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# Environmental Degradation and Energy Consumption: A case study of China

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**ABSTRACT**

The main aim of the research is to check the relationship between the environmental degradation and energy consumption in context of the China for the era of 1980 to 2020 by applying the Ordinary Least Square (OLS) Method to find out the empirical results. Findings of Ordinary Least Square (OLS) Method indicate that Energy Consumption (ENERGY) is statistically significant and has positive impact on the Carban Dioxide Emissions (CO2) of the country China. Foreign Direct Investment (FDI) is statistically significant and has positive impact on the Carban Dioxide Emissions (CO2) of the country China. The Chinese Governments need to encourage financial growth with empirical results with their negative and significant effects on environmental emissions. They can also encourage investment in new energy sector resources that are advantageous in terms of CO2 emissions.

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## Introduction

In promoting economic activity, the natural environment plays a significant role. It participates directly by providing the natural resources required as components for the producing goods and services, including water, forestry and mineral, and indirectly by supplying ecological functions, like biofuel production, water purification, flood risk management, and nutrient cycling. Natural resources also are important, not just today, however for generations to come, to maintain sustainable economic development. The interaction between the climate and economic development is complicated. There are many obstacles, including the scale and structure of the economy, in general the contribution of services in the GDP as compared to manufacturing industries and manufacturing, and the potential for technological progress to minimize environmental impact of manufacturing and sales choices, thereby promoting economic development.

In the phase of sustainable development, environmental degradation is a critical problem because it has challenging implications for economy and human well-being. It is the source of multiple negative effects on resource depletion and climate change-related natural disasters. Environmental contamination happens when the natural environment is susceptible to the decomposition of materials that are unnaturally generated and are not treated by humans. Atmospheric, water, sound, land decrepitude, and soil are focal sources of contamination.

Environmental impacts here include combustion of fuels to generate energy for combined heat and power generation in the residential and commercial spaces; the emission of pollutants from transport vehicles that use, among many other items, diesel, petrol and oil; and the output of waste gases, smoke and energy from construction plants containing chemical producers and electricity generators.

Auci and Trovato (2011) illustrated because as economy evolves, the climate is likely to be impacted, that would have a detrimental effect on the natural environment, culture, economy, including infrastructure. The negative relationship between economic growth and co2 emissions requires adequate municipal, provincial, global, and global environmental policy actions and approaches. Sebri and Ben-Salha (2014) explored that the increases in Carbon emission in BRICS countries are the major contributor to global warming.

Over time, economic situations and policies shift and changes can have various impacts on their economies. During the age of Globalization, energy demand is growing exponentially, and energy is highly dependent on all countries. It became one of the world's principal issues. The effect of this energy dependence on the economy must be established. In the last few centuries, emissions from emerging economies have been increasing fast.

In recent times, the impact of global warming and climate change on the life quality have intensified. This is assumed that increasing economic growth as well as the continual environmental deterioration are one of the main factors giving credence to this trend. In developing countries, because of the manufacturing structure of those states, the associated with economic issues and environmental deterioration may be more environmentally harmful. According to the Djezou (2013) a significant environmental issue is linked to increased destruction in countries with a low of industrial development as well as increased concentrations of vegetation cover, commonly recognized as its intensification of agricultural territories but not along carbon emissions.

Kasman and Duman (2015) stated that not only did the industrialization begin a new era of economic expansion among nations, and it also bringing the famous phenomenon of today, global climate change, as well as global warming. The transition of the international economy from natural economies based on living organisms resources to inorganic economies based on fossil fuels is among the significant components of the industrialization. Use of such fossil fuels clearly and continually destroyed the atmospheric levels of carbon and thus allowed the atmospheric heat to be retained. This mechanism contributes to climate changes. Compared to developed countries, CO2 emissions from energy usage have risen dramatically in newly industrialised countries since about the 1990s. The degradation in the quality of the atmosphere has entered troubling levels, raising questions regarding global climate change. Therefore, in current history, understanding of the reasons inside environmental damage as well as its relationship with growth in the economy has become more and more important.

International trade and the acquisition of large currency through economic globalisation has contributed to environmental problems. In industrialized economies, the transition to environmentally sustainable high-tech goods and schemes has mitigated the effect of these issues, while poorly developed emissions regulations in developing countries are still causing environmental quality degradation. There are numerous viewpoints on the environmental effects of globalisation for this purpose. People are becoming more aware of greenhouse gas

(GHG) pollution and its effects on air quality, the connection between energy use and economic growth as well as economic growth and environmental degradation has recently attracted a lot of attention.

**Research Questions**

1. What is the impact of energy consumption on Co2 emission in China?
2. What is the impact of globalization on Co2 emission in China?
3. What is the impact of Trade on Co2 emission in China?
4. What is the impact of FDI on Co2 emission in China?
5. What is the impact of DI on Co2 emission in China?

**Research Objectives**

1. To investigate the impact of energy consumption on Co2 emission in China.
2. To investigate the impact of globalization on Co2 emission in China.
3. To investigate the impact of Trade on Co2 emission in China.
4. To investigate the impact of FDI on Co2 emission in China.
5. To investigate the impact of DI on Co2 emission in China.

**Literature Reviews**

Sriyalatha (2019) explored presence of the EKC from 1960-2016 in selective SAARC states. In order to examine the relation among environmental pollution, economic development, capital stock and trade liberalization, the study apply multiple OLS regression econometric methodology for the cubic and squared requirements. Nepal exhibits a N shaped curve, whereas the N Shaped curve is opposed to all of the other states. At the initial phase of development, due to reduced industrialization in such economies, there seems to be an insignificant influence on Carbon emission from growth in the economy. It is necessary for such countries to have an effective environmental plan to minimize overall Carbon emission without harming economic development, because these nations already belonging to emerging economies. Politicians should devise policies to discourage excessive usage of energy in order to increase energy efficiency. From the other side, the use of fewer energy-intensive equipment, the minimization of voltage drops during transmission and distribution cycles, and its use of various tariff structures to regulate the use of energy are among the main policies that can improve energy efficiency for such economies.

Wang and Dong (2019) explored a balanced panel series of 14 SSA countries from 1990 to 2014 is used to compensate for the indicators of environmental pollution by balancing for the important roles performed by economic development, non-renewable and renewable energy use and urban growth. AMG estimates show that economic growth, usage of non-renewable energy and urban growth have a positive influence on the EF in the

Sub - saharan african countries, whereas usage of renewable energy performs a negative role in the EF. Economic development, non-renewable usage, urban growth, and the EF are correlated with bidirectional long-run causality; unidirectional causality, on the other side, is show to run from renewable energy usage to the EF.

Liu and Hao (2018) investigated the relation of energy use and economic growth in the Belt and Road economies, using a data panel for 69 economies over the period from 1970 to 2013. The assessment findings show that the linkages between energy use as well as economic activity differ among various subgroups through use of VECM, FMOLS and DOLS methods. The results indicate that the economies including trade of China and the Belt and Road economies have considerable potential for collaboration.

Alvarado and Toledo (2017) explored the Ecuador's alliance between economic development and deterioration of the climate since 1971 until 2010. The presence of an opposite relationship between real GDP as well as vegetation cover suggests that environmental deterioration is the basis of this country's production. By Johansen co-integration analyses there is a long-term equilibrium relationship from the first gaps in real GDP, vegetable cover, as well as the rate of urbanization. The ECM revealed that the correlation of vegetation cover, GDP and the rate of urbanization is short-term. Ultimately, among the indicators, results did not detect Granger causality. A major recommendation based on the finding is that environmental protection strategies would not adversely affect economic development but would not restrict the country's rapid urbanization.

Shahbaz et al. (2017) explored the EKC hypothesis for China in the existence of globalisation. Findings of the research indicate that cointegration is exist among all the variables for the era of 1970 to 2012. Moreover, both in the short and long term, the EKC hypothesis is accurate in China. Coal use substantially boosts CO2 emissions. Globalization's overall index including sub-indices show that globalisation is declining CO2 emissions in China. The findings of causality show that economic development induces CO2 pollution, proving that the EKC hypothesis holds. Among coal consumption and CO2 emissions, there is a feedback effect. Globalization triggers Granger's CO2 pollution.

Azam (2016) studied the effect of the deterioration of the atmosphere by CO2 emissions on 11 Asian countries' economic growth during 1990 in 2011. Empirical results of the Fixed Effect indicate that environmental pollution has a dramatically negative effect on economic development. The empirical results indicate that environmental problems would be controlled. Consequently, Asian nations need to adopt ecologically development strategies to minimize CO2 emissions and fuel consumption by transportation and industries. A successful road to sustainable development is the implementation of secure carbon emission turnover strategies.

Magazzino (2016) stated that over the 1970-2006 period, the relation amongst CO2 emissions, energy consumption and economic growth in Italy. The empirical findings show that there is no co-integration of CO2 emissions, energy use and economic development. In addition, the non-causality test of Toda and Yamamoto Granger indicates a two - way causality between emissions of CO2 and economic growth, as well as between emissions of CO2 and energy consumption. Forecast error variance decompositions of error variance indicate that the errors in actual GDP are primarily due to uncertainty in GDP itself, whereas the errors in forecasting energy consumption and CO2 emissions from the other two equations are susceptible to disruptions.

Kasman and Duman (2015) investigated the for a group of new EU representatives and participant states over the span from 1992 to 2010, the causality was found between energy use, carbon emissions, economic development, trade openness as well as urban growth. Evidence that supports to EKC hypothesis is given by the key findings. There seems to be an inverted U-shaped association between sampled countries' climate and incomes. Findings show that there is a short-run unidirectional causal relationship exist that runs from energy usage, trade openness as well as urban growth to carbon dioxide emissions, from GDP to energy usage, from GDP to energy usage and urban growth to trade openness, from urban growth to GDP, as well as from urban growth to trade openness. The findings suggest that carbon emissions, energy use, GDP, and trade openness coefficients are statistically relevant with respect to the long-run causal association, showing that such four factors could play a significant role in the process of adjustment even as framework moves away from the long-run stability.

**Data and Methodology**

To see the relationship between the environmental degradation and energy consumption in the case of Chin. The study used annual data from 1980 to 2020. The data is collected from various sources world development indicators (WDI), International Monetary Fund (IMF). Mathematical equation of the model is below that show Carbin Dioxide Emissions is the function of the flowing variables.

$$CO2 = f (ENERGY, GLOB, TRADE, DI, FDI)$$

Following econometric model is used to analyze the relationship between dependent and independent variables:

$$CO2 = \beta_0 + \beta_1 ENERGY + \beta_2 GLOB + \beta_3 TRADE + \beta_4 DI + \beta_5 FDI + \varepsilon$$

Here,

CO2= Carbin Dioxide Emissions

ENERGY= Energy Use

GLOB= Globalization

TRADE= Total Trade

DI= Domestic Investment

FDI= Foreign Direct Investment

ε=Error Term

This equation shows the relationship between dependent variable CO2 Emissions and independent variables (ENERGY, GLOB, TRADE, DI, FDI). CO2 Emissions is the proxy of the environmental degradation and similarly Gross Fixed Capital Formation is the proxy of the Domestic Investment.

**Descriptive Analysis**

Brief descriptive coefficients summarizing a given set of data that can be either a representative of a population as a whole or a sample. This is subdivided into central tendency measures and variability measures (spread).

**Table: Descriptive Statistics (1980 – 2020)**

Source: Software E-Views 9.0

| | CO2 | ENERGY | GLOB | TRADE | DI | FDI |
|---|---|---|---|---|---|---|
| Mean | 4.045117 | 1263.085 | 50.30076 | 36.93774 | 35.45134 | 2.615755 |
| Median | 2.820568 | 898.9873 | 53.72538 | 36.05608 | 34.44062 | 2.613162 |
| Maximum | 7.557211 | 2236.73 | 64.79038 | 64.47888 | 44.51877 | 6.186882 |
| Minimum | 1.460432 | 597.1467 | 26.88947 | 12.42485 | 23.98875 | 0.02982 |
| Std. Dev. | 2.259015 | 626.116 | 13.63383 | 13.52581 | 6.238777 | 1.727243 |
| Skewness | 0.528802 | 0.538477 | -0.38468 | 0.262527 | -0.01369 | 0.160684 |
| Kurtosis | 1.615044 | 1.589301 | 1.57309 | 2.410275 | 1.680246 | 1.911124 |
| Jarque-Bera | 5.187576 | 5.381081 | 4.4895 | 1.065072 | 2.976773 | 2.201921 |
| Probability | 0.074736 | 0.067844 | 0.105954 | 0.587114 | 0.225737 | 0.332552 |
| Sum | 165.8498 | 51786.48 | 2062.331 | 1514.448 | 1453.505 | 107.246 |
| Sum Sq. Dev. | 204.126 | 15680847 | 7435.249 | 7317.898 | 1556.893 | 119.3347 |
| Observations | 41 | 41 | 41 | 41 | 41 | 41 |

Table of descriptive statistics show the 41 observations for the era of 1980 to 2020. In this study variables are Energy Consumption (ENERGY), Globalization (GLOB), Trade (TRADE), Domestic Investment (DI), and Foreign Direct Investment (FDI) are Independent variables while the Carban Dioxide Emissions (CO2) is dependent variable.

Carban Dioxide Emissions (CO2) is the first variable of the model in this table. Mean value of Carban Dioxide Emissions (CO2) is 4.045117, median value is 2.820568, maximum value is 7.557211, minimum value is 1.460432. The standard deviation points out the spread out used data while higher value of standard deviation displayed larger spread. The value of the standard deviation of Carban Dioxide Emissions (CO2) is 2.259015. Skewness is used to measure the symmetrical trend of data. The skewness value of the Carban Dioxide Emissions (CO2) is 0.528802 and show Carban Dioxide Emissions (CO2) is positively skewed. For Kurtosis, 3 is the standard value but Carban Dioxide Emissions (CO2) has 1.615044 value of kurtosis that represent the data has Platykurtic distribution. Jarque-Bera test for Carban Dioxide Emissions (CO2) has 5.187576 value which is greater than 0.5 and forecast that data is not normally distributed. If probability of data is less than 0.05 means rejected null hypotheses. Probability (P) value of Carban Dioxide Emissions (CO2) is 0.074736 which shows that it is statistically insignificant.

Energy Consumption (ENERGY) is second variable of the model. Mean value of Energy Consumption (ENERGY) is 1263.085, median value is 898.9873, maximum value is 2236.73, minimum value is 597.1467. The value of standard deviation of Energy Consumption (ENERGY) is 626.116 and 0.528802 is value of skewness, represent that Energy Consumption (ENERGY) is positively skewed. Kurtosis value of Energy Consumption

(ENERGY) is 1.589301, represent that the data has Platykurtic distribution. Jarque-Bera is 5.381081. Probability value is 0.067844 that is showing Energy Consumption (ENERGY) is statistically insignificant.

Globalization (GLOB) is third variable of the model. Mean value of Globalization (GLOB) is 50.30076, median value is 53.72538, maximum value is 64.79038, minimum value is 26.88947. The value of standard deviation of Globalization (GLOB) is 13.63383 and -0.38468 is value of skewness, represent that Globalization (GLOB) is negatively skewed. Kurtosis value of Globalization (GLOB) is 1.57309, represent that the data has Platykurtic distribution. Jarque-Bera is 4.4895. Probability value is 0.105954 that is showing Globalization (GLOB) is statistically insignificant.

Trade (TRADE) is fourth variable of the model. Mean value of Trade (TRADE) is 36.93774, median value is 36.05608, maximum value is 64.47888, minimum value is 12.42485. The value of standard deviation of Trade (TRADE) is 13.52581 and 0.262527 is value of skewness, represent that Trade (TRADE) is positively skewed. Kurtosis value of Trade (TRADE) is 2.410275, represent that the data has Platykurtic distribution. Jarque-Bera is 1.065072. Probability value is 0.587114 that is showing Trade (TRADE) is statistically insignificant.

Domestic Investment (DI) is fifth variable of the model. Mean value of Domestic Investment (DI) is 35.45134, median value is 34.44062, maximum value is 44.51877, minimum value is 23.98875. The value of standard deviation of Domestic Investment (DI) is 6.238777 and -0.01369 is value of skewness, represent that Domestic Investment (DI) is negatively skewed. Kurtosis value of Domestic Investment (DI) is 1.680246, represent that the data has Platykurtic distribution. Jarque-Bera is 2.976773. Probability value is 0.225737 that is showing Domestic Investment (DI) is statistically insignificant.

Foreign Direct Investment (FDI) is sixth variable of the model. Mean value of Foreign Direct Investment (FDI) is 2.615755, median value is 2.613162, maximum value is 6.186882, minimum value is 0.02982. The value of standard deviation of Foreign Direct Investment (FDI) is 1.727243 and 0.160684 is value of skewness, represent that Foreign Direct Investment (FDI) is positively skewed. Kurtosis value of Foreign Direct Investment (FDI) is 1.911124, represent that the data has Platykurtic distribution. Jarque-Bera is 2.201921. Probability value is 0.332552 that is showing Foreign Direct Investment (FDI) is statistically insignificant.

**Correlation Matrix**

It is used to understand the statistical relationship between a matrix of variable correlations. If one variable is increased, while another variable is decreased, the variable's relation is negative. But at the other hand, if one variable is elevated along with another variable, then the relation between the variables is positive. It also displays the orientation of the variables by showing if the variable in the data has a positive or a negative direction.

**Correlation Matrix**

| | ENERGY | GLOB | TRADE | DI | FDI |
|---|---|---|---|---|---|
| ENERGY | 1 | | | | |
| GLOB | 0.872962 | 1 | | | |
| TRADE | 0.597067 | 0.843555 | 1 | | |

| | | | | | |
|---|---|---|---|---|---|
| DI | 0.918517 | 0.899035 | 0.7247 | 1 | |
| FDI | 0.113126 | 0.473468 | 0.655802 | 0.340122 | 1 |

Source: Software E-Views 9.0

Findings of the table 2 represent that Energy Consumption (ENERGY) has positive association with the Globalization (GLOB), Trade (TRADE), Domestic Investment (DI), and Foreign Direct Investment (FDI). Similarly, Globalization (GLOB) has positive association with the Trade (TRADE), Domestic Investment (DI), and Foreign Direct Investment (FDI). Likewise, Trade (TRADE) has positive association with the Domestic Investment (DI), and Foreign Direct Investment (FDI). Also, Domestic Investment (DI) has positive association with the Foreign Direct Investment (FDI). Correlation Matrix is also used to check the multicollinearity in the data. According to the findings of the correlation matrix, multicollinearity not exist in the data of the study.

**Table: Auto-correlation**

| Breusch-Godfrey Serial Correlation LM Test: | | | |
|---|---|---|---|
| F-statistic | 0.2036 | Prob.Value | 0.8168 |

Source: Software E-Views 9.0

Auto-correlation is checked by employing the Breusch-Godfrey Serial Correlation LM Test in the data. Findings of the test show that auto-correlation is not present in the data because probability value is 0.8168 that is greater than 5%.

**Table: Heteroskedasticity Breusch-Pagan-Godfrey**

| Heteroskedasticity Test: Breusch-Pagan-Godfrey | | | |
|---|---|---|---|
| F-statistic | 1.590156 | Prob.Value | 0.1885 |

Source: Software E-Views 9.0

Heteroskedasticity is checked by employing the Heteroskedasticity Breusch-Pagan-Godfrey test. Findings of the test show that heteroskedasticity is present in the data because probability value is 0.1885 that is lesser than 5%.

**Regression Analysis**

Regression analysis is applied to check the impact of all the independent variable on the dependent variable. In this study dependent variable is CO2 while the independent variables are ENERGY, GLOB, TRADE, DI and FDI. After checking the multicollinearity that is data problem and error terms such as auto correlation and hetro. If they exist in the study, then after removing them we will be able to run the regression analysis.

**Table Regression Results**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| ENERGY | 0.003799 | 0.000112 | 33.89276 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| GLOB | -0.00917 | 0.005043 | -1.81907 | 0.0775 |
| TRADE | 0.00047 | 0.002961 | 0.158848 | 0.8747 |
| DI | -0.00518 | 0.008895 | -0.58193 | 0.5643 |
| FDI | 0.061873 | 0.017379 | 3.560152 | 0.0011 |
| R-squared | 0.99799 | | F-statistic | 3475.328 |
| Adjusted R-squared | 0.997703 | | Prob(F-statistic) | 0 |
| Durbin-Watson stat | 1.966961 | | | |

Source: Software E-Views 9.0

Table 4.5 show the regression results of the research. Energy Consumption (ENERGY), Globalization (GLOB), Trade (TRADE), Domestic Investment (DI), and Foreign Direct Investment (FDI) are Independent variables while the Carban Dioxide Emissions (CO2) is dependent variable in this study.

Probability value of Energy Consumption (ENERGY) is 0.0000 and its coefficient value is 0.003799 that indicate that Energy Consumption (ENERGY) is statistically significant and has positive impact on the Carban Dioxide Emissions (CO2) of the country China. When Energy Consumption (ENERGY) is increased by 1 unit, then the Carban Dioxide Emissions (CO2) will be increased by 0.003799 unit. This result is similar to the Khan et al. (2020).

Probability value of Globalization (GLOB) is 0.0775 and its coefficient value is -0.00917 that indicate that Globalization (GLOB) is statistically insignificant and has negative impact on the Carban Dioxide Emissions (CO2) of the Chinese ‘country. That show that Globalization (GLOB) is not taking part in China.

Probability value of TRADE (TRADE) is 0.8747 and its coefficient value is 0.00047 that indicate that TRADE (TRADE) is statistically insignificant and has positive impact on the Carban Dioxide Emissions (CO2) of the Chinese ‘country. That show that TRADE (TRADE) is not taking part in China.

Probability value of Domestic Investment (DI) is 0.5643 and its coefficient value is -0.00518 that indicate that Domestic Investment (DI) is statistically insignificant and has negative impact on the Carban Dioxide Emissions (CO2) of the Chinese ‘country. That show that Domestic Investment (DI) is not taking part in China.

Probability value of Foreign Direct Investment (FDI) is 0.0011 and its coefficient value is 0.061873 that indicate that Foreign Direct Investment (FDI) is statistically significant and has positive impact on the Carban Dioxide Emissions (CO2) of the country China. When Foreign Direct Investment (FDI) is increased by 1 unit, then the Carban Dioxide Emissions (CO2) will be increased by 0.061873 units. This result is similar to the Shahbaz et al. (2015).

Value of R squared is 0.99799 that indicate 99 % variations in the model is explained by independent variables for the dependent variable. Overall fitness of the model is representing by the F-Stat. Its value is positive and its probability value is 0.0000 that show model is fit. Value of the Durbin-Watson stat is 1.966961 which represent auto-correlation is not present in the data.

## Conclusion

The main aim of the research is to check the relationship between the environmental degradation and energy consumption in context of the China for the era of 1980 to 2020 by applying the Ordinary Least Square (OLS) Method to find out the empirical results. Energy Consumption (ENERGY), Globalization (GLOB), Trade (TRADE), Domestic Investment (DI), and Foreign Direct Investment (FDI) are Independent variables while the Carban Dioxide Emissions (CO2) is dependent variable in this study. The present study reviews various literature which are related to environmental degradation and energy consumption. Through the previous literature reviews, the study investigated the mixed results between environmental degradation and energy consumption.

Firstly, we find the result of descriptive statistics. Secondly, the present study analyses correlation results which show that multicollinearity not exist among the independent variables (Energy Use, Globalization, Trade, Domestic Investment, Foreign Direct Investment). In the next step, the study applies Breusch-Godfrey Serial Correlation LM Test and Heteroskedasticity Breusch-Pagan-Godfrey Test to check the auto-correlation and heteroskedasticity. The present study also applies Ordinary Least Square (OLS) method to check the impact of the independent variables on the dependent variable. Findings of Ordinary Least Square (OLS) Method indicate that Energy Consumption (ENERGY) is statistically significant and has positive impact on the Carban Dioxide Emissions (CO2) of the country China. This result is similar to the Khan et al. (2020). While, Globalization (GLOB), TRADE (TRADE) and Domestic Investment (DI) are statistically insignificant that show that these variables are not taking part in China's Carban Dioxide Emissions (CO2). On the other hand, Foreign Direct Investment (FDI) is statistically significant and has positive impact on the Carban Dioxide Emissions (CO2) of the country China. This result is similar to the Shahbaz et al. (2015). the Chinese Governments need to encourage financial growth with empirical results with their negative and significant effects on environmental emissions. They can also encourage investment in new energy sector resources that are advantageous in terms of CO2 emissions.

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