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GREENHOUSE GASES EMANATION (GHGS), ENERGY UTILIZATION AND ECONOMIC GROWTH OF GROUP SEVEN (G7) COUNTRIES

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ABSTRACT

The basic idea of this research work started to understand the relationship between greenhouse gases emissions, energy utilization and economic growth of group seven (G7) countries. This concept was resultant by the recent issues of environmental degradation due to global warming and climate change. Based on the result indicated income level of group seven countries increasing gradually, the environmental quality first declines and improves further later goes weak subsequently. Hence the environmental quality of these countries will have ups and downs all the time and also at the end the environmental quality again goes weak. The result further indicate that, there is a long term effect with energy use and greenhouse gas emission. This shows that due to energy utilization the emission of greenhouse gases is high and the effect will be in long term manner.

KEYWORDS: *greenhouse gases emissions, energy use, economic development, panel data models, Environmental Kuntz Curve*

JEL Classification: *C4, O4, Q4, Q5*

I.INTRODUCTION

The present research work started with the basic idea behind the relationship of greenhouse gases emissions, energy utilization and economic growth. The ultimate motive of any country to improve their economic position as much as possible i.e. Gross Domestic Product. Suppose the country desires to improve their economic position they are bound to use widely their manufacturing sector by the help of energy sources i.e. Petrol, Diesel and Gasoline etc. If the countries are using huge energy resources automatically there will be high emission of greenhouse gases namely carbon dioxide (CO_2), methane (CH_4), Nitrous oxide (N_2O), Ozone (CO_3) and Chlorofluorocarbons (CFCS). Due to

greenhouse gases emissions, it leads to decline environmental quality and also increasing unseasonal natural disasters like flood, tsunami etc. So it may be understand that there is a close relationship between greenhouse gases emission, energy use and economic growth. Hence there is a need for studying the relationship between greenhouse gases emission, energy use and economic development.

Industrial revolution helps to improve the economic growth worldwide but at the cost of environmental degradation. The resources were exploited, energies were consumed persistently on the eve of industrialization, unmindful of the imbalances caused in the natural setting of the earth and environment, which resulted in the global warming and climate change. The growth of the countries through industrialization was directly related to consumption of energy, exploitation of natural resources that resulted in environmental degradation through dumping the energy waste. The corrosion of environmental quality all over the countries has reached alarming stage and the long lasting consequences of it not only on the life and health of present generation but for the future generations also has, of late, got greater attention worldwide. The evil effect of global warming and climatic change has made the world conseous about it and all out efforts are made to check the environment not to fall further in its grade to save the world from various catastrophes. Thus conscience have been built to improve the economic growth without making environmental degradation and it has become a serious topic for the researchers to probe in to it in the recent times.

Environmental degradation caused due to high emission of greenhouse gases (CHGs) emitted by the industrial houses has made it critical and of late the concerns are rising to maintain the social and environmental welfare. The global warming caused due to environmental degradation is expected to lead to sea level rising by 20 ft further by 2020 as per the prediction. In case the global warming increase by 3 to 4 Celsius it will result in unseasonal flood, drought etc., which may affect more than 340 million people. The increasing greenhouse gas emissions is threatening the global warming situation continuously. It looks as if the developed countries are developing at the cost of the whole world, more specifically the developing and underdeveloped world. In the Kyoto protocol summit 1997 where the governments of all the countries of the world decided to pay heed to such as alarming situation of greenhouse gases emission and decided that countries around the world should attempt to reduce their greenhouse emission to an extent of 5% by 2008-12 from 1990 level. Recently the meeting held at Paris (December 2015) have decided all the countries to reduce greenhouse gases emission by 2% with an immediate effort. Another meeting held at Japan (June 2016) with Group Seven (G7) countries are discussed the ways to reduce greenhouse gases emissions. Taking all these efforts, the countries in the world are tries to reduce greenhouse gases emission in regard as to improve the environmental quality. Hence this may be a small piece of work to find out the factors influencing for increase the greenhouse gases emission and the relationship between greenhouse gases emission, energy utilization and economic growth of group seven countries.

Rest of the paper is organized as follows; Section 2 provide an overview of earlier research works relating greenhouse gases emissions, energy use and economic growth. Section 3 discusses materials & methods of panel econometric analysis. Section 4 discusses empirical results of greenhouse gases emissions, energy use and economic growth relationship. Section 5 provides concluding remarks of the research work.

II.LITERATURE REVIEW

The present study focuses on three different approaches relating greenhouse gases emission, consumption of energy and economic development in line with Zang, X. P and Cheng, X. M (2009) and Ghosh, S (2010). The first approach focused on environmental degradation and economic growth by attempting to trace evidence of Environmental Kuznets Curve (EKC) i.e. the hypothesis produce different types of curve in relation between greenhouse gases emission, energy use and economic growth. Sun, J. W (1999) tested

CO_2-EKC hypothesis in peak energy countries and found inverted U-shaped curve against per capita GDP. Halicioglu, F (2009) investigated the relationship between CO_2 emissions, energy consumption, national income and international trade over the period of 1960 to 2005 through time series data of Turkey. Based on the results he found that EKC hypothesis did not hold good. He, C and Sandberg, R (2012) studied EKC hypothesis in Canada using time series data during the period 1948 to 2004 and found no evidence of EKC hypothesis. Fodha, M and Zaghdoud, O (2010) studied relationship based on EKC hypothesis, between toxin emissions like CO_2, SO_2 and real GDP for Tunisia during 1961-2004 and found that there is an evidence of EKC hypothesis with SO_2 not CO_2. The study also found that there is a long run equilibrium relationship between emissions and GDP. Dinda, S et al. (2000) investigated relationship of suspended particular matter (spm) i.e. divided solids liquids that may be dispersed through air and sulphur oxide emissions (SO_2) with per capita national income during 1979–1990 by using quadratic income formula and found no evidence of EKC hypothesis. Galeotti, M et al. (2006) find out the relationship between per capita CO_2 emission and EKC hypothesis using cubic function of OECD and non-OECD countries with two different data sets i.e. for energy data period was 1960 – 1998, for CO2 emission data period is 1950 – 1997 and found the evidence of EKC only for OECD countries. Canas, A et al. (2003) studied the EKC hypothesis for 16 industrialized countries during 1960 – 1998 by using cubic function and found that inverted U – shaped EKC relationship. Perman, R and Stern, D. I (2003) examined the EKC hypothesis of 74countries between per capita sulphur dioxide emissions with per capita income quadratic function and they found no evidence of EKC hypothesis. Azomahou, T et al.(2006) examined 100 countries during 1960–1996 and found the application of EKC hypothesis. The other studies also used with larger data sets and found the evidence of EKC hypothesis Bertinelli, L and Strobl, E (2005), Taskin, F and Zaim, O (2000).

The second approach focused on relating energy consumption and economic development. Kraft, J and Kraft, A (1978) traced the causal relationship between energy use and economic growth on United States economy. The studies like Yu, E. S. H and Choi, J. Y (1985), Ferguson, R et al. (2000), and Toman, M and Jemelkova, B (2003), pointed out absence of defined relationship between energy consumption and growth. Lee, C. C (2006) measured the relationship between energy use and economic growth of 11 major industrialized countries by using econometric tools of panel approach and found that bi-directional relationship exists between energy use and economic growth in case of USA and existence of uni-directional relationship in case of France, Italy and Japan and no relationship for the rest of the countries like UK, Germany and Sweden.

Third approach combined the above two approaches i.e. relationship between carbon dioxide emissions, energy consumption and economic development. Ang, J. B (2007) linked carbon dioxide emissions, energy usage and economic development of France during the study period 1960 to 2000 by using quadratic econometric model and found that long run relationship exists between CO_2 emission, energy use and economic development. The study also found bi-directional relationship between the variables. Jalil, A and Mahmud, S. F (2009) studied inter linkages between CO_2 emission, energy use, real GDP and international trade for China for the period 1975 – 2005 and found that long run relationship exists between the variables. The relationship was found to be uni-directional between real GDP and CO_2 emission. Shafik, N and Bandyyopadhyay, S (1992) found existence of the relationship between CO_2 emission and real GDP by using cubic function of GDP and suggested the macroeconomic variables like trade, debt to have effect on environment. Grossman, G and Krueger, A (1993) and Panayotou, T (1993) measured the relationship between SO_2 and NO_2 with macroeconomic variables like per capita GDP, trade intensity and population and found significant relationships between the environment degradation

and macroeconomic variables. Selden, T. M and Song, D (1994) used quadratic relationship and found a defined relationship between SO_2, NO_2 and CO_2 on per capita GDP of Turkey. Shafik, N (1994) studied the relationship between environmental quality, per capita income and other variables like endowment, income, technology and policy. Heil, M. T and Selden, T. H (1999) measured the relationship between international trade and pollution among cross – country by collecting the data of 132 countries over the period 1950 to 1992. Through the study the conclusion arrived was that increased trade intensity leads to higher CO_2 emissions in lower – income countries and similarly it is lower CO_2 emission in higher income countries. Cole, M. A (2004) studied the relationship between pollution and trade among developed countries by using cubic function and found that trade openness is significantly related to pollution. Ghosh, S (2010) investigated causal relationship between CO_2 emission, energy consumption, economic development, real investment and employment by using econometric models in India during 1971 - 2006. From the results it was concluded that no relationship exists between the variables and there is a bi-directional relationship between economic development and CO_2 emission. Halicioglu, F (2009) used quadratic function for identifying the relationship between CO_2 emission, per capita energy consumption, per capita income and trade openness and found bi-directional relationship between carbon dioxide emission and income in Turkey. Hussain, M et al (2012) studied the relationship between carbon dioxide emission, per capita energy consumption and economic growth in case of Pakistan using the data from 1971 to 2006 and found that long term relationship exists among the variable with bi-directional relationship between CO_2 emission and energy consumption.

On the basis of literature review as well as the knowledge of author less attempt has been made yet to relate greenhouse gases emission, energy consumption and economic growth of group seven (G7) countries by employing panel data models. The study also considered the suggestion given by Hussain et al (2012) that the future study should focuses on industrial sectors rather than other sectors. Taking clue from the above studies the present study tried to fill the gap and made an attempt to relate greenhouse gases emissions, energy consumption and economic growth of Group Seven (G7) countries over the period of 1960 to 2014 by using panel econometric models.

III.MATERIALS & METHODS

The main objective of this study is to examine the relationship between greenhouse gases emissions (GHGs), energy consumption, economic growth of group seven countries. Since the study is able to differentiate three different approach in the field of greenhouse gases emissions, energy use and economic growth it is appropriate to use all three approaches. So the present study made three sub objectives i.e. 1. To explore the EKC hypothesis for greenhouse gases emission data over the period of 1960 to 2014 for group seven countries. 2. To study the relationship between environmental pollution and economic growth 3. To examine the relationship between greenhouse gases emissions, energy consumption, economic growth of group seven countries. Variables used in this study are greenhouse gases emission per capita which is measured in metric tons per capita (GHGs), per capita GDP is used as proxy for economic position of the country (GDP), and energy consumption is measured in kg of oil equivalent per capita (EU), have been used in natural logarithm form. The necessary data has been collected from group seven countries such as Canada, France, Germany, Italy, Japan, United Kingdom and United States over the period of 1960 to 2014 from World Bank; World Development Indicators.

This study followed cubic function that was used by Fodha, M and Zaghdoud, O (2010). Since the nature of the data in both time series and cross section panel econometric models such as Panel unit root, Panel Auto Regressive Distribution Lag model were used.

IV. RESULTS & DISCUSSION

1.EKC Hypothesis

The study followed the basic model used by Fodha, M and Zaghdoud, O (2010) to examine the EKC hypothesis of group seven countries. For

finding out the relationship of EKC hypothesis with greenhouse gases emissions, the study used the variables like greenhouse gases emissions, energy use and economic growth. The model applied the following equation.

$$GHG_{s_{it}} = \delta_0 + \delta_1 eu_{it} + \delta_2 gdp_{it} + \delta_3 gdp^2_{it} + \delta_4 gdp^3_{it} + \varepsilon_{it}$$

Where GHG_s – greenhouse gases emissions per capita, EU – measured in kg of oil equivalent per capita and GDP – per capita gross domestic product proxy of economic growth. Where δ0 is a constant and δ1, δ2, δ3, and δ4 are the slope parameters. It is assumed that higher level of energy consumption will result higher economic growth and possibility of high emissions of greenhouse gases emission therefore δ1 > 0 as per the equation (1). Based on the EKC hypothesis, the greater economic growth will produce more greenhouse gases emissions. Therefore it is expected that δ2 > 0, δ3 < 0 and δ4 > 0. The above equation also tries to find out different types of environmental economic relationships.

If δ2 > 0, δ3 < 0, δ4 > 0, it produces a N – shape curve
If δ2 < 0, δ3 > 0, δ4 < 0, it produces inverted N – shape curve
If δ2 < 0, δ3 > 0, δ4 = 0, it produces an U – shape curve
If δ2 > 0, δ3 < 0, δ4 = 0, it produces an inverted U – shape curve

N – Shape relationship indicate with income level of country is increasing gradually, the environmental quality declines initially and improves later and goes weak subsequently. For inverted N - shape relationships as countries' income levels improves gradually, environmental quality first improves and subsequently decline and at last improves. Similarly for U – shape relationship for countries income in lower levels the environmental quality will improve as income rises, when the income level is high, environmental quality decline as income rises. For inverted U – shape relationship when income at lower level, environmental quality declines as income rises, whereas when income levels are high the environmental quality improves as income rises.

Table – 1, Results of EKC hypothesis

Variables	Co – eff	SE	P – value
Δ EU	0.9464	0.0343	0.0000
Δ GDP	0.0081	0.0054	0.8825
Δ GDP^2	-0.0126	0.0004	0.7582
Δ GDP^3	0.0038	0.0007	0.6013
C	6.9447	0.5516	0.0000

From the results of EKC hypothesis it was found that EU > 0 (0.9464 > 0), indicating high energy usage lead to increase the country's economic growth as well as high level of greenhouse gases emission among group seven countries. It was also observed that the present study supports N – shaped EKC hypothesis i.e. δ2 > 0, δ3 < 0, δ4 > 0 (0.0081 > 0, -0.0126 < 0, 0.0038 > 0). Thus it indicated that income level of group seven countries increasing gradually, the environmental quality first declines and improve further and later goes weak subsequently. Hence the environmental quality of these countries will have ups and downs all the time and also at the end the environmental quality again goes weak. Thus it can be concluded that these countries emit more greenhouse gases at most of the time so that the environmental degradation will be high. So these countries should take necessary steps to reduce the level of greenhouse gases emission in an immediate effect.

2.Panel unit root test

Any economic data series analysis requires application of the unit root test to transform non stationarity data to stationarity to avoid spurious or

misleading result in regression modelling. By differencing or detrending the data series the panel unit root test is preferred for non stationarity economic data series. The standard panel unit root tests follows the model as

$$y_{it} = \rho y_{it-1} + \delta_0 + \delta_1 t + n_i + v_t + \varepsilon_{it}$$

From the model testing the coefficient of $^{\circ}$ is equal to one. Where i = 1, 2, ….., N represent the N individual items included in the panel. As the data is balanced panel having same number of years and countries the study adopts common as well as unit specific trends are measured for models advocated by LLC, IPS, Fisher ADF & PP tests where individual unit root test statistics are averaged. All the tests follow Augmented Dickey Fuller (ADF) principle i.e. stationarity or presence of unit root as null hypothesis and non stationarity or absence of unit root as alternative hypothesis.

Table – 2, Panel Unit root results

Series	***GHGs***	***EU***	***GDP***
Levels			
Levin, Lin, and Chu	-4.1907 (0.0000)	-0.7401 (0.2296)	2.6698 (0.9962)
Im, Pesaran and Shin	-6.5461 (0.0000)	1.4929 (0.9882)	3.3001 (0.9995)
Fisher – ADF	80.6825 (0.0000)	6.6187 (0.9323)	11.3498 (0.6584)
Fisher – PP	81.4963 (0.0000)	3.4557 (0.9979)	5.0343 (0.9853)
First differences			
Levin, Lin, and Chu	-	-13.3387 (0.0000)	-10.1112 (0.0000)
Im, Pesaran and Shin	-	-13.4018 (0.0000)	-11.4018 (0.0000)
Fisher – ADF	-	220.393 (0.0000)	139.385 (0.0000)
Fisher – PP	-	227.405 (0.0000)	135.962 (0.0000)

LLC = Levin, Lin, Chu (2002), IPS = Im, Pesaran, Shin (2003), based on ADF and PP, these test statistics are asymptotically distributed as standard normal with a left hand rejection area. The null hypothesis of non stationarity. The selection of lag is based on modified Akaike information criteration. Newly – West selection using Bartlett kernel. Fisher tests are asymptotic chi-square distribution. Figure in the parentheses are p – value to understand the significance level.

Table -2 presents the results of panel unit root test through LLC, IPS, Fisher ADF and PP models for group seven (G7) countries to check the stationarity and integration properties of the selected variables. The result reported that the variables are showing mix of stationarity i.e. greenhouse gases shows stationarity at level and the other variables like energy utilization and GDP shows non-stationarity shows non-stationarity at level and got stationarity at first difference. This lead to a conclusion that the series are showing mix of stationarity process i.e. I(0) and I (1) panel Auto Regressive Distribution Lag (ARDL) was applied to investigate the existence of long run and short run relationship between the variables.

3.Panel Auto Regressive Distributed Lag Model (ARDL)

ARDL is a least square regression and it contains different lags of dependent and independent variables. ARDL can be applicable when mix of stationarity process of the variable. ARDL produce different lags of order to get accuracy of the results this can be termed as dynamic regressors. ARDL can be estimated through least square regression and the standard Akaike information criteria used in the present model. ARDL model can be written as

$$y_{it} = \alpha + \sum_{i=1}^{p} \gamma_i y_{it-1} + \sum_{j=1}^{k} \sum_{i=0}^{q_j} X_{j,it-i}{}' \beta_{j,i,t} + \varepsilon_{it}$$

Traditional methods of estimating cointegrating relationships, such as Engle-Granger (1987), Johansen's (1991, 1995), Fully Modified OLS, Dynamic OLS can use the variables are in same integration process or either I (0) or I (1). To alleviate this issue, Pearsan and Shin (1999) create ARDL cointegration model when the variables are mix of stationarity process. ARDL model representation does not require symmetry of lag lengths, each variable can have a different number of lags. Further the ARDL cointegration can be confirmed with bound test to identify the relationship between the variables.

Table – 3, Auto Regressive Distributed Lag Model (2, 1, 1) results

Variable	Co-eff	S.E.	Prob
Long – run relationship			
EU	1.0135	0.0660	0.0000
GDP	0.0083	0.0549	0.8793
Short – run relationship			
GHGs (-1)	-0.1981	0.0611	0.0013
EU	0.2018	0.3673	0.5830
GDP	0.5788	0.4074	0.1564
Cointg	-0.4090	0.0629	0.0000
C	0.1497	0.0369	0.0000
F – Stat	463.809		0.0000

The results of ARDL model presented in the table-3, this result can be divided into two i.e. long term and short term relationship. The accuracy of ARDL model supports the lag of (2, 1, 1) and the lag information get from Akaike information criteria and the lag information given below in the graphical format. From the result of long term relationship it can be identified that the null of no relationship can be rejected and accept there is a long term effect with energy use and greenhouse gas emission. This shows that due to energy utilization the emission of greenhouse gases is high and also the effect will be in long term manner. It is also interesting GDP did not find significant relationship and shows that there will be no long term effect in relation with GDP. This shows that the country can use energy for increasing their GDP but it is not showing direct impact with greenhouse gases emission. For short run relationship the result suggests that variable having negative indication and significant value will be treated of having a long run relationship. Whereas the variable having negative indication but not significant value indicate of having short run relationship only. Further confirmation of the model one can see wald – F statistics. For overall model can be predicted by error term (U_t) for the relationship. From the table greenhouse gases shows long term relationship and rest of the variables did not find any relationship. The overall model support that the variables are showing long term relationship rather than short term relationship. The study also confirmed with F-statistic which shows long term relationship exist between the variables.

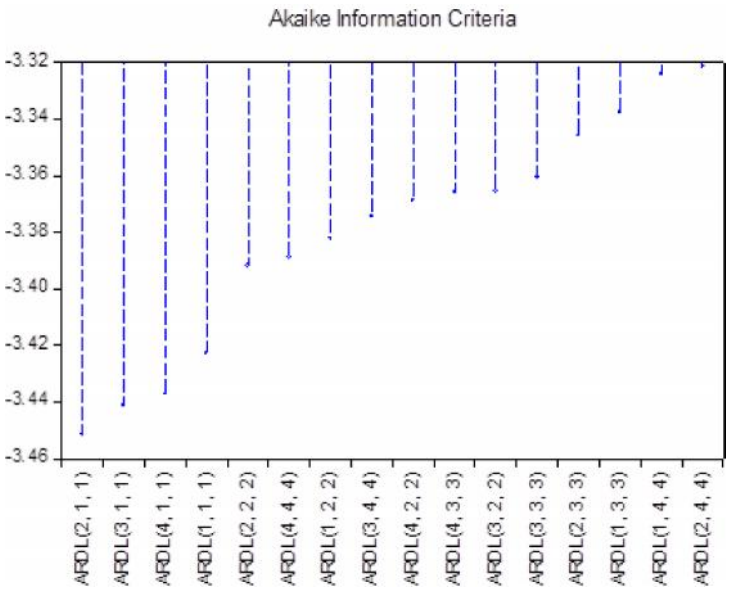

Table – 4, Cross – Country effect of group seven (G7) countries

Variable / Country	GHGs	EU	GDP	Ut	C
Canada	-0.0693 [0.0183] (0.0327)	-1.6261 [2.8598] (0.6094)	2.4698 [4.6856] (0.6346)	-0.5141 [0.0242] (0.0002)	0.2468 [0.0070] (0.0001)
France	-0.4609 [0.0142] (0.0001)	1.0250 [0.3093] (0.0453)	1.6548 [1.5222] (0.3565)	-0.1948 [0.0081] (0.0002)	0.0545 [0.0010] (0.0000)
Germany	-0.3163 [0.0318] (0.0022)	0.9709 [0.4543] (0.1222)	0.1321 [0.9687] (0.9001)	-0.3717 [0.0372] (0.0021)	0.1754 [0.0098] (0.0004)
Italy	-0.1660 [0.0067] (0.0001)	0.0236 [0.0407] (0.6027)	0.4752 [0.0577] (0.0037)	-0.5870 [0.0122] (0.0000)	0.2738 [0.0035] (0.0000)
Japan	0.0140 [0.0077] (0.1684)	0.6002 [0.0317] (0.0003)	-0.4569 [0.0523] (0.0032)	-0.2340 [0.0053] (0.0000)	0.1303 [0.0025] (0.0000)
UK	-0.2694 [0.0193] (0.0008)	0.8680 [0.1689] (0.0143)	-0.0886 [0.3765] (0.8290)	-0.3479 [0.0207] (0.0005)	0.1666 [0.0057] (0.0001)
USA	-0.1190 [0.0177] (0.0068)	-0.4486 [2.9500] (0.8888)	-0.1349 [1.5024] (0.9341)	-0.6139 [0.0293] (0.0002)	0.0007 [0.0019] (0.7178)

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Table 4- reveals that cross country effect in respect with greenhouse gases emission, energy utilization and economic development of group seven countries. This result suggest that variables having negative indication and significant value will be treated of having a long run relationship. Whereas the variable having negative indication but not significant value indicate of having short run relationship. The overall relationship can be identified through error term (U_t), if the Ut shows negative and significant relationship then it can be confirmed that the variables are having long run effect. From the table greenhouse gas emission shows long term effect with all the countries except Japan. In recent times Japan is trying to improve their economy with environment concern i.e. they are running their industries by using environmental safety like renewable energy sources. This may be the reason for not having direct effect of greenhouse gases emission. For short run relationship the country like Canada and USA shows negative but insignificant value then it can be said that they have short term effect with energy consumption and greenhouse gases emission and also USA indicate short term effect when they are trying to improve their economic position. Rest of the variables are not showing the relationship individually. It is also quite interesting error correction term it was found negative with significant value hence it can be concluded that the model do support long run relationship between greenhouse gases emissions, energy utilization and economic development of group seven countries.

V.CONCLUDING REMARKS

The empirical investigation on the relationship between greenhouse gases emissions, energy consumption and economic growth of group seven countries. The result reveals that higher level of energy consumption will lead to increase the country's economic growth and high level of greenhouse gases emissions among group seven countries. The present study found that it supports N – shape relationship thus indicated that income level of group seven countries increasing gradually, the environmental quality first declines and improve further and later goes weak subsequently. Hence the environmental quality of these countries will have ups and downs all the time and also at the end the environmental quality again goes weak. Thus it can be concluded that these countries emit more greenhouse gases at most of the time so that the environmental degradation will be high. The modelling suggest that there exists long run relationship between greenhouse gases emission, energy consumption and economic growth of group seven countries. Individual countries result shows that greenhouse gases emission having long term effect with all the group seven countries whereas Canada and USA shows short run effect with energy consumption and only USA shows short run relationship with economic development. For overall the present study indicate that there is a long term effect with greenhouse gases emission, energy consumption and economic growth of group seven countries during the study period. Hence the present study suggest that these countries are more or less energy dependent so these countries would take essential steps for energy policy such as oil reservation apparatus, develop energy efficiency and swap for oil usage in order to reduce energy catastrophes on economic development.

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