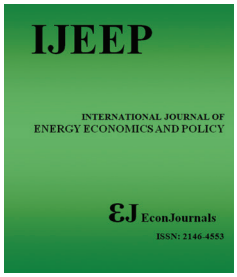


International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2017, 7(1), 156-165.

Is Environmental Kuznets Curve Still Relevant?

Abid Rashid Gill[1]*, Kuperan K. Viswanathan[2], Sallahuddin Hassan[3]

[1]Othman Yeop Abdullah Graduate School of Business, Universiti Utara Malaysia, Malaysia, [2]Othman Yeop Abdullah Graduate School of Business, Universiti Utara Malaysia, Malaysia, [3]School of Economic, Finance and Banking, Universiti Utara Malaysia, Malaysia. *Email: abid.rashid@iub.edu.pk

ABSTRACT

The main purpose of this study is to evaluate the relevancy of environmental Kuznets curve (EKC) hypothesis to the environment problem of today world. According to EKC hypothesis, continuous economic growth eventually reverses the environmental degradation created at the early stage of economic development. This hypothesis emerged in the 1990s and led many serious commentators of economic development to assume that developing countries should focus on economic growth and any environmental problem would be automatically solved by the process of economic growth. The necessary message of EKC was "grow now clean later." The empirical studies on EKC lead to the conclusion that EKC transition exists only for local pollutants. We found that EKC empirical literature is not econometrically sound and the relationship of many types of pollutants with income has not been tested yet due to the non-availability of data. We also conclude that EKC transition is not Pareto efficient and EKC growth strategy is resource intensive and has huge environmental cost that this planet may not be able to absorb in future. The key recommendations of the study are that developing world should follow different growth path than that of EKC. They should choose a growth path that is not detrimental to the environment so that stock of pollution created by advanced countries can be contained and advanced countries should make green technologies affordable to developing countries.

Keywords: Environment Degradation, Sustainable Development, Local and Global Pollutants, Green Technologies, Pareto Efficient
JEL Classifications: Q50, Q54, Q55, Q58

1. INTRODUCTION

Before the advent of environmental Kuznets curve (EKC), there was a debate on the limited ability of the earth to absorb industrial and urban wastes. But the EKC shifted the debate from the scarcity of natural resources to the necessity of economic growth to overcome the problem of environmental degradation. As a result, high economic growth became the main focus of all government policies of developing countries to fight against poverty and this high economic growth produced massive environmental cost in term of urban and industrial waste accumulation, deterioration of air and soil quality, water pollution, loss of biodiversity, climate changes and global warming and so on. Nowadays, this environmental degradation poses a serious threat to the survival of life on this planet.

The issue of environmental degradation got considerable attention in the 1960s and 1970s and two conflicting views emerged that time. National governments and global institutions believed that economic growth could provide the resources to tackle the problem of the environment while the environmentalist argued that fast industrial growth, was the root cause of deterioration of the environment. Meadows et al. (1972) with a team from Massachusetts Institute of Technology, constructed a world model to estimate the impact of exponential economic growth on the environment under certain assumptions. They produced a report for Club of Room with the title "The Limits to Growth." This report concluded that world economy would reach to its physical limits very soon and the future world would collapse due to significant dangerous environmental implications of economic growth. One year later to this report, first oil crisis occurred that led to the sense that world was entering into the period of scarcity of energy and natural resources.

The major criticism of this report came from Cole (1973) who criticized the assumptions of the model like static technology and

static preferences. Cole believed that economic growth would lead to technical progress, change in inputs and output composition that would relax the physical limits of economic growth. Some years later it was clear that world was not going to collapse as predicted by the Club of Room report.

In the beginning of 1980s, the attention turned from Limits to Growth to the notion of sustainable development. The sustainability of economic growth is a welfare process, developed as an evolution of first United Nation (UN) conference on the environment. Sustainability of economic growth refers to the growth process that meets the needs of present generation without compromising the needs of future generation. It refers to intergenerational balance for the use of the natural resources. Brundtland and Khalid (1987) brought this concept at the top of agenda of world institutions such as the UNs and the World Bank. The goals of sustainable development had been adopted by an ever-increasing number of organizations and bodies. But for the serious commentator of economics, pollution remained a consequence of market failures. They did not include the scarcity of natural resources in economic growth models as pointed out by Stern (2004). The main idea about the EKC emerged by the series of empirical studies about income and pollution relation in the early 1990s. Beckerman (1992) was the first who used to say that "too poor to be green" means to say that least developed countries have deficient resources for the protection of the environment and it is economic growth that can provide the resources to resolve the environmental problems. World Development Report[1] (1992) concluded that certain environmental problems aggravated by economic growth are linked with the deficiency of economic development. The report recommended that accelerated equitable income growth as a mean to realize more world output and an improved environment. This suggestion placed the basis of the so-called EKC literature, which appeared at the start of the 1990s. The first set of the empirical EKC studies appeared in Shafik and Bandyopadhyay (1992), Grossman and Krueger (1991).

Panayotou (1993) used the term EKC first time in the literature due to its resemblances to Kuznets hypothesis of income inequalities. He used cross-country data and found a strong link between certain indicators of pollution and per capita income as an inverted-U curve. Since from, EKC has developed to a basic notion to define the connection between environmental quality and economic growth. The basic thinking of the EKC-theory is reflected in Beckerman's assessment about the consequence of economic growth that there is "clear evidence that, economic growth usually leads to environmental deterioration in the early stages of development but in the end, the best and probably the only way to attain a decent environment in most countries is to become rich" (Beckerman, 1992).

According to the EKC hypothesis, further economic growth can improve environmental degradation after an economy has reached to an adequate level of economic growth. In the early stages of economic growth, when primary production dominates, there is an abundance of natural resource and a limited generation of wastes because of limited economic activity. In the course of development, through industrialization, there occurs a significant depletion of natural resources and wastes accumulation. During this phase, there is a positive relationship between economic growth and environmental degradation. With further economic growth, services expand, technology improves and information diffuse that limit the material basis of an economy and result is reduced environmental degradation (Panayotou, 1993) as shown in Figure 1.

According to the proponents of EKC, the proposition that "more economic activities would hurt environment conditions of a country" is based on the assumptions of static preference and static technology. If the EKC hypothesis was true, then rather than being a threat to the environment, as claimed by the environmental movement and associated scientists in the past like Meadows et al. (1972), economic growth would be a means to improve the environment.

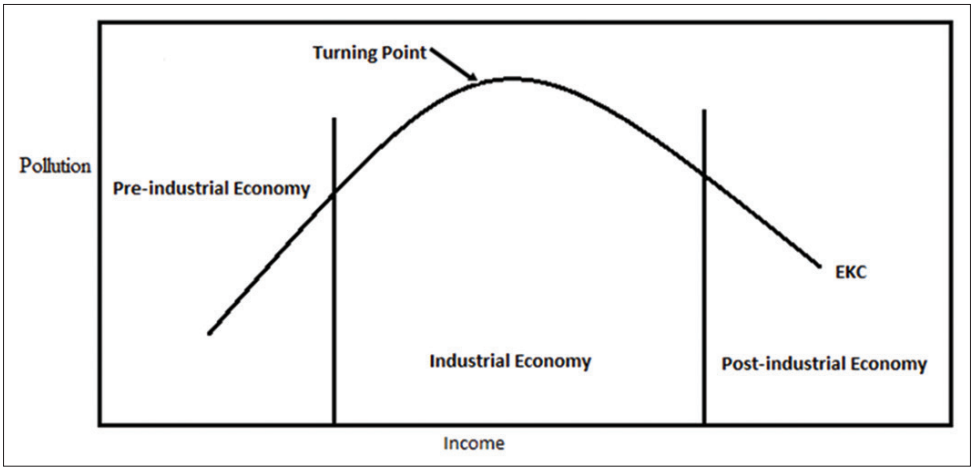
Webber and Allen (2004) claimed that EKC relationship had very important inferences that developing countries should peruse for fast economic growth instead of implementing pro-environment policies. Because, economic growth eventually leads to attain both environmental and economic goals, whereas pro-environment policies just slow down the economic growth. Therefore, the necessary message of the EKC relationship was that the priority of the developing countries should be economic growth, no matter how much its environment cost because as these countries become rich it would be possible for them to reverse the trend and to compensate the damages of economic growth.

EKC hypothesis brought a shift in the development policies of the developed and developing countries. It also affected the policies of world development institutions as they put more stress on pro-growth policies. Following the EKC growth trajectories "grow now clean latter" the world economies led the today world to the risk of global warming. According to Global Environment Outlook (2016), "The environmental change sweeping the world is occurring at a faster pace than previously thought, making it imperative that governments act now to reverse the damage to the planet. These worrying trends are also making it increasingly hard for the world to feed itself" and according to Martin (2016), "A new UNs report warns that pollution and global warming are causing millions of more deaths than conflicts. The UN's environment agency has called for an urgent roll-back on harmful substances and fossil fuels."

The fast economic growth of advanced and emerging economies has created a huge environmental cost that has put a question mark on the survival of this planet. Given this precarious situation of today world, there is an urgent need to critically evaluate "grow now clean latter" growth strategy recommended by the EKC hypothesis. The purpose of this paper is to critically evaluate the EKC literature and theory on the environmental problem of the world today. Specifically, the objectives are to assess the validity of the EKC hypothesis for environmental policies in developing countries.

1 The World Development Report 1992 of the World Bank as a part of the study for the relationship between growth and environment Shafik and Bandyopadhyay (1992).

Figure 1: Environmental Kuznets curve relationships between economic development and pollution



2. PROBLEMS WITH EKC

2.1. Different EKC for Different Pollutants

The empirical studies on EKC all over the world have used different estimation methods, different dataset, and different environment indicators and resulting in a broad spectrum of interpretations. The empirical studies on EKC have diverse results depending on the type of the pollutant. The EKC transition is found very true for the pollutants that have local and regional dimensions and can be reduced at the relatively low cost of economic growth (Ansuategi and Escapa, 2002; Dinda, 2004; Lieb, 2004). These are the pollutants that have a damaging impact on the environment of that area where they are being produced like sulphur dioxide (SO_2), carbon monoxide, nitrogen oxides (NOs), particulate matter, urban garbage and water pollution. The NOs and SO_2 have local as well as transboundary impacts and are the main cause of acid rain. Special separation is easy for local pollutants relative to the global pollutants. So as the income of the society increases the demand for quality environment increases and government have to respond by strengthening the environment laws and by investing in green technologies. According to Shafik and Bandyopadhyay (1992) "because of the greater local benefits of abatement, local pollutants tend to decline with income when countries reach the middle-income level, while global pollutants continue to increase."

Most of the studies like (De Bruyn, 1997; Stern, 2004; Deacon and Norman, 2006; Brajer et al., 2008; Fodha and Zaghdoud, 2010; Miah et al., 2010; Orubu and Omotor, 2011; Chiu, 2012; Alonzo and Puzon, 2013; Farhani et al., 2014; Shahbaz et al., 2015; Al-Mulali et al., 2015; Ben Jebli et al., 2016) found empirical support for the existence of EKC for local pollutants. Many developed countries have managed their urban and industrial wastes, water pollution and local air pollution as they entered to the advanced stages of economic development.

The global pollutants are taken attributed to worldwide warming. They are less detrimental to the environment of the area where they are being produced. Carbon dioxide, chlorofluorocarbons, and methane are the examples of global air pollutants. They deplete the ozone layer and causing world temperature to rise. Due to global nature of the impact of these pollutants, the local governments have little incentive to take measures to tackle theses pollutants. Moreover, the states can free-ride and benefit from the efforts of other nations to abate these pollutants.

Most of the studies like (Aslanidis and Iranzo, 2009; Cantore, 2010; He and Richard, 2010; Miah et al., 2010; Wagner, 2010; Naglis-Liepa, 2011; Zanin and Marra, 2012; Robalino-López et al., 2014; Tan et al., 2014; Ozturk and Al-Mulali, 2015) examined the existence of the EKC in case of green house gases (GHG) like CO_2 and made number of conclusions. The most of the empirical studies find that carbon emissions seem to increase at ever decreasing rates, and predicted peaks of the EKC in different countries and region are far outside reasonable income levels. As a global pollutant involving cross-border externalities, no country has sufficient incentive to regulate these emissions. Therefore, the empirical literature on EKC did not provide the answers to the most of the critical questions.

2.2. Data and Estimation Problems

The main argument against the EKC was that it demonstrates only for a subset of pollution indicators. For example, most of the EKC studies focus on air pollutants such as SOx, COx, NOx, and particulates. There are numerous empirical studies on EKC with different specifications and most of these studies rely on global environmental monitoring system (GEMS) for their data on pollution. GEMS is sponsored by UNs and it gathered data from developing and developed countries. GEMS has limited scope as it contains information on commonly regulated water and air pollutants like carbon monoxide, ozone, sulfur dioxide, suspended particulates, and NO and lead.

Secondly, the information about many pollutants is very rare even in developed countries. There are so many unregulated toxic pollutants causing disease, deaths and birth defects and theses toxic emissions are still untested. Although, advanced countries have started to gather data in this regard, but developing countries did not pay any attention to these dangerous toxic emissions. As a result, these untested unregulated toxins remained outside from the focus of the EKC studies.

Thirdly, almost all EKC studies used the pollution data till the 1970s. These studies cover the time period when advanced

countries have turned their EKC (Vincent, 1997). So any valid inference of the EKC based on these studies cannot be made. Finally, there are many environmental problems for which the empirical estimation is not possible due to lack of data. These environment issues are a loss of biodiversity, desertification, soil erosion, pollution of ground water and much more. Therefore, the EKC studies based on few limited pollutants may not be the true representative of pollution environment relation.

Similarly, the empirical literature on EKC is not econometrically sound. The main purpose of econometric analysis of EKC was to test the validity of the apparent relationship between economic growth and level of environmental pollution and to determine if the relationship is spurious but most of the empirical studies assume that if individually or jointly coefficients are significant then EKC proposition exist. Now, the empirical studies on the EKC include all type specification and data set like time series, cross-sectional and panel. These studies also include models with parametric, semi-parametric and non-parametric specifications and the empirical results of these EKC studies are very sensitive to the assumptions, specifications, and functional forms. It is also observed that very little attention has been paid to omit variable bias and to model adequacy. The methodology and econometric techniques of the EKC studies are also in question and highly criticized by Müller-Fürstenberger and Wagner (2007) and Aslanidis (2009). Similarly, the outcome of EKC studies is also very sensitive to the inclusion of higher order polynomial term of income per capita.

2.3. Consumption Side Issues

According to Kaika and Zervas (2011), the EKC emphasized on the production side activities of economic growth and ignored the growth of consumption. The EKC analysis focused on only domestic production, it did not consider the effect of imported goods on pollution (Dinda, 2004). Similarly, the EKC studies did not focus on the income elasticity of demand for pollution-intensive goods. If this demand does not decrease with the process of economic growth, then the aggregate demand well be met by the imported goods from developing countries (Cole, 2004). Therefore, any improvement in environment quality by technological advancement or by structural changes from production side will be offset if final consumption remains pollution intensive and consequently, the whole effect may be greater environmental degradation. Wagner (2010) pointed out that, despite the significant technological progress, the advanced countries still have unmaintainable consumption patterns as evinced by the constant growth of urban wastes and of GHGs. It seems that people in advanced countries did not change their preference and kept on consuming pollution-intensive goods and services. Different studies showing N shape relation between income and pollution for advanced countries that indicate that at higher income level again rise in mass consumption and pollution.

Martinez-Alier (1995) also criticized the assumption of the EKC that rich people are more careful of the environment than the poor. According to Turner and Hanley (2011) and Sorrell (2015), after reaching to high-income level, pollution again starts to rise gradually due to augmented demand for electronics and luxuries that may lead to a cubic form of the EKC.

It is also argued that social and environmental changes occur at a different rate. The shift in the preference of people and change in social customs is a slow adaptive process. It may fall behind the fast rate of environment degradation. This discrepancy between these two changes is contrary to the EKC transition.

2.4. Different Growth History

According to the EKC proposition, developing countries are on the rising part of the EKC (early stage of economic development) and developed countries are in the falling part of the EKC (advanced stage of economic development). Panayotou (2000) noted that developing countries are at that stage of economic development, where Japan was 50 years ago, USA was 100 years ago and the UK was 150 years ago. Income growth in these advanced countries also led to rapid growth of pollution but, this does not imply that developing countries would also be able to follow the same growth path of advanced countries. Grimes and Roberts (1997) stated that the EKC patterns of growth were valid only for advanced countries before the oil crises of the 1970s. These advanced countries had a colonial history and geopolitical powers to exploit the resources and markets of their colonies and these growth conditions are not available to the developing world of today.

It is also specified that advanced countries have shifted their pollution-intensive production process to developing countries and have become cleaner. As a result, total pollution of the world has not decreased rather have been relocated. This phenomenon is known as pollution haven hypothesis. Stern (2004) also had the same type of concerns that in our limited world, current developing countries would not be able in future to find more countries to transfer their polluting industries as developed countries did.

Cole (2004) also pointed out that current developing countries may not face same domestic and international conditions for growth as developed countries of today had faced. Nahman and Antrobus (2005) also highlighted that development pattern of EKC might not be available to the present underdeveloped countries. Given the growth conditions of today world, developing countries will have to face a difficult task to reduce the production of their pollution-intensive goods. There is no guarantee or a rule that the EKC growth path of developed countries of today can be repeated or be followed by current developing countries in the future.

2.5. Income Inequality

Several studies such as (Panayotou, 2000; Dinda, 2004; Lieb, 2004) pointed out that most of the empirical studies on the EKC using either cross-sectional or panel data, tried to assess a turning point of the EKC for average income level of the countries by assuming that that world income was normally distributed. But, world income is highly skewed with a greater number of people living below the world average income. As Milanovic (2002) by using household surveys, found that world income is highly skewed. And according to Roser (2015), "Before the second world war, up to 18% of all income received by Americans went to the richest 1%. Since then, the share of the top 1% first dropped substantially and then – starting in the early 80s –increased again and in the US it returned to the level of the pre-war period. This means that inequality, as measured by top income shares, fell and

then rose again. In fact, the development in other English-speaking countries same pattern."

The serious consequence of using average income is that the estimated turning point of the studies on EKC, beyond which environment may start to improve is not an achievable income level for the representative economic agent. Therefore, the estimation of the turning point income level of the EKC is meaningless if the major part of the population of a country is well below the average income.

Irrespective of the course of change in worldwide income, the distribution of world income within countries, regions and across the globe still remained highly skewed. Therefore, the use of average income, in empirical studies of the EKC hypothesis is cynical when a major part of the world population is well below the world average income.

2.6. Pollution is Irreversible

Dasgupta et al. (2002) argued that EKC may work for only traditional pollutants (e.g., SOx), it does not apply to newer pollutants (e.g., carcinogenic chemicals) which remain unregulated almost everywhere other than industrialized countries. From the geohistorical analysis of a brownfield from the city of Worcester (Massachusetts, USA), Sinha (2010) challenged the EKC assumption that environment impacts of industrialization disappear at a later stage of economic development. He maintained that environmental impacts of industrial pollution are complicated, long-term and very costly to remedy, and probably impossible to reverse.

The proponents of EKC continuously propagated that environmental degradation and limitations on natural resources can easily be solved by the use of better technologies, institutional arrangements like an open market, and investment in environment protection. But Sinha stated the case of the USA where the relocation of polluting industries to other parts of the world has led to some visible reduction in air and water pollution yet the economic prosperity has not been successful in removing or reversing some of the most serious environmental impacts of industrial activities. He referred that in USA state governments, local municipalities have spent several billion dollars on brownfield but still there exist more than one million polluted properties in the soil. He further submitted that EKC proponents have shaped their views on the basis of limited knowledge of pollution and have ignored the groundwater, soil and surface and other toxic pollutants. According to him, it will require a huge amount of money and the long span of time to reverse these environment losses.

Gallagher and Thacker (2008) also pointed out the same that most developing countries were imitating the "grow now, clean up later" strategy invigorated by EKC literature and exponents of EKC had formed their conclusion on the basis of very limited knowledge of environmental degrading and economic development. They claimed that pollution intensive industrialization in developing countries would generate pollution in soil, surface and groundwater, and irreparable loss of environmental services and it would take large sums of money and decades to repair these losses that developing countries might not be able to afford. The EKC studies focused on only selected air and water pollutants and ignored the several toxic and carcinogenic compounds that originate from industrial activities. These pollutants are still found in brownfield of advanced countries and are almost irreparable. It requires a large sum of money and decades to eradicate these pollutants.

3. EKC GROWTH PATH AND PARETO EFFICIENCY

The growth strategy (grow now clean latter) that developed and developing nations are perusing nowadays, is highly resources intensive and highly capital intensive and is not Pareto efficient. Pareto efficiency is a state where resource are optimally allocated in such a way that ensure best possible output and then the output is distributed in such way that best maximum utility is being achieved. It is a state where resources are efficiently allocated and output is efficiently distributed. But according to IEA (2015), the following countries produce carbon emission per person with the following details: The USA 16.5 tons, the European Union (6.7), China (5), Japan (10.1), Canada (15.9), Australia (17.3) and South Korea (12.3). These advanced countries of the today have the huge environmental cost of the economic growth that this planet may not be able to absorb in future. These nations are filling the entire air space with carbon and developing the world and future generation may not find space to grow in future.

It is also true that a very small portion of the world is using a highly disproportionate share of the world environment resources. First pollute then clean with efficient and costly technologies and due to mass consumption at higher income level, again increase in the different type of pollution, 'therefore' these growth models always keep behind the environment problems. The developing countries following these growth models have huge toxic fallouts.

Their rivers are dying with chemicals and their cities have very bad air quality having very dangerous repercussions for human health. The abatement technologies are not affordable for them at early stages of economic development. According to OECD (2014), the impact of pollution on health including premature death in OECD countries and in India and China is $ 3.5 trillion per year and in some countries like China, this cost is more than 10% of the gross domestic product (GDP). Rohde and Muller (2015) showed that a particular matter (PM2.5) in China is responsible for 1.6 million annual premature deaths and in India the problem is, even more, worse them China. Fossil (coal, oil, gas) is still the cheapest source of energy for the advanced countries that is the most toxic and alone responsible for two third pollution of the world. According to IEA (2015), Coal/peat contributes (41.3%), natural gas (21.7%) and oil (4.4%) to world energy production. Among the fossil fuel, coal is the most polluted and toxic source of energy generation. Fossil fuel is cheapest because of heavy indirect subsidies. But if we take into account climate effect, and loss of live and livelihood of fossil fuel then it would not be that cheaper. The heavy dependence on fossil fuel results in GDP growth, energy consumption, and CO_2 emission strongly

correlated. So the current mods of development in developed and emerging economies are fundamentally unsustainable and cannot be termed as an efficient growth model.

Although clean energies are being developed in advanced and developing countries but their scale is still limited to meet the large scale demand of energy. At the moment, more than of the world's population is living in those countries where consumption is rising rapidly. More than three billion peoples are moving up the food chain and have started to use more materials. The result is the skyrocketing in the demand of environment resources and technological advances. Environment efficiency is low in emerging economies so it is possible that when these countries would grow, world efficiency would go dawn because less efficient economies would grow faster.

Similarly, rich people use more resources, so more rich people we have environmental resources will be used and given the fixed quantity of environment resources we are moving to limits to growth. So it would be a zero sum gain some people are getting rich at the cost of others. The efforts to tackle the problem of the environment also have unwanted side effect as if you save energy and spend this saved money on something else then the embodied energy of the product you purchased partly offset the initial energy savings. Renewable energy helps to reduce the carbon emission but increase the demand for metals.

There is also inertia in the social system, as the change in the habits of individuals to become environment-friendly and to overcome the influence of vested interests in the course of economic development is extremely difficult. It is not as an easy transition as recommended by EKC hypothesis. There is a lot of loss of environmental resources before the process of environmental degradation reverse automatically by economic growth. Therefore, it can be asserted that EKC growth path is not best available efficient growth path.

4. TECHNOLOGICAL GROWTH VERSUS ENVIRONMENTAL CHANGE

The basic message of EKC is that changes in technology and in preference as a result of economic growth would lead to environment improvement in the later stages of economic development. Now the basic question arises whether these changes are enough to reverse the fast environmental degradation of today resulting from fast economic growth. There is no measure to quantify these changes. Some recent environmental and technological changes around the globe are cited here to provide the example.

According to Neslen (2015), "Europe will likely get more than half of its electricity from renewable sources by the end of the next decade." Arthur (2015) reported that "On unusually windy days, Denmark found itself producing 116% of its national electricity needs from wind turbines." Mace (2015) reported that "The Scottish Government has granted consent for the world's largest floating offshore wind farm to be developed off the coast of Peterhead." According to Moylan (2015), "UK's remaining coal-fired power stations will be shut by 2025 with their use restricted by 2023." According to Gonzalez (2016), "Carbon emissions apparently had stopped increasing last year as the world chose renewable and sustainable energy. In 2015, solar capacity grew by 32.6% while wind power by 17.4%. Additionally, the UK's renewable energy capacity grew by 4.8%, while Germany had 10.9%, and the US by 19.7%."

At the movement, Europe is the third largest emitter of CO_2 emission. So the development of clean energy in these countries has very significant implication for the global warming and environmental changes.

According to Borgmann (2016), "The Emirate of Dubai set a new world record for the cost of solar power. It is as low as 3.00 US cents per kWh. This beats all available fossil-fuel options in Dubai on cost." Farmer and Lafond (2016) reported that "Since the 1980s, panels to generate electricity from the sunshine have got 10% cheaper each year. That is likely to continue, the study said, putting solar on course to meet 20% of global energy needs by 2027."

Due to costly technologies of the solar, it has not been affordable for developing economies. So it is a very significant technological improvement in term of the cost that will make cleaner technologies affordable in future.

According to Parke (2016), "Morocco has switched to world's largest concentrated solar power plant. It could produce enough energy to power over one million homes by 2018 and reduce carbon emissions by an estimated 760,000 tons per year" Amin (2016) reported that "The UAE is building one of the world's largest solar photovoltaic plants. Additional projects are in the works in Egypt, Jordan, and Saudi Arabia." Davidson et al. (2016) reported that "China is on track to generate more than a quarter of its electricity from wind power by 2030 and The Japanese electronics multinational Kyocera has begun work on world's biggest floating solar farm."

According to World Bank (2016), energy sector contributes 40% of world GHG emission and 75% of this emission come from six major economies and according to TSP (2014), 67% energy is being produced by fossil fuels. So the development of these clean energies by renewable sources will have a significant impact on curtailing global warming and environmental changes.

According to Pilita (2015), World's largest steel company of Belgium planning to spend €87 m to use a microbe originally found in a rabbit's gut to turn a waste gas that contributes to global warming into fuel. Factories using Lanza Tech's technology are also being built in China and Taiwan. Chan (2016) reported that "Researchers in Iceland found a new way of tackling climate change by pumping carbon dioxide underground and turning it into stone. Other carbon capture and storage methods store CO_2 as a gas, but problems include a high cost and concern about leakage. This new method of burying CO_2 and turning it into stone is cheaper and more secure". McGrath (2016) reported that

"Researchers say they have found the first clear evidence that the thinning in the ozone layer above Antarctica is starting to heal. The scientists said that in September 2015 the hole was around 4 million so km smaller than it was in the year 2000. The gains have been credited to the long-term phasing out of ozone-destroying chemicals."

According to Stern (2015), the half of world pollution is living in cities and they produce 75% of world pollution. If cities are managed with efficient governance it would have a far-reaching effect on environment improvement. According to Nicholas (2015), "In many European cities, recycling levels are in the region of 50% of domestic waste, Copenhagen sending a mere 3% of its waste to landfills, Stockholm reduced emissions by 35% from 1993 to 2010, Copenhagen has reduced its carbon emissions by more than 40%, New York aims to cut its annual GHG emissions by 30% over the period between 2007 and 2030; Los Angeles plans 35% cuts in emissions between 1990 and 2030; Seoul plans 40% cuts from 1990 to 2030; and Hong Kong plans 50-60% cuts over the period from 2005 to 2020."

Greenblatt and Saxena (2015) reported that "Self-driving electric taxis could reduce GHG emissions from conventional car travel in the US by 94% in 2030, according to a study by Lawrence Berkeley National Laboratory. These future "robocars" would be battery-powered and driven without human intervention, picking up and dropping off passengers using automated technologies. GHG reductions would be made by running the vehicles from the electricity grid, which by 2030 will use a greater proportion of renewable power. In addition, human drivers are responsible for between 20% and 30% of inefficiencies in vehicles, so the shift to autonomy has the ability to use the car in a very efficient manner. On average, 62% of vehicle miles traveled in the US are for a single person, often traveling in a much larger five-seater car. To overcome this inefficiency, the researchers suggest future autonomous vehicles will include smaller cars designed for just one, or two people, as well as larger vehicles."

After energy, the transport sector is considered most pollution generating sector. So the improvement in the mode of transport, transport technologies would also have a far-reaching effect on the environment.

King (2016) reported that Canada, France, Germany, Italy, Japan, the US and the UK committed to eliminate inefficient subsidies on fossil by 20,025. According to International Monetary Fund, 5.3 trillion US$ indirect and direct annual subsidies are being given to fossil fuels worldwide. This amount is more than the total health spending of world government. If this amount is redirected it would be a game changer in favor of clean energies. So if major economies who are the main user of fossil tax the fossil fuel to internalize its externalities and redirect this amount to clean energies it would be a game changer.

Considering that fossil fuels are alone responsible for 70% of the pollution in the world, an international network of campaigns and campaigners working toward freeing communities from fossil fuels launched a campaign to convince the investors to divest their funds from fossil fuel. According to Fossil-Free (2016), different economic agent around the globe have pledged to divest 3.4 trillion US$ from fossil fuel. These groups include faith-based (27%) foundations (23%) government organizations (14%) college universities and schools (14%) pension funds (13%) NGOs (6%) for profit corporations (3%) health (1%). According to Fossil-Free (2016), divestment campaigns have been successful to curtail tobacco advertising, targeting violence in Darfur and others. It had been most impactful on the issue of Apartheid Government of South Africa. So they are hopeful that their campaign would significantly reduce investment in fossil fuel that is the single most important determinant of pollution.

4.1. Environmental Changes

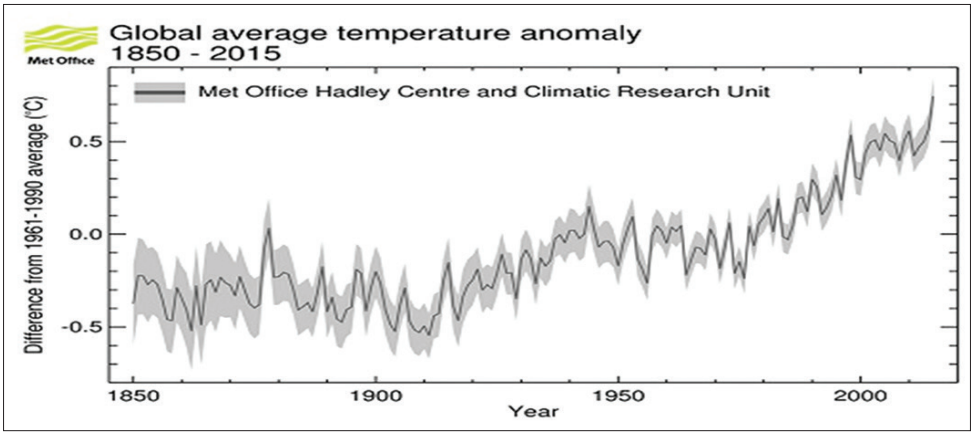
Environmental changes are also taking place at a very fast pace as Milman (2016) reported that "ocean water has absorbed more than 90% of the excess heat and nearly 30% of the carbon dioxide generated by human consumption of fossil fuels" so the oceans are getting warmer at an accelerating rate having serious implications for human and sea life. According to Davis (2016), oceans are warming and becoming acidic. As result of fast economic growth, we are pumping more and more CO_2 into the atmosphere and throwing plastic into the oceans. Today life is dominated by the use of packaging for food, and we are addicted to plastic. If the current trend of consumption and producing ocean trash continues then in the near future this ocean trash will outweigh all types of seafood.

According to Met-Office (2016), "2015 was the warmest year in a record dating back to 1850. Experts from Met Office Hadley Centre and the University of East Anglia's Climatic Research Unit produce the HadCRUT4 warned that global warming is sloping climate into 'uncharted territory.' Met Office and NASA data confirmed that the year 2015 smashed the record for the hottest year since reporting began in 1850" as shown in Figure 2.

According to Milman (2016), data from 2002 to 2014 shows that the seas are expanding about 1.4 mm a year and as a result severe storm can surges. Carrington (2016) warned that unprecedented temperature levels mean more heat waves, more flooding, wildfires and more hurricanes. The climate scientists are warning that climate change has reached at unprecedented levels and is no longer a serious threat for the future. Alongside the soaring temperatures, other records have tumbled around the world, from vanishing Arctic sea ice to a searing drought in India and the vast bleaching of the Great Barrier Reef. Sample (2016) noted that air pollution has become a major contributor to the stroke for the first time and it has severely harmed lungs, heart, and brain of the human beings worldwide. According to Slezak (2016), emissions of reactive nitrogen have increased more than 10-fold over the past 150 years, contributing to deaths from air and water pollution and have countless other impacts including acid rain and degradation of ecosystems such as the Great Barrier Reef.

So, on one hand, important technological changes are taking place in advanced countries in all spheres of life and according to EKC these changes would reverse the process of environmental degradation. But on the other hand global warming, environmental

Figure 2: Global average temperature anomaly



changes are also taking place at an alarming rate. We have cited some of these technological and environmental changes.

5. CONCLUSION

The proponents of EKC have blind faith in technology and efficiency. They believe that as nations get richer, they will cut more emissions. But how much technology growth is needed to meet the safe limit of carbon emission; it is the burning question of today. The EKC proponents believed that technological growth will relax the assumption of fixed supply of the resources. But the target of COP21 (2015) to prevent global temperatures from rising 2°C above pre-industrial levels, again put a limit on world economies for growth. Given the dependence of world economies on fossil fuel, the world would have to sacrifice economic growth to cut the carbon emission. At the moment the rich countries have added so much stock of carbon in the atmosphere, that they have borrowed from the future and if the current rate of emission continues then no space will be left for developing the world to grow in near future. To limit the global temperature to rise below 2°C which may not be enough to avoid extraordinary losses according to leading ecologist, the decarbonization of the world economies would have to be faster in next decades.

The EKC growth strategy that "grow first with the excessive use of resources and clean latter with costly technologies" is no more relevant today. We need a different kind of development that is more inclusive. The most of the poor live on environment resources so if we destroy these resources, how we can increase their wellbeing. So the challenge is not environment versus development as the EKC suggests, rather it is the environmental improvement that can be stated as an economic development. Clean soil and clean water and clean air are the fundamental human rights. The poor and less developed countries are not solely responsible for the environmental degradation and climate changes but they are the most victimized of these. Therefore, there is a need for a new development strategy based on environmental justice.

We need the growth models that produce more resources, more knowledge, more airways, better transport, better electric appliance, better food production, green technologies, and more trees with same resources and with less toxic pollutants. We are not recommending to stop the growth because if we stop growth we will lose all these technological advancements, we are suggesting to grow differently. We need a development model that reduces poverty without reducing forests, polluting air, and water and without damaging the sustainability of agriculture. Developing countries need a different model of mobility and energy generation than that of the developed world. A global mechanism is also required that pays the differences between fossil energy and renewable energy by taxing fossil and subsidizing renewable.

Developing countries cannot follow "first pollute clean later" as recommended by the EKC hypothesis. Now science is more certain about climate changes. The world needs drastic changes in the way we grow food, the way we produce energy, the way we are building our cities, buildings, roads and our transport systems. We need an economy that is not led by mindless consumption but on the actual wellbeing of the people. It is tougher, more challenging, it requires extraordinary courage, knowledge; it requires to make the people understand the crisis, the imperatives and the possibilities.

REFERENCES

Al-Mulali, U., Tang, C.F., Ozturk, I. (2015), Estimating the environment Kuznets curve hypothesis: Evidence from Latin America and the Caribbean countries. Renewable and Sustainable Energy Review, 50, 918-924.

Alonzo, R.P., Puzon, K.M. (2013), Environmental quality, economic development, and political institutions in East Asia: A survey of issues. DLSU Business and Economics Review, 22(2), 15-36.

Amin, A.Z. (2016), Renewables are changing the climate narrative from sacrifice to opportunity. Available from: https://www.theguardian.com/environment/2015/nov/19/renewables-are-changing-the-climate-narrative-from-sacrifice-to-opportunity.

Ansuategi, A., Escapa, M. (2002), Economic growth and greenhouse gas emissions. Ecological Economics, 40(1), 23-37.

Arthur, N. (2015), Wind power generates 140% of denmark's electricity demand. Available from: http://www.theguardian.com/environment/2015/jul/10/denmark-wind-windfarm-power-exceed-electricity-demand.

Aslanidis, N. (2009), Environmental Kuznets Curves for Carbon Emissions: A Critical Survey.

Aslanidis, N., Iranzo, S. (2009), Environment and development: Is there a Kuznets curve for CO2 emissions? Applied Economics, 41(6), 803-810.

Bank, W. (2016), Understanding CO2 emissions from the global energy sector. Available from: http://www.documents.worldbank.org/curated/en/873091468155720710/Understanding-CO2-emissions-from-the-global-energy-sector;jsessionid=nebZgYTCmuow5C2KQg-TUfNi.

Beckerman, W. (1992), Economic growth and the environment: Whose growth? Whose environment? World Development, 20(4), 481-496.

Ben Jebli, M., Youssef, S.B., Ozturk, I. (2016), Testing environmental Kuznets curve hypothesis: The role of renewable and non-renewable energy consumption and trade in OECD countries. Ecological Indicators, 60, 824-831.

Borgmann, D.M. (2016), Dubai Shatters all Records for Cost of Solar with Earth's Largest Solar Power Plant.

Brajer, V., Mead, R.W., Xiao, F. (2008), Health benefits of tunneling through the Chinese environmental Kuznets curve (EKC), Ecological Economics, 66(4), 674-686.

Breakdown of Electricity Generation by Energy Source. (2014). Available from: http://www.tsp-data-portal.org/Breakdown-of-Electricity-Generation-by-Energy-Source#tspQvChart.

Brundtland, G.H., Khalid, M. (1987), Our Common Future, Brundtland Commission (WCED) Report. Oxford, UK: Oxford University Press.

Cantore, N. (2010), Social preferences and environmental Kuznets curve in climate change integrated assessment modeling. International Journal of Global Environmental Issues, 10(1), 123-142.

Carrington, D. (2016), Shattered records show climate change is an emergency today, scientists warn. Available from: https://www.theguardian.com/environment/2016/jun/17/shattered-records-climate-change-emergency-today-scientists-warn.

Chan, R. (2016), Researchers Turn CO2 Into Stone in Climate Change Breakthrough.

Chiu, Y.B. (2012), Deforestation and the environmental Kuznets curve in developing countries: A panel smooth transition regression approach. Canadian Journal of Agricultural Economics/Revue Canadienne Agroeconomic, 60(2), 177-194.

Cole, M.A. (2004), Trade, the pollution haven hypothesis and the environmental Kuznets curve: Examining the linkages. Ecological Economics, 48(1), 71-81.

Cole, H.S.D. (1973), Thinking about the Future: A Critique of the Limits to Growth: Chatto & Windus.

COP21. (2015), Paris Agreement: Points that Remain in Suspense. Available from: http://www.cop21.gouv.fr/en/parisagreement-points-that-remain-in-suspense/.

Dasgupta, S., Laplante, B., Wang, H., Wheeler, D. (2002), Confronting the environmental Kuznets curve. The Journal of Economic Perspectives, 16(1), 147-168.

Davidson, M.R., Zhang, D., Xiong, W., Zhang, X., Karplus, V.J. (2016), Modeling the potential for wind energy integration on China's coal-heavy electricity grid. Nature Energy, 1(7), 16086

Davis, J. (2016), Plastic In Oceans Will Outweigh Fish By 2050.

De Bruyn, S.M. (1997), Explaining the environmental Kuznets curve: Structural change and international agreements in reducing sulphur emissions. Environment and Development Economics, 2(04), 485-503.

Deacon, R.T., Norman, C.S. (2006), Does the environmental Kuznets curve describe how individual countries behave? Land Economics, 82(2), 291-315.

Dinda, S. (2004), Environmental Kuznets curve hypothesis: A survey. Ecological Economics, 49(4), 431-455.

Farhani, S., Mrizak, S., Chaibi, A., Rault, C. (2014), The environmental Kuznets curve and sustainability: A panel data analysis. Energy Policy, 71, 189-198.

Farmer, J.D., Lafond, F. (2016), How predictable is technological progress? Research Policy, 45(3), 647-665. Available from: http://www.dx.doi.org/10.1016/j.respol.2015.11.001.

Fodha, M., Zaghdoud, O. (2010), Economic growth and pollutant emissions in Tunisia: An empirical analysis of the environmental Kuznets curve. Energy Policy, 38(2), 1150-1156.

Fossil-Free. (2016). Available from: http://www.gofossilfree.org/commitments/.

Gallagher, K.P., Thacker, S.C. (2008), Democracy, income, and environmental quality.

Global Environmental Outlook . (2016), Global environmental outlook 6: Regional reports detail New Threats. Retrieved April 05, 2016, from http://unfoundationblog.org/global-environmental-outlook-6-regional-reports-detail-new-threats/[4].

Gonzalez, J. (2016), Oil Giant BP: World Carbon Emissions Stopped Growing Last Year. Available from: http://www.natureworldnews.com/articles/24254/20160626/oil-giant-bp-world-carbon-emissions-stopped-growing-last-year.htm.

Greenblatt, J.B., Saxena, S. (2015), Autonomous taxis could greatly reduce greenhouse-gas emissions of US light-duty vehicles. Nature Climate Change, 5(9), 860-863.

Grimes, P.E., Roberts, J. (1997), Carbon intensity and economic development 1962-1991: A brief exploration of the environmental Kuznets curve. World Development, 25(2), 191-198.

Grossman, G.M., Krueger, A.B. (1991), Environmental Impacts of a North American Free Trade Agreement: National Bureau of Economic Research.

He, J., Richard, P. (2010), Environmental Kuznets curve for CO2 in Canada. Ecological Economics, 69(5), 1083-1093.

IEA. (2015), World Energy Outlook 2015.

Kaika, D., Zervas, E. (2011), Searching for an environmental Kuznets curve (EKC)-pattern for CO2 emissions. Recent Researches in Energy, Environment and Landscape Architecture (LA'II), 19-24.

King, E. (2016), G7 Leaders Set 2025 Deadline to Scrap Fossil Fuel Subsidies.

Lieb, C.M. (2004), The environmental Kuznets curve and flow versus stock pollution: The neglect of future damages. Environmental and Resource Economics, 29(4), 483-506.

Mace, M. (2015), Scotland set for world's largest floating offshore wind farm. Available from: http://www.edie.net/news/6/World-s-largest-floating-offshore-wind-farm-set-for-Scotland/.

Martin, N. (2016), United Nations Report.

Martinez-Alier, J. (1995), The environment as a luxury good or "too poor to be green"? Ecological Economics, 13(1), 1-10.

McGrath, M. (2016), Healing Detected in Antarctic Ozone Hole.

Meadows, D.H., Meadows, D.L., Randers, J., Behrens, W.W. (1972), The Limits to Growth. New York: Universe Books. p102.

Met-Office. (2015), The warmest year on record, say scientists. From http://www.metoffice.gov.uk/news/releases/archive/2016/2015-global-temperature[3]. [Last accessed on 2016 January 21].

Miah, M.D., Masum, M.F.H., Koike, M. (2010), Global observation of EKC hypothesis for CO2, SO x and NO x emission: A policy understanding for climate change mitigation in Bangladesh. Energy Policy, 38(8), 4643-4651.

Milman, O. (2016), World's Oceans Warming at an Increasingly Faster Rate, a New Study Finds.

Milman, O. (2015), Rate of environmental degradation puts life on Earth at risk, say scientists. Retrieved March 12`, 2016, from: https://www.theguardian.com/environment/2015/jan/15/rate-of-environmental-degradation-puts-life-on-earth-at-risk-say-scientists.

Milanovic, B. (2002), True world income distribution, 1988 and 1993: First calculation based on household surveys alone. The economic journal, 112(476), 51-92.

Moylan, J. (2015), UK's coal Plants to be Phased out within 10 Years. BBC News. Retrieved from http://www.bbc.com/news/

business-34851718.
Müller-Fürstenberger, G., Wagner, M. (2007), Exploring the environmental Kuznets hypothesis: Theoretical and econometric problems. Ecological Economics, 62(3), 648-660.
Naglis-Liepa, K. (2011), The environmental Kuznets curve hypothesis as theoretical approach in renewable energy promotion in Latvia. Management Theory and Studies for Rural Business and Infrastructure Development, 27(3), 140-147.
Nahman, A., Antrobus, G. (2005), The environmental Kuznets curve: A literature survey. South African Journal of Economics, 73(1), 105-120.
Neslen, A. (2015), Wind Power Generates 140% of Denmark's Electricity Demand, The Guardian. Available from: http://www.theguardian.com/environment/2015/jul/10/denmark-wind-windfarm-power-exceed-electricity-demand.
Nicholas, D.Z.A. (2015), Climate change and cities: A prime source of problems, yet the key to a solution. Available from: https://www.theguardian.com/cities/2015/nov/17/cities-climate-change-problems-solution.
OECD. (2014), The Cost of Air Pollution. Paris: OECD Publishing.
Orubu, C.O., Omotor, D.G. (2011), Environmental quality and economic growth: Searching for environmental Kuznets curves for air and water pollutants in Africa. Energy Policy, 39(7), 4178-4188.
Ozturk, I., Al-Mulali, U. (2015) Investigating the validity of the environmental Kuznets curve hypothesis in Cambodia. Ecological Indicators, 57, 324-330.
Panayotou, T. (1993), Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development. Geneva: International Labour Organization.
Panayotou, T. (2000), Globalization and Environment. Cambridge, MA: Center for International Development at Harvard University.
Parke, P. (2016), World's largest concentrated solar plant switches on in the Sahara. Available from: http://www.edition.cnn.com/2016/02/08/africa/ouarzazate-morocco-solar-plant/.
Pilita, C. (2015), Microbes from rabbit gut help turn waste to fuel. Available from: http://www.ft.com/cms/s/0/788d87ec-273b-11e5-bd83-71cb60e8f08c.html#axzz3uz9Lylgn.
Robalino-López, A., García-Ramos, J.E., Golpe, A.A., Mena-Nieto, Á. (2014), System dynamics modeling and the environmental Kuznets curve in Ecuador (1980-2025). Energy Policy, 67, 923-931.
Rohde, R.A., Muller, R.A. (2015), Air pollution in China: Mapping of concentrations and sources. PLoS One, 10(8), e0135749.
Roser, M. (2015), Democratisation. Our World In Data. org. Available from: http://www.ourworldindata.org/data/political-regimes/democratization. [Last accessed on 2016 Mar 23].
Sample, I. (2016), Air Pollution Now a Major Contributor to Stroke, Global Study Finds.
Shafik, N., Bandyopadhyay, S. (1992), Economic Growth and Environmental Quality: Time-Series and Cross-Country Evidence. Vol. 904. Washington, DC: World Bank Publications.
Shahbaz, M., Dube, S., Ozturk, I., Jalil, A. (2015), Testing the environmental Kuznets curve hypothesis in Portugal. International Journal of Energy Economics and Policy, 5(2), 475-481.
Sinha, D.R. (2010), The environmental Kuznets curve hypothesis and legacy pollution: A Geohistorical Analysis of the Environmental Consequences of Industrialization in Worcester, Massachusetts. The Industrial Geographer, 7(1), 1-18.
Slezak, M. (2016), The Study Reveals Your Nitrogen Footprint - And Who It Is Impacting.
Sorrell, S. (2015), Reducing energy demand: A review of issues, challenges and approaches. Renewable and Sustainable Energy Reviews, 47, 74-82.
Stern, D.I. (2004), The rise and fall of the environmental Kuznets curve. World Development, 32(8), 1419-1439.
Stern, D.Z.A. (2015), Climate Change and Cities: A Prime Source of Problems, Yet the Key to a Solution.
Tan, F., Lean, H.H., Khan, H. (2014), Growth and environmental quality in Singapore: Is there any trade-off? Ecological Indicators, 47, 149-155.
Turner, K., Hanley, N. (2011), Energy efficiency, rebound effects and the environmental Kuznets curve. Energy Economics, 33(5), 709-720.
Vincent, J.R. (1997), Testing for environmental Kuznets curves within a developing country. Environment and Development Economics, 2(04), 417-431.
Wagner, G. (2010), The energy content of world trade. Energy Policy, 38(12), 7710-7721.
Webber, D.J., Allen, D.O. (2004), Environmental Kuznets Curves: Mess or Meaning?
World Development Report. (1992). OUP.
Zanin, L., Marra, G. (2012), Assessing the functional relationship between CO2 emissions and economic development using an additive mixed model approach. Economic Modelling, 29(4), 1328-1337.