obtained by introducing better technology even economy continues to grow.

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