The Policies That Enhance the Decoupling of Economic Growth and Environmental Degradation

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Abstract

The concept of decoupling has emerged as a critical pathway towards sustainable development. Decoupling refers to the separation of economic growth and development from resource consumption and environmental degradation.

The belief that there is a direct relationship between economic growth and environmental pollution remained constant and move in the same direction. Therefore, in order to reduce pollution and emissions, it is necessary to reduce the pace of economic growth. However, the presence of new evidence supporting the possibility of separating them has garnered global attention. This has led to increased international and local efforts in formulating policies and initiatives that promote the pursuit of decoupling economic growth from environmental degradation and accelerating the process of sustainable development.

This study aims to explain the policies that enhance the decoupling by China, Egypt, and European Union (EU) countries to address environmental challenges. The findings highlight the measures undertaken by these countries and regions to mitigate pollution and promote sustainable development. China has made significant progress in reducing air pollution and transitioning to renewable energy sources. Egypt has also implemented various initiatives, particularly in renewable energy and waste management. EU countries, as a group, have adopted ambitious policies and achieved notable decoupling from carbon-intensive practices. However, challenges remain in meeting international climate targets. The study concludes that while progress has been made, further efforts are needed worldwide to accelerate decoupling and achieve sustainable development goals.

Keywords: Decoupling strategies, climate change, Sustainable Development, co2 emission, Environmental Degradation.

السياسات التي تعزز انفصال النمو الاقتصادى عن التدهور البيئى

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الملخص

تطورت فكرة الفصل بين النمو الاقتصادي والتنمية على أنها مسار حاسم نحو التنمية المستدامة. يشير الفصل إلى إمكانية تحقق النمو الاقتصادي والتنمية بعيداً عن مزيد من استهلاك الموارد وتدهور البيئة.

وقد ظل الاعتقاد بوجود علاقة مباشرة وطردية بين النمو الاقتصادي وتدهور البيئة سائداً. وبالتالي، فإن الحد من التلوث والانبعاثات يتطلب تقليل وتيرة النمو الاقتصادي. ومع ذلك، فإن وجود أدلة جديدة تدعم إمكانية الفصل بين النمو الاقتصادي والتلوث البيئي جذب الاهتمام العالمي وأدى إلى زيادة الجهود لوضع السياسات والمبادرات سواء على المستوي الدولي أو المحلي لتعزيز الفصل بين النمو الاقتصادي وتدهور البيئة وتفعيل عملية التنمية المستدامة.

وقد هدفت الدراسة إلى شرح السياسات التي تعزز الفصل بواسطة الصين ومصر ودول الاتحاد الأوروبي لمعالجة التحديات البيئية. كما سلطت الضوء على التدابير التي اتخذتها هذه البلدان للتخفيف من التلوث وتعزيز التنمية المستدامة. وقد أحرزت الصين تقدمًا ملحوظاً فى الفصل بين تلوث الهواء والانتقال إلى مصادر الطاقة المتجددة. كما نفذت مصر أيضًا مبادرات مختلفة، خاصة فى مجال الطاقة المتجددة وإدارة النفايات. واعتمدت دول الاتحاد الأوروبي، سياسات طموحة وحققت فصلًا ملحوظًا عن الممارسات كثيفة الكربون. ومع ذلك، تبقى التحديات قائمة فى تحقيق الأهداف المناخية الدولية. خَلصت الدراسة إلى أنه على الرغم من إحراز تقدم، فإنه من الضروري بذل مزيد من الجهود فى جميع أنحاء العالم لتسريع الفصل وتحقيق أهداف التنمية المستدامة.

الكلمات الرئيسية: استراتيجيات الفصل، تغير المناخ، التنمية المستدامة، انبعاثات ثاني أكسيد الكربون، تدهور البيئة.

1. Introduction

Addressing global environmental challenges has made the achievement of sustainable development an urgent and essential priority. Sustainable development seeks to balance economic growth, social progress, and environmental protection, ensuring that the needs of the present generation are met without compromising the ability of future generations to meet their needs. At the heart of sustainable development lies the concept of decoupling, which plays a pivotal role in breaking the traditional link between economic growth and environmental degradation.

The compatibility between economic growth and ecological sustainability is a subject that continues debated, almost fifty years after the publication of the report "Limits to Growth' in 1972.

The debate revolves around two contrasting perspectives. Advocates of "green growth" argue that technological advancements and structural transformations can facilitate the decoupling of natural resource consumption and environmental effects from economic development and growth. They posit that increased efficiency can pave the way for a higher production of goods and services while minimizing the associated environmental costs. In contrast, proponents of "degrowth" or "post-growth" contend that the limitless expansion of the economy fundamentally clashes with the finite biosphere. According to their stance, reducing environmental pressures necessitates a reduction in production and consumption in affluent nations, which may result in a decrease in GDP compared to current levels. The degrowth approach emphasizes sufficiency, highlighting the notion that consuming fewer goods and services represents the most viable pathway toward achieving ecological sustainability.

currently, the concept of green growth wields significant influence within political circles. The Organization for Economic Co-operation and Development (OECD) officially embraced decoupling as a central goal in 2001, subsequently incorporating it into their comprehensive strategy known as "Towards Green Growth" in 2011. Following suit, the European Commission asserted its commitment to severing the traditional nexus between economic growth and environmental harm in the 6th Environment Action Programme titled "Environment 2010: Our Future, Our Choice" (EU Commission, 2001, p. 3). Furthermore, the European Commission's roadmap to a resource-efficient Europe and the United Nations Environment Programme (UNEP)'s strategy on the green economy both reaffirmed the objective of decoupling growth from resource consumption (European Commission, 2011; UNEP, 2011a, p. 18). These initiatives anticipated that the pursuit of green growth would yield a significant reduction in environmental risks and ecological scarcities.

This paper aims to provide a comprehensive analysis and comparison of decoupling strategies employed by China, Egypt, and EU countries. By evaluating the effectiveness of their policies, identifying areas for improvement, and highlighting successful practices, this study contributes to the ongoing discourse on sustainable development and environmental stewardship. The findings can inform policymakers, researchers, and other stakeholders in shaping future policies and actions towards achieving global decoupling and a sustainable future for all.

2. Methodology

This study employed a comparative analysis approach to evaluate the decoupling strategies of China, Egypt, and EU countries. Primary data was collected from official documents, reports, and government publications. The data was analyzed using qualitative methods, including content analysis and thematic categorization, to identify key policy measures and outcomes. this paper follows quantitative method by calculating elasticity index method for the whole world economies classified according to different income levels, calculating the major countries &sectors contributing co2 emissions, calculating the relationship of co2 and economic growth by the trend equation, & regression analysis which provides an estimated relationship between GDP growth rate and the growth rate of CO2 emissions in Egypt. The Climate Action Tracker ratings were also considered to assess the alignment of countries' efforts with the goals of the Paris Agreement.

3. Literature review

The roots of the decoupling concept can be traced back to several key organizations and initiatives. The Organization for Economic Co-operation and Development (OECD), the World Business Council for Sustainable Development (WBCSD), and the European Union (EU) have played significant roles in promoting and adopting the concept of decoupling.

The Organization for Economic Co-operation and Development (OECD), in its policy paper "Environmental Strategy for the First Decade of the 21st Century" in 2001, recognized resource decoupling as one of the main objectives. The Organization for Economic Co-operation and Development has defined decoupling as breaking the link between environmental impacts (referred to as 'environmental bads') and economic growth ('economic goods').[1]

The World Business Council for Sustainable Development (WBCSD) introduced the term 'eco-efficiency' much earlier in 1992. Eco-efficiency aims to provide competitively priced goods and services that meet human needs while progressively reducing environmental impacts throughout the entire product life cycle. Although the term 'decoupling' was not explicitly used, the concept of reducing resource intensity and environmental impacts aligns with the principles of decoupling.

The European Union (EU) has also embraced the concept of decoupling in its policy frameworks. In 2005, the EU adopted the Lisbon Strategy for Growth and Jobs, which emphasized the sustainable use of natural resources and called for more sustainable consumption and production. This was followed by the EU's objective strategy on the Sustainable Use

(1) OECD Environment Programme. Indicators To Measure Decoupling of Environmental Pressure from Economic Growth, P (1-3)

of Natural Resources, by reducing negative environmental impacts while ensuring economic growth. Through achieving a more sustainable use of resources. The strategy recognized the importance of decoupling resource use and its impacts from economic growth.

In the same context, there are various studies have explored different dimensions of decoupling in different countries and regions to identified trends, obstacles and proposed strategies to achieve decoupling and to be close to achieve sustainable development goals.

In the paper titled "Decoupling Economic Growth and CO2 Emissions in the MENA: Can It Really Happen?" authored by Nathalie Hilmi, Sevil Acar, Alain Safa, and Geoffroy Bonnemaison, the focus is on examining the possibility of reducing carbon emissions while simultaneously fostering economic growth in the Middle East and North Africa (MENA) region. The study encompasses the period from 1960 to 2013. The authors found that while there was some evidence of decoupling between economic growth and CO2 emissions in some MENA countries during certain time periods (such as Tunisia from 2000-2013), overall, there was no clear evidence of decoupling in the region as a whole. They also found that factors such as energy use and sectorial composition had a significant impact on CO2 emissions in the region.

Study the decoupling index for the water use for agriculture with respect to the footprint of agricultural consumption and it has been estimated to indicate relative decoupling. It was found also that the decoupling index for pesticide use and fertilizer use per capita gross agricultural production showed "relative decoupling. It also shows that the dependence of economic development on water resources is gradually decreasing. The government needs to focus on wastewater treatment, promote awareness of water conservation at the same time, and use tiered pricing standards to reasonably control municipal water use. (Gaber, R., & Nour El-Din, M. (2021).

Other study aimed to examine the effect of government policies on the decoupling between air pollution and economic development. analyze the relationship between regional economic growth and air pollution in key regions of air pollution control in China (BTHS, YRD, and PRD). Li, J., Hou, L., Wang, L., & Tang, L. (2021). To evaluate the relationship between regional economic growth and air pollution, this review utilizes the Tapio decoupling theory. based on data of GDP and the concentrations of SO2, PM10, and NO2 for 31 provinces in China from 2000 to 2019. The results show that the SO2, PM10, and NO2 pollution in the key regions show strong and weak decoupling. The findings additionally indicate that government policies have played a significant role in improving the decoupling between air pollution and economic development.

The decoupling of Southeast Asian Nations (ASEAN) region, the ASEAN region experienced an expensive negative decoupling (END) status, indicating a lack of decoupling between economic growth and carbon emissions. Weak decoupling (WD) status was also observed in the region. However, at the national level, Singapore exhibited the most significant strong decoupling (SD) status, while other countries mostly experienced END and WD statuses. The extended decomposition model further clarifies the decoupling process. The results highlight that population, affluence, and energy structure act as major constraints to decoupling, inhibiting the separation of economic growth from carbon emissions. Conversely, energy intensity and carbon intensity contribute positively to the decoupling outcome, thus propelling ASEAN countries toward a region with minimal emissions. Khan, S., & Majeed, M. T. (2020).

In context of studying the world's 20 largest emitters, by using the trend/cycle decomposition that is widely used in many other fields in economics—to investigate the decoupling of emissions and growth. For the twenty largest emitters, the average trend elasticity, viz. the response of trend emissions to a (1%) change in trend GDP, is 0.4. For the advanced economies within this group, the elasticity averages zero; some countries have negative elasticities, suggesting that they had made progress in decoupling their trend emissions from trend GDP. (Cohen, G., Jalles, J. T., Loungani, P., & Marto, R. (2018))

4. Decoupling concept

The relationship between economic growth and environmental pollution has continued to move in the same direction. So, increasing production (GDP) currently raises pressure on the environment However, the presence of new evidence supporting the possibility of separating them has garnered global attention. This has led to increased international and local efforts in formulating policies and initiatives that promote the pursuit of decoupling economic growth from environmental degradation and accelerating the process of sustainable development.

Decoupling concept refers to the separation of economic growth and development from resource consumption and environmental degradation. Decoupling represents a strategic approach for moving forward a global Green Economy - one that "results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.[1]

Fischer-Kowalski (2011) expands on the concept of resource decoupling by noting that decoupling is reducing the rate of resource use per unit of economic activity. Furthermore, this is the idea of using less material, energy, water, and land resources for the same economic output (Fischer-Kowalski 2011). Decoupling theory has been used to study this relationship between economic growth and various indicators on environmental impact, specifically energy consumption (Wu et al. 2018). [2]

Although it may be difficult to design a system-wide set of interventions capable of decoupling resource use from all negative environmental impacts simultaneously, it has become a core goal in many economies to be able to achieve economic growth while reducing environmental deterioration.

(1) United Nations Environment Programme. International Resource Panel. (2011). Decoupling natural resource use and environmental impacts from economic growth. UNEP/Earthprint, page(11-13)

(2) Somani, Z. (2021). Decoupling of Economic Growth from Environmental Degradation. In: Leal Filho, W., Azul, A.M., Brandli, L., Lange Salvia, A., Wall, (eds) Decent Work and Economic Growth. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. https://doi.org/10.1007/978-3-319-95867-5_27 p (5)

"Decoupling" becomes one of the main objectives of environmental strategy by the OECD Ministers in 2001, which refers to breaking the link between "environmental bads" and "economic goods." Decoupling occurs when the growth rate of an environmental pressure is less its economic driving force (e.g. GDP) at a given period.[(1)]

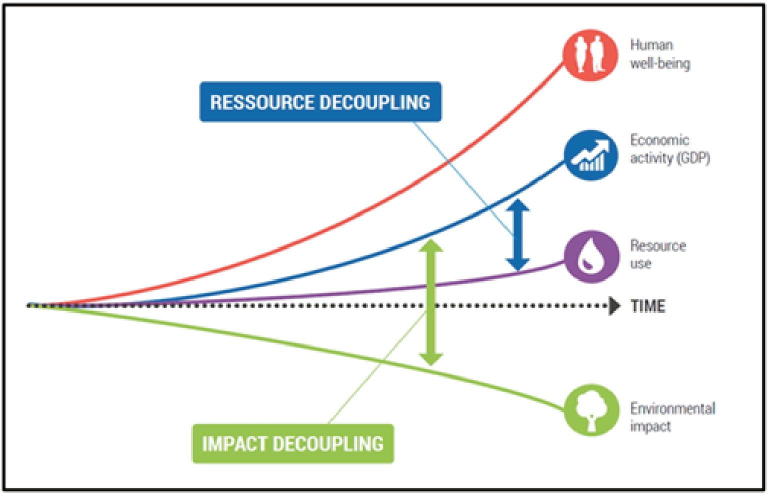
Decoupling can be classified into two types as follow:

1.1 Relative decoupling: This occurs when the rate of environmental degradation or resource use decreases relative to economic growth. In other words, while the negative environmental impacts may still increase, they do so at a slower rate compared to economic expansion. Relative decoupling is often achieved through improvements in efficiency, technological advancements, and changes in production and consumption patterns.

1.2 Absolute decoupling: This refers to a situation where economic growth is no longer accompanied by an increase in environmental degradation. In absolute decoupling, the negative environmental impacts decrease in absolute terms, even as the economy continues to grow. This requires not only efficiency improvements but also fundamental changes in production systems, energy sources, and the adoption of sustainable practices.

(1) Rosa María Regueiro-Ferreira, Pablo Alonso-Fernandez. Ecological elasticity, decoupling, and dematerialization: Insights from the EU-15 study (1970–2018),journal of *Ecological Indicators,* Volume 140, july 2022, 109010,p(2-5)

Figure (1) Types of Decoupling



Source: Circular Economy, utopia or promising new business model? An evaluation of Circular Economy efficiency against environmental challenges, September 2019.

Decoupling Index “DI” is the ratio between the relative variation of environmental impacts (EI) and the relative variation of the economic output, in terms of GDP [1], for a defined timeframe as illustrated as the following equation (1):

$$DI = \frac{\Delta EI}{\Delta GDP} = \frac{(EI_{t+1} - EI_t)/EI_t}{(GDP_{t+1} - GDP_t)/GDP_t} \quad \text{.......................} (1)$$

$$DI = \frac{\Delta EI}{\Delta GDP} = \frac{(EI_{t+1} - EI_t)/EI_t}{(GDP_{t+1} - GDP_t)/GDP_t}$$

5. Global Emissions by Gas

At the global scale, the key greenhouse gases emitted by human activities are:

1. Carbon dioxide (CO_2): CO_2 accounts for approximately 73% of total greenhouse gas emissions. It is primarily released through

(1) Rabab Gaber, M Nour El-Din. “Enhancement Of Water Security by Decoupling Water use from Economic Development in Egypt”, Journal of Al-Azhar University Engineering Sector, 2021, pages. (1-3)

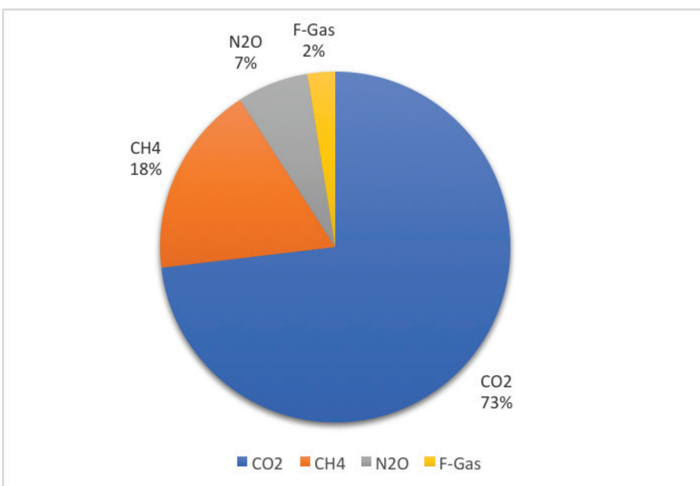
the burning of fossil fuels, deforestation, and land-use changes. CO2 emissions are closely tied to energy production, transportation, and industrial processes.

2. Methane (CH4): Methane contributes to around 18% of global greenhouse gas emissions. It is emitted from various sources, including agricultural practices such as livestock farming and rice cultivation, as well as the extraction and transport of fossil fuels. Methane is also released from natural sources like wetlands and permafrost.

3. Nitrous oxide (N2O): Nitrous oxide is responsible for approximately 7% of global greenhouse gas emissions. It is mainly emitted from agricultural activities, such as the use of nitrogen-based fertilizers and livestock waste management. Industrial processes and the combustion of fossil fuels also contribute to N2O emissions.

4. Fluorinated gases (F-Gases): F-Gases make up roughly 3% of global greenhouse gas emissions. This category includes hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). These gases are primarily released from industrial processes, such as refrigeration and air conditioning, electrical transmission systems, and semiconductor manufacturing.

Figure (2): Global Emissions by Gas



Source: prepared by the researchers, climate watch data website

6. Global CO2 Emissions

Emissions of carbon dioxide and other greenhouse gases– are a primary driver of climate change – and present one of the world's most pressing challenges. This link between global temperatures and greenhouse gas concentrations – especially CO2 – has been true throughout Earth's history.

Global CO2 emissions declined by 5.8% in 2020, or almost 2 Gt CO2 – the largest ever decline and almost five times greater than the 2009 decline that followed the global financial crisis. CO2 emissions fell further than energy demand in 2020 owing to the pandemic hitting demand for oil and coal harder than other energy sources while renewables increased. Despite the decline in 2020, global energy-related CO2 emissions remained at 31.5 Gt, which contributed to CO2 reaching its highest ever average annual concentration in the atmosphere of 412.5 parts per million in 2020 – around 50% higher than when the industrial revolution began.[(1)]

In 2021 global energy-related CO2 emissions are projected to rebound and grow by 4.8% as demand for coal, oil and gas rebounds with the economy. The increase of over 1 500 Mt CO2 would be the largest single increase since the carbon-intensive economic recovery from the global financial crisis more than a decade ago, it leaves global emissions in 2021 around 400 Mt CO2, or 1.2%, below the 2019 peak.[(2)]

Most of the world's energy needs are met by burning fossil fuels, which releases carbon dioxide. The rise in global emissions has been dramatic: half of all human-generated carbon dioxide emissions since 1750 have occurred since 1970 (IPCC, 2014a). Humans added about 42 Giga tonnes of carbon dioxide to the atmosphere in 2018.

the global CO2 emissions remained relatively stable from 2000 to 2005, ranging between 23.5 and 26.2 billion metric tons. However,

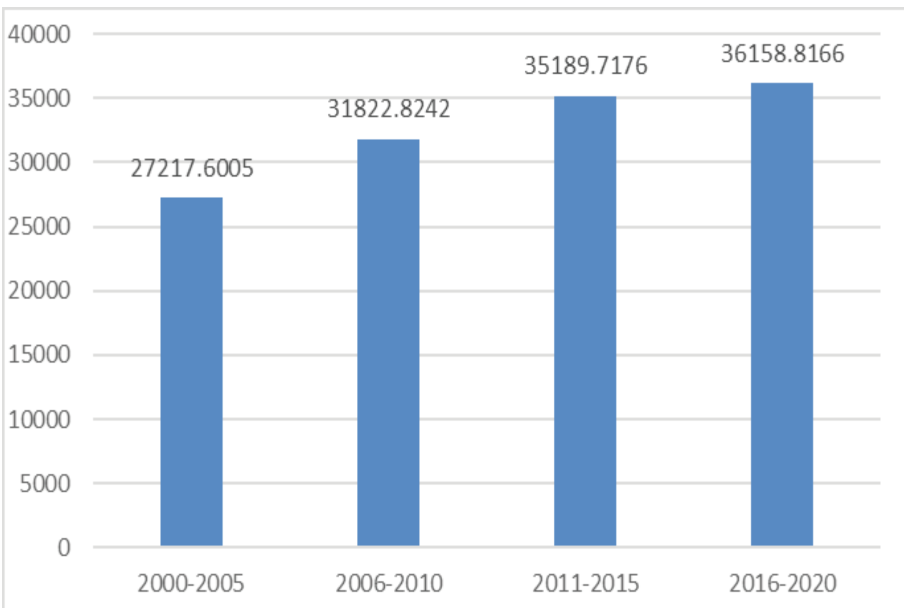
(1) International Energy Agency website: https://www.iea.org/reports/global-energy-review-2021/co2-emissions> accessed on 15/5/2023

(2) Ibid

starting from 2006, there was a steady increase in emissions. This upward trend continued with fluctuations until 2010 when the emissions crossed the 30 billion metric ton mark for the first time. Between 2010 and 2015, there was a significant acceleration in CO2 emissions. The emissions rose from 30.2 billion metric tons in 2010 to 35.4 billion metric tons in 2015. This period witnessed a substantial increase in industrialization, energy consumption, and economic growth in various parts of the world, leading to higher emissions.

The years 2016 to 2019 saw a continuation of the increasing trend, but with a slower pace. The global CO2 emissions reached a record high of 36.8 billion metric tons in 2019. This highlights the ongoing challenges of addressing and reducing CO2 emissions to mitigate climate change and its associated impacts.

FIGURE (1): World Co2 Emission From 2000-2020 (In Mtco2)



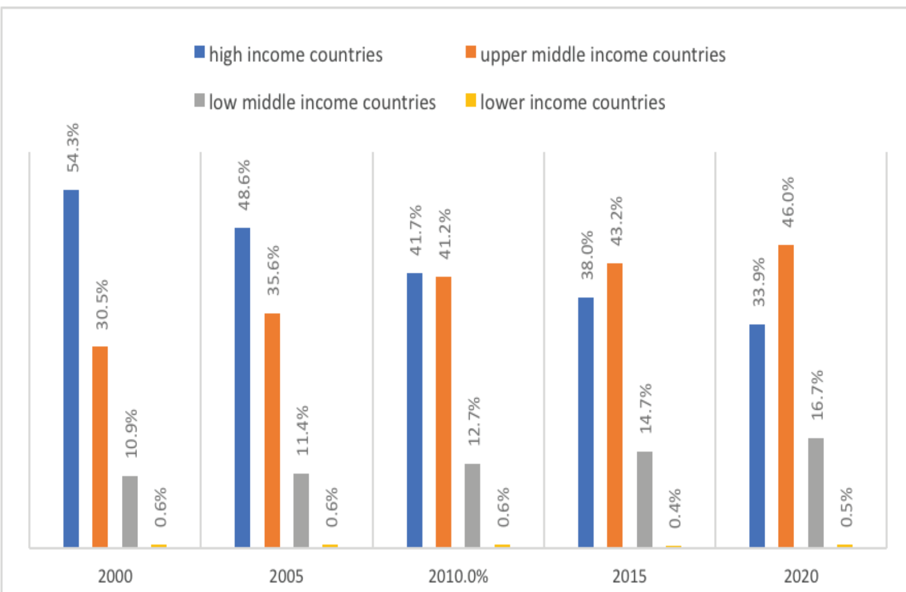
Source: prepared by the researchers, using World Bank indicators database and climate watch data website

Referring to figure (2) we can notify that in spite of the high-volume rates of co2 emission that were generated from the high-income levels countries, these emission witnesses a declining trend from 54.3% in 2000 to 33.9% in 2020.

This suggests that high-income levels countries have been successful in reducing their CO2 emissions over time. It indicates that these countries have likely implemented effective environmental policies, adopted cleaner technologies, and promoted renewable energy sources.

In contrast to the high-income trend the CO2 emissions in upper-middle income countries have shown a consistent increase from 30.5% in 2000 to 46.0% in 2020. See figure (2)

Figure (2): Development of CO2 Emissions by Different Income Levels Countries.



Source: prepared by the researchers, using World Bank indicators database and climate watch data website

CO2 emissions in low-middle income levels countries have increased steadily over the years, from 10.9% in 2000 to 16.7% in 2020. Similar to upper-middle income countries, this trend suggests economic growth and industrialization.

Where CO2 emissions in lower income levels countries have remained relatively stable throughout the years, fluctuating between 0.4% and 0.6%. Due to their limited industrialization and economic activities, the contribution of lower income countries to global CO2 emissions is minimal. However, it is essential to provide comprehensive support to these nations in their development efforts, ensuring the early adoption of sustainable practices.

In 2020, global CO_2 emissions from fuel combustion showed an unprecedented decline of nearly 6% as the COVID-19 pandemic decreased global energy demand. Fossil fuels still represented 80% of the total energy supply (TES) globally, with oil comprising 29%, followed by coal (27%) and natural gas (24%). Global emissions from fuel combustion were dominated by coal (45%), followed by oil (32%) and natural gas (22%).[1]

China and the United States together were responsible for 45% of the global fuel combustion emissions, followed by European Union, India, the Russian Federation and Japan. Exploring the evolution of GHG emissions from fuel combustion across a range of countries in our interactive chart below.

(1) Calculated by researchers using World Bank indicators database and climate watch data website, accessed on 20/5/2023

Table (1): shows the proportion of global

CO2 emissions attributed to each country or region

Country/Region		2000	2005	2010	2015	2020
China	mtCO2e	3644.46	5876.56	8616.65	9866.9	10956.21
	percent	14.3%	19.8%	25.8%	27.7%	31.1%
United States	mtCO2e	6016.35	6137.6	5681.39	5376.58	4715.69
	percent	23.6%	20.7%	17.0%	15.1%	13.4%
European Union (27)	mtCO2e	3602.4	3735.9	3432.6	3092.7	2621.8
	percent	14.2%	12.6%	10.3%	8.7%	7.4%
India	mtCO2e	978.1	1184.93	1676.49	2270.77	2445.01
	percent	3.8%	4.0%	5.0%	6.4%	6.9%
Russia	mtCO2e	1478.18	1559.08	1626.19	1629.71	1624.22
	percent	5.8%	5.3%	4.9%	4.6%	4.6%
Japan	mtCO2e	1264.59	1290.6	1215.06	1223.61	1042.22
	percent	5.0%	4.4%	3.6%	3.4%	3.0%

Source: calculated by the researchers by using climate watch data website

From the previous table we can illustrate that:

- China has experienced a significant increase in CO2 emissions over the studying period, increasing from 3644.46 mtCO2e in 2000 to 10956.21 mtCO2e in 2020. The percentage of global CO2 emissions contributed by China has also increased steadily, from 14.3% in 2000 to 31.1% in 2020. This trend can be attributed to China's rapid economic growth and industrialization during this period. It suggests that China's increasing energy demands and reliance on fossil fuels have contributed to higher carbon emissions.

- The United States has experienced relatively stable CO2 emissions over the years, with a slight decline from 6016.35 mtCO2e in 2000 to 4715.69 mtCO2e in 2020, while the contribution percentage by the United States of global CO2 emissions has decreased from 23.6% in 2000 to 13.4% in 2020.

- The CO_2 emissions of the European Union (27) have shown a gradual decrease from 3602.4 mtCO2e in 2000 to 2621.8 mtCO2e in 2020. The contribution percentage of global CO2 emissions by the European Union (27) has also decreased from 14.2% in 2000 to 7.4% in 2020. This decline can be attributed to efforts aimed at improving energy efficiency, promoting renewable energy, and implementing climate policies within the European Union.

- India's CO2 emissions have steadily increased over the years, rising from 978.1 mtCO2e in 2000 to 2445.01 mtCO2e in 2020. The contribution percentage of global CO2 emissions by India has also increased from 3.8% in 2000 to 6.9% in 2020.

- Russia's CO2 emissions have remained relatively stable, with only slight fluctuations between 1478.18 mtCO2e in 2000 and 1624.22 mtCO2e in 2020. The contribution percentage of global CO2 emissions by Russia has remained around 5% throughout this period.

- Japan's CO2 emissions have shown a slight decline from 1264.59 mtCO2e in 2000 to 1042.22 mtCO2e in 2020. The contribution percentage of global CO2 emissions by Japan has also decreased from 5.0% in 2000 to 3.0% in 2020.

7. The global CO2 emissions by sectors

The analysis of CO2 emissions by sectors provides valuable insights into the global distribution of greenhouse gas emissions and sheds light on the key contributors to climate change. Understanding the sectoral breakdown of emissions is crucial for identifying areas where targeted interventions can have the greatest impact in reducing carbon footprints. In this analysis, we will delve into the data representing CO2 emissions by sectors worldwide and explore the implications for policymakers, businesses, and individuals striving to address the urgent challenge of climate change.

The data reveals a comprehensive picture of CO2 emissions, encompassing various sectors that significantly contribute to the global carbon footprint. We will examine each sector in detail, considering their respective contributions and potential strategies for emission reduction. By adopting an economist's perspective, we will explore the economic implications and opportunities associated with transitioning to more sustainable practices within each sector.

Referring the data of table (3), it reveals that the energy sector is the main contributor to global CO2 emissions, which accounting for 73.2% of the total emissions of co2. This is a significant finding and emphasizes the urgent need to address emissions from energy production and consumption. It suggests that transitioning to cleaner and more sustainable energy sources should be a top priority in mitigating climate change. Within the energy sector, emissions from buildings and industry constitute a considerable portion, with 17.5% and 24.2% respectively. This highlights the importance of improving energy efficiency in buildings and implementing cleaner technologies in industrial processes. Investing in renewable energy and promoting energy conservation measures can significantly reduce CO2 emissions in these areas.

The transport sector accounts for 16.2% of global CO2 emissions. This is a significant share and indicates the environmental impact of transportation systems worldwide. Encouraging the adoption of electric vehicles, improving public transportation infrastructure, and promoting alternative modes of transport such as cycling and walking can help reduce emissions in this sector.

Agriculture, Forestry & Land Use is another significant contributor, accounting for 18.4% of global CO2 emissions. Within this sector, emissions from livestock and manure are particularly noteworthy, representing 5.8% of total emissions. This suggests that sustainable agricultural practices, such as efficient livestock management and waste management systems, are crucial for reducing emissions in this sector.

The industrial processes sector, including cement production and chemical/petrochemical industries, contributes 5.2% of global CO2 emissions. Implementing cleaner technologies, improving process efficiency, and promoting circular economy principles can help mitigate emissions in these industries.

Waste management, including landfills and wastewater, accounts for 3.2% of global CO2 emissions. This indicates the importance of implementing waste reduction strategies, recycling programs, and adopting sustainable waste treatment methods to minimize emissions.

Table (3): Shows Global co2 emission by sectors in 2020

Energy	73.2	Transport	16.2
		Energy in buildings (electricity and heat)	17.5
		Energy in industry	24.2
		Energy in Agri & Fishing	1.7
		Unallocated fuel combustion	7.8
		Fugitive emissions from energy	5.8
Industrial processes	5.2	Cement	3
		Chemical & petrochemical (industrial)	2.2
Waste	3.2	Landfills	1.9
		Wastewater	1.3
Agriculture, Forestry & Land Use (AFOLU)	18.4	Livestock & Manure	5.8
		Rice Cultivation	1.3
		Agricultural Soils	4.1
		Crop Burning	3.5
		Forest Land	2.2
		Cropland	1.4
		Grassland	0.1

Source: calculated by the researchers, using World Bank indicators database and climate watch data website

8. Decoupling in China

8.1 Decoupling index for China

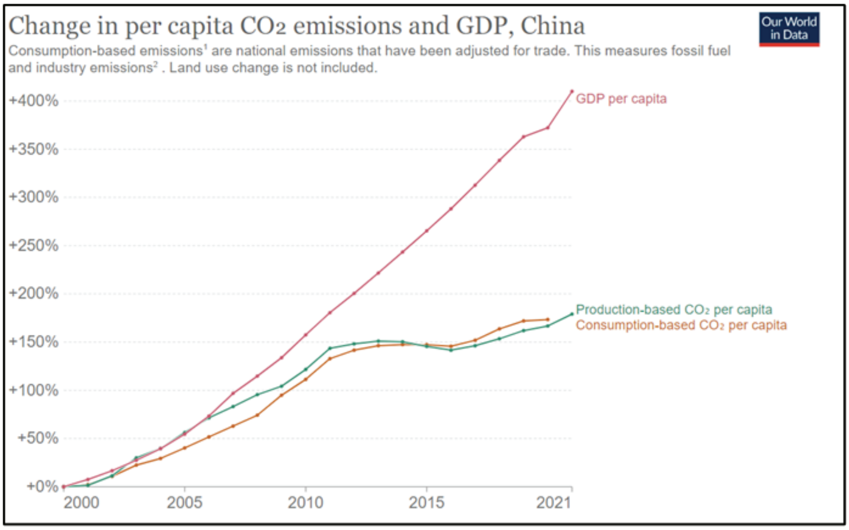
The decoupling trend in China fluctuates over the years. From 2000 to 2006, there is a general increasing trend, indicating a positive decoupling between CO2 emissions and economic growth. However, after 2006, the trend becomes more volatile with periods of positive and negative decoupling. this relationship can be illustrated by the following trend equation:

CO2 Emissions Growth Rate = 0.295 * GDP Growth Rate + 2.073

The decoupling index (0.295) indicates to relative decoupling through the studying period (2000-2021).

Where the decoupling trend per capita in China shows a steady increase in GDP per-capita from 2000 to 2021. Where the growth of co2 per-capita rise but, in less percentage. AS GDP per capita increased approximately 409.97% from the base year 2000, while CO2 emissions per capita (production-based) grew about 179.37%, and CO2 emissions per capita(consumption-based) increased around 172.53% during the same period. as illustrate in the following figure (3):

Figure (3): Change In Per-Capita CO2 And GDP IN CHINA



Source: Our World in Data Website https://ourworldindata.org/co2/country/china?country=~CHN

8.2 Main Source of Co2 Emissions in China

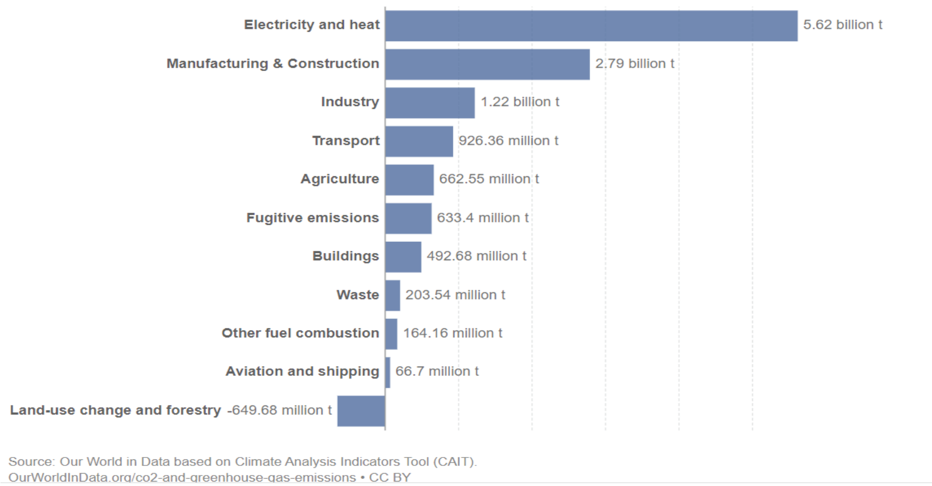
The largest source of CO2 emissions in China is from the production of electricity and heat. With its vast energy demands, China heavily relies on coal-fired power plants, which contribute significantly to carbon emissions accounting for 5616.35 million metric tons (52%) of emissions, followed by manufacturing and construction at 2785.76 million metric tons (26%).

As one of the world's manufacturing powerhouses, China's industries often use energy-intensive methods, leading to substantial CO2 emissions. Implementing energy-efficient practices and adopting cleaner technologies could help mitigate emissions in this area.

The industrial sector accounts for 11.4% of China's CO2 emissions. The emissions stem from energy-intensive heavy industries such as steel and cement production.

The transport sector is responsible for 8.6% of China's CO2 emissions. As the number of vehicles and transportation demands increase, so do emissions from this sector. Where The agriculture sector contributes 6.2% of China's CO2 emissions, primarily due to methane emissions from livestock and rice cultivation. Other sectors have As shown in the following figure ()

Figure (4): The CO2 Emissions in China by Sectors



source: Our World in Data Website: https://ourworldindata.org/co2/country/china?country=~CHN

9. Decoupling in European union (EU)

9.1 Decoupling index in European union (EU)

The EU experienced mixed performance in terms of decoupling during the analysed periods. As show in the following table:

Table (4): Decoupling index in European union (EU) from 2000-2020

periods	GDP Growth Rate (%)	Growth Rate of Co2 Emissions (%)	DI
2000-2004	2.14	0.91	0.42
2005-2009	0.97	-2.32	-2.38
2010-2014	0.99	-1.79	-1.81
2015-2019	2.20	-0.87	-0.39

the previous table (4) illustrated the following:

- In the first period from 2000 to 2004, the economy experienced a positive GDP growth rate of 2.14%. At the same time, CO2 emissions increased by 0.91%. The DECOUPLING value of 0.42 suggests that there was a modest but positive effort to decouple economic growth from carbon emissions, indicating that the economy managed to achieve some level of economic growth while keeping the growth of CO2 emissions relatively low.
- In the next period from 2005 to 2009. The DI value is negative (-2.38), indicating strong decoupling. During this period, the EU achieved economic growth while reducing CO2 emissions, showing progress towards sustainability.
- During the (2010-2014) The Decoupling value of -1.81 suggests that the economy maintained a relatively strong degree of decoupling between economic growth and carbon emissions, aligning with sustainable development goals.
- Where the period from (2015-2019) the Decoupling value of -0.39 indicates that the economy continued to achieve a certain level of decoupling, though not as strong as in the previous period.

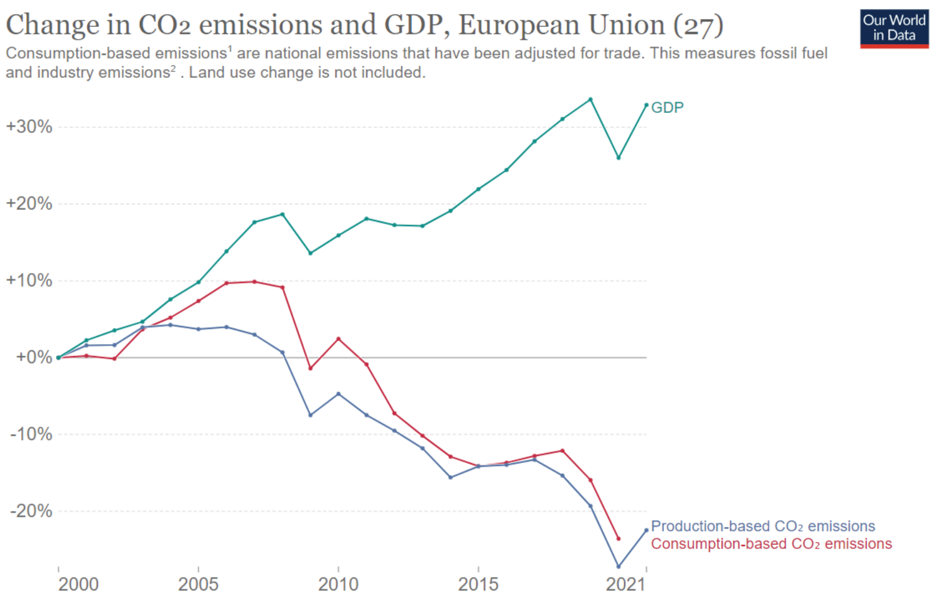
As a result of the COVID-19 pandemic during 2020 the EU economy experienced a sharp decline in GDP growth, with a negative rate of -5.68%. Simultaneously, there was a significant reduction in CO2 emissions growth, with a decline of -9.79%. The DECOUPLING value of 1.72 indicates that, despite the economic contraction, there was a notable decoupling effect.

The overall relationship of co2 and economic growth rate in EU can be illustrated by the following trend equation:

CO2 Emissions Growth Rate = -0.355 * GDP Growth Rate + 1.019

The decoupling coefficient -0.355 indicate to a medium decoupling between co2 emissions and economic growth rate. The following figure shows the growth of GDP and co2 emissions in EU per-capita illustrated strong decoupling starting from 2009 to 2020.

Figure (5): Change in Per-Capita CO2 And GDP in EU



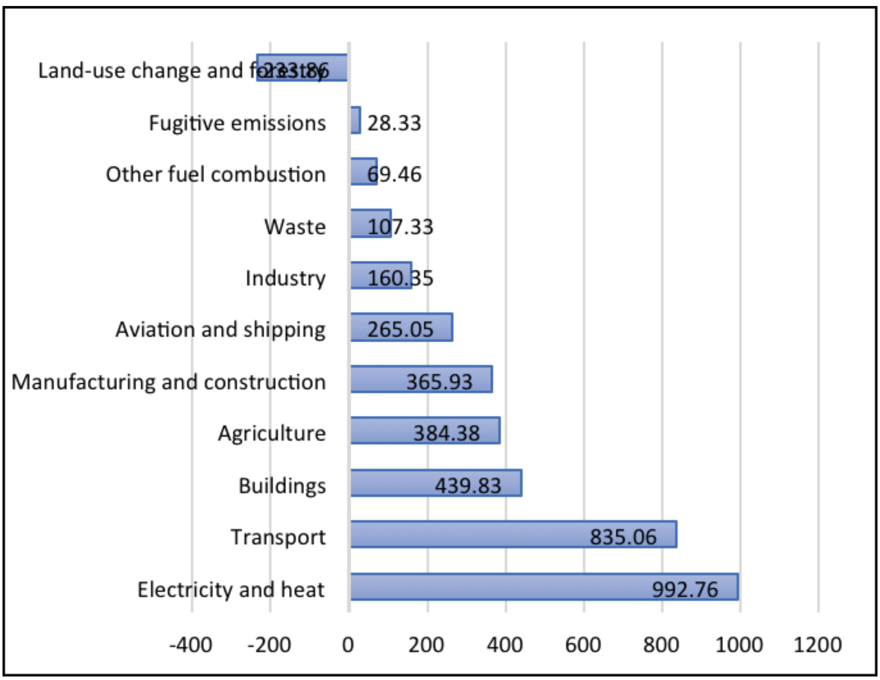
Source: Our World in Data Website: Source: Our World in Data Website https://ourworldindata.org/co2/

9.2 Main Source of Co2 Emissions in EU

The electricity and heat sector are the largest contributor (34%) with 992.76 MtCO2, this sector includes emissions from the production of electricity and heat through various sources, such as coal, natural gas, oil, and renewable energy sources. followed by transport sector that emits 835.06 MtCO2 which represent (29%) This sector includes emissions from road transport, aviation, shipping, and other transportation modes. and the buildings sectors emits 439.83 MtCO2 that represent (15%).

While Agriculture and manufacturing emits 384.38 MtCO2 and 365.93 MtCO2 respectfully, each contribute 13%, while aviation and shipping account for 9% of emissions. This is illustrated in the following figure (6)

Figure (6): CO2 Emissions in European Union (27) By Sectors



Source: prepared by researchers depending on data from our world in data website: https://ourworldindata.org/

10. Decoupling in Egypt

10.1 Decoupling index for Egypt

In order to find if Egypt is achieving decoupling, we had to measure Decoupling Index "DI" to figure out if Egypt succeeded to achieve economic growth with the least negative effect on environment.

Table (5) shows Decoupling Index "DI" for Egypt

Egypt, Arab Rep.	GDP Growth Rate (%)	Growth Rate of Co2 Emissions (%)	Decoupling
2000-2004	3.9	4.2	1.1
2005-2009	6.0	6.4	1.1
2010-2014	2.8	2.3	0.8
2015-2019	4.8	2.6	0.5
2020	3.6	-7.9	-2.2

Source: calculated by the researchers, using World Bank indicators database

From the previous schedule after calculations for growth in co2 emissions , GDP growth rate, elasticity to find the value of decoupling index ,we found that average value for the index through approximately 20 years is "0.7" which indicates a relative decoupling "0<DI<1", which means that the environmental negative impact increases with a slower rate than the rate of the economic growth, and this assures the government efforts to eliminate the negative effect of economic growth on environment which reflects the main goal of government sustainable development plans.

Based on the provided data for Egypt, analysing the behaviour of the GDP growth rate, growth rate of CO2 emissions, and the decoupling index for four different periods: 2000-2004, 2005-2009, 2010-2014, 2015-2019 and 2020.

- During the period from 2000 to 2004, Egypt experienced positive GDP growth of 3.9%. Simultaneously, CO2 emissions also increased by 4.2%. this indicates a "non- decoupling" case.

- In period between (2005-2009), The Decoupling value of 1.1 remained the same as in the previous period, indicating that the decoupling effect was consistent, suggesting that the growth in economic activity was still closely linked to the increase in carbon emissions.

- During this period from 2010 to 2014, the growth rate of CO2 emissions (2.3%) was relatively lower than the GDP growth rate (2.8%), indicating a weaker level of decoupling. This suggests that the economic growth during this period was more closely tied to the increase in carbon emissions

- During (2015-2019), the GDP growth rate increased to 4.8%, while the growth rate of CO2 emissions reached to 2.6%, which illustrates an improvement in decoupling index compared to the previous period, indicating that an environmental impact grows at a slower rate than economic growth.

- In 2020, Egypt experienced positive GDP growth of 3.6%. Surprisingly, CO2 emissions decreased by -7.9%, indicating a significant reduction in carbon emissions during the year. The Decoupling value of -2.2 suggests a strong decoupling effect.

The regression equation of the relationship between GDP growth rates and the growth rate of CO2 emissions for Egypt would be:

$Y = -0.507 + 0.375X$

Where: X represents the GDP growth rate and Y represents the growth rate of CO2 emissions.

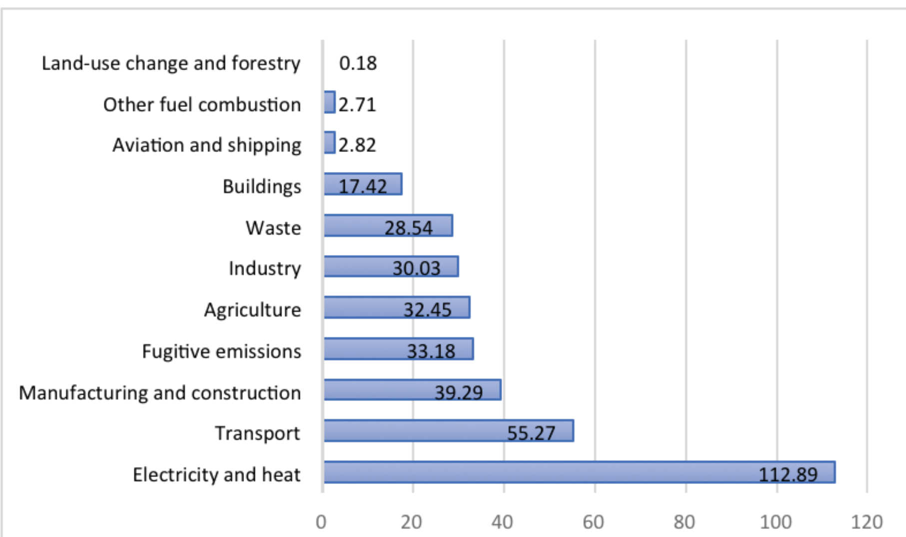
This equation shows the estimated relationship between the GDP growth rate (X) and the growth rate of CO2 emissions (Y) in Egypt. The coefficient 'b' (0.375) indicates that for every 1% increase in GDP growth rate, the growth rate of CO2 emissions is expected to increase by 0.375%.

10.2 Main Source of Co2 Emissions in Egypt

The data on CO2 emissions by sectors of Egypt provides valuable insights into the major contributors to the country's greenhouse gas emissions. The largest contributor is the "Electricity and Heat" sector, accounting for 112.89 metric tons of CO2 equivalent emissions. This sector encompasses emissions from power plants and industrial facilities that burn fossil fuels to generate electricity and heat. Given its significant share, it highlights the importance of transitioning towards cleaner and more sustainable energy sources to reduce the country's carbon footprint.

The "Transport" sector follows closely behind, contributing 55.27 MtCO2e. This sector includes emissions from various modes of transportation, such as road, rail, air, and maritime. Another notable contributor is the "Manufacturing and Construction" sector, accounting for 39.29 MtCO2e. This sector's emissions stem from industrial processes and construction activities. The following figure (7) illustrate the Main Source of Co2 Emissions in Egypt.

Figure (7) Main Source of Co2 Emissions in Egypt by sectors



Source: our world in data website: https://ourworldindata.org/co2/country/egypt

11. Polices that enhancing the decoupling indicators

Enhancing decoupling indicators between (CO2) emissions and economic growth is a global priority in the pursuit of sustainable development. By examining the policies implemented in the European union and China, we can observe common themes and approaches that have proven effective in enhancing decoupling indicators.

11.1 China policies:

Pollution levels in China rated the country as one of the most polluted nations in the world over the past few decades. In 2019, China accounted for more than a quarter of global greenhouse gas emissions, with per capita CO2 emissions of 9 tons, exceeding the EU's approximate level of 7.5 tons and the global average of 6.26 tons.(1)

Recognizing the challenge of air pollution, China has taken remarkable steps in recent years to address the issue through decisive actions and policies. The Chinese government has implemented strategies to reduce air pollution and successfully waged a war against it. Between 2013 and 2020, pollution exposure across the Chinese population decreased by an average of 39.6%.

To improve air quality, China launched "the National Air Quality Action Plan", which sets certain targets aiming to be achieved by the end of 2017. The plan allocated $270 billion, with an additional $120 billion set aside by the Beijing city government, to combat air pollution.

The government has implemented several strategies to achieve these goals. It has included pollution reduction as a criterion for government officials' incentives, linking promotions to both environmental audits and the economic performance of their positions. This incentivizes provincial and local officials to prioritize environmental improvements as part of their responsibilities.

(1) International Energy Agency, CO2 Emissions in 2022, China, 2023

China has also taken measures such as prohibiting the construction of new coal-fired plants and encouraging existing coal plants to reduce emissions or natural gas transition. In 2017, China shut down 27 coal mines in Shanxi province as they were largest coal producers. Beijing closed its last coal-fired power plant by January 2018, and plans for the construction of 103 more plants were cancelled at the national level.

The country has made significant progress in increasing renewable energy generation, with renewable sources accounting for nearly a quarter of China's energy production in 2017.

China has addressed air pollution in the industrial sector by eliminating the capacity of making iron and steel. During (2016 - 2017), 115 million tons of steel capacities were shut down.

To control vehicle emissions, China has implemented measures such as restricting the number of cars in major cities like Beijing, Shanghai, and Guangzhou. The mentioned above have a limited quota for the issuance of new license plates each year, effectively reducing the total number of cars on the roads.(1)

Stringent emissions standards have been enforced, leading to the suspension of production for 553 car models in 2017. These vehicles did not meet fuel economy standards, including those produced by both foreign and local companies.

China has also prioritized credibility as a result of transparency in reporting air quality statistics. By March 2017, there were more than 5,000 monitoring stations throughout the country.

China has implemented large-scale reforestation and landscape restoration programs, recognizing the land-use change and forestry (LULUCF) sector as a crucial carbon sink. In 2019, this sector absorbed approximately 5% of China's greenhouse gas emissions, with the capacity of the LULUCF sink doubling since 2005.

(1) Gregor Erbach and Ulrich Jochheim; Graphics: Ville Seppälä. China's climate change policies, European Parliamentary Research Service,2022, p (1-4)

China became a party to the United Nations Framework Convention on Climate Change (UNFCCC) and ratified the Paris Agreement in 2016. The Paris Agreement aims to limit global warming and enhance countries' ability to address climate change impacts. China's efforts in reducing pollution have played a significant role in the global average decline since 2013. After consistently ranking among the five most polluted countries from 1998 to 2019, China became no longer one of the top five in 2020. The Beijing-Tianjin-Hebei area, previously heavily polluted, experienced a 48.8% reduction in particulate pollution.

As the largest emitter of CO2 among UNFCCC members (20.09%), China is classified as a non-Annex I country and is eligible for support from developed nations.

In October 2021, China officially submitted its own long-term low greenhouse gas emission development strategy ahead of COP26. The strategy includes targets to achieve carbon neutrality by 2060, reducing the intensity of Carbon to 65% by 2030, reach over 1200 GW of installed wind and solar power, and increase the country's forest stock by 6 billion Cm3 above the 2005 level by 2030.

However, according to the Climate Action Tracker, China's emissions by 2030 are projected to be 28% higher than 2010 levels, compared to 1990 and 2010. The Nationally Determined Contribution (NDC) target, which is a climate action plan, is deemed insufficient both against modelled domestic pathways and the fair share perspective. Notably, China lacks a separate target for LULUCF, although it does have a forest stock volume target.

The "Insufficient" rating signifies that China's NDC target for 2030 requires significant improvements to align with the 1.5°C temperature limit. If other countries adopt China's approach, global warming could exceed 2°C or even reach 3°C.

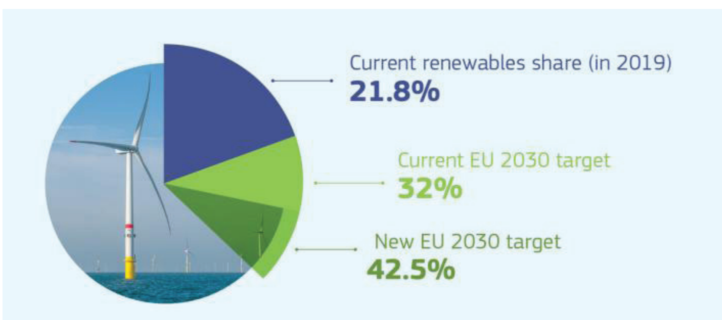
Climate Action Tracker also evaluated China's net-zero target as "Poor." The Long-Term Strategy (LTS) submitted by China only covers CO2 emissions, while it is assumed that it should encompass all greenhouse gases. China has not provided information regarding its intention to use international offset credits to achieve its net-zero target.[1]

11.2 EU policies:

The European Union (EU) has a remarkable contribution regarding a global climate policy, particularly through its active participation in the Paris Agreement. EU shares its expertise with non - EU countries & encourages partners to take more effective actions against global warming, & providing advice where or when needed. In fact, the EU and its member states are recognized as the largest providers of public climate finance worldwide, having provided €23 billion in funding to developing countries in 2021.

Early in the end of 2008, the European Parliament stated a package for Climate and Energy, as it well-known 20-20-20 targets. Three major goals for climate and energy policy were set as follow: Lessing co2 emissions by at least 20% of 1990 levels, decreasing energy consumption by 20% of 2020 levels through improved energy efficiency, and encouraging the percentages of renewable energy sources to 20% of total energy outcome (currently around 8.5%).[2]

Figure (8) shows Eu's renewable energy binding targets



Source: European commission, Renewable energy targets

(1) Climate Action Tracker, China, 2023, p (3-8)
(2) https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2020-climate-energy-package_en accessed on 10/6/2023

The EU has also taken significant steps to address emissions from vehicles. It implemented the first binding limits on CO2 emissions in 2009, aiming to lessen the average amount of car sold in Europe emitted no more than 130 g/km of CO2 by 2015, and no more than 95 g/km by 2020. Additionally, the EU amended the Fuel Quality Directive to include requirements for reducing greenhouse gas intensity in road transport through a Low Carbon Fuel Standard.

To contribute to the global aim of reducing the average temperature rise to no more than 2°C above pre-industrial levels, EU committed to limit greenhouse gas emissions. In 2015, this commitment has led efforts toward reducing the temperature increase to 1.5°C. The key aim of The Europe 2020 strategy is to transform the EU into a "low carbon zone" economy relying on renewable energy sources and energy efficiency. As part of this strategy, the EU count on a roadmap for a competitive low-carbon economy by 2050, which sets the ambitious goal of cutting local greenhouse gas emissions to 80% below 1990 levels.

In recent years, the EU has launched the "Green Deal," which serves as a roadmap for boosting the efficient resources usage, a circular economy transmission, addressing climate change, and reducing pollution across all economic sectors, including energy, buildings, transport, industries, & agriculture.[1]

The EU has taken specific policy actions within the framework of the Green Deal. For instance, it adopted the EU action plan for the Circular Economy (CEAP) II, consisting of two action plans (2015 and 2020), which cover the entire lifecycle of products, from production to waste management. The EU also focuses on resource-intensive sectors to promote circularity and sets requirements for product design to improve durability, reusability, reparability, recyclability, and energy and resource efficiency.

Addressing the effect of the food system on global climate change and environmental degradation, the EU has implemented "The Farm to Fork

(1) **European Council**, Climate change: what the EU is doing, Belgique,2021, p (1-5)

Strategy" to ensure that fisheries, agriculture, and the food value chain contribute to a climate-neutral Union by 2050. The significant role of the manufacturing, processing, retailing, packaging, and transportation of food in greenhouse gas emissions and pollution has been recognized by this strategy.

In the quest to reduce pollution, the EU has introduced the "Zero Pollution Action Plan." This plan aims to strengthen the implementation of legislation targeting air, water, soil, and noise pollution. It also includes a review of EU waste laws and seeks to reduce the EU's external pollution footprint by restricting the export of harmful products and wastes to third countries.

Furthermore, the EU's commitment to climate action is evident in the "Fit for 55" agreement presented under the European Green Deal. The target of this package is to reduce greenhouse gas emissions by at least 55% by 2030 compared to the levels obtained in 1990, and aiming to achieve climate neutrality by 2050.[1]

It aims at ambitious targets for instance: increased emissions reductions within all sectors included in the EU Emissions Trading System (EU ETS) and the Effort Sharing Regulation, as well as a strengthened target for renewable energy.

While the EU has made progress in reducing emissions, there are challenges to overcome. Investments in new fossil fuel infrastructure, such as LNG terminals and fossil gas pipelines, can undermine decarbonization efforts. Additionally, the EU's Nationally Determined Contributions (NDC) target is considered "Almost sufficient" when compared to the necessary emissions reductions within the EU, and international public climate finance contributions are rated as "Insufficient" However, the target of EU's net-zero has been evaluated as "Acceptable" with a regular review and assessment process.[2]

Overall, the EU's policies and initiatives demonstrate its commitment

(1) **European Council,** Fit for 55, Belgique, 2023, p (2-6)
(2) Climate Action Tracker, EU,2023, p (2-5)

to addressing climate change, promoting a circular economy, and achieving a low-carbon future. By implementing and improving upon these policies, the EU aims to lead the way in global decarbonization efforts, striving to limit global warming to safe levels while fostering sustainable economic growth.

11.3 Egypt policies:

In 2017, the Egyptian parliament gave its approval to "The Paris Agreement," even though the agreement had already come into effect on November 4th, 2016. Despite Egypt's greenhouse gas emissions constituting only 0.52% of the total for ratification, the country has implemented various policies to address environmental degradation.[(1)]

In July 2022, Egypt updated its initial Nationally Determined Contribution (NDC), focusing on the following aspects:

Renewable energy: Egypt has initiated significant investments in large-scale renewable energy projects. The country plans to increase the share of the generated electricity from renewable sources to 20% by 2022 and 42% by 2035. By 2035, wind energy is projected to contribute 14%, hydropower 1.98%, photovoltaic (PV) systems 21.3%, concentrating solar power (CSP) 5.52%, while conventional energy sources would account for 57.33%.

During FY2019/20, the total installed capacity of wind and solar power plants reached 3,016 MW, marking a 340% increase from FY2015/16. The total capacity of renewable energy, including hydropower, amounted to 5,848 MW in FY2019/20. Notably, Egypt established the Benban solar park, a $2 billion project with a production capacity of 1,465 MW, which ranks among the largest globally.

Egypt adopted renewable energy targets for 2022 and 2035 as part of its "Integrated Sustainable Energy Strategy to 2035" (ISES 2035). These targets, including the goal of generating 42% of electricity from renewable sources by 2035, are reaffirmed in Egypt's updated NDC.

(1) Henrique Morgado Simões and Branislav Stanicek; Graphics: Ville Seppälä. Egypt's climate change policies, European Parliamentary Research Service, 2022, p (1-4)

As a signatory of the coal exit pledge, Egypt does not currently operate any coal plants. The government has implemented fiscal, monetary, and trade policies to promote sustainability in the energy sector, encourage investment, and develop renewable energy sources. Notably, renewable energy capital components are subject to a reduced value-added tax (VAT) rate of 5% instead of the standard 14%, as per the VAT law.

To incentivize banks to finance small and medium-sized companies, the Central Bank of Egypt included the renewable energy sector in the initiative for medium-sized companies and enterprises in February 2017. Additionally, efforts have been made to remove investment barriers and encourage private sector participation in renewable energy projects.[1]

Energy efficiency and low carbon fuels in the petroleum sector: In 2016, Egypt implemented the oil and gas sector modernization project to enhance energy efficiency. The promotion of vehicles running on low carbon fuels is also prioritized. Although Egypt is not a signatory to the electric vehicles initiative, the government launched a nationwide program aiming to convert over 400,000 cars to operate on compressed natural gas (CNG) by 2023, bringing the total number of natural gas-powered cars to one million.

Furthermore, the government plans to install 3,000 charging stations by 2023 to encourage the use and purchase of locally produced electric vehicles. The expansion of the underground metro, high-quality service buses, and the introduction of the 'Monorail' project, which is anticipated to enhance transportation speed, comfort, safety, and environmental friendliness, are among the national projects receiving significant attention. The 'Monorail' project is estimated to cost approximately 2.5 billion Euros.

In June 2022, Egypt joined the Global Methane Pledge, which aims to reduce global methane emissions by at least 30% in the next decade. It is worth noting that approximately half of Egypt's methane emissions come from the waste sector, while around one-third originate from

(1) Egyptian Environmental Affairs Agency. Egypt's first biennial update report to the United Nations Framework Convention on Climate Change, August 2021, p (2-6)

agriculture, and the remaining portion is attributed to the energy sector. Egypt excluded the agriculture sector from its Nationally Determined Contribution (NDC) due to concerns about the increasing population rate and its potential impact on agricultural policies. However, the country has outlined measures to reduce emissions in the waste sector. It is unclear whether the proposed reductions in the waste and oil and gas sectors will achieve a 30% reduction from current emission levels.

Although Egypt is not part of the 'Beyond oil & gas alliance' aimed at phasing out oil and gas exploration and extraction, the country has plans to significantly develop its oil and gas reserves in the coming years(1).

Regarding energy efficiency on the demand side, various programs have been implemented to reduce electricity consumption in FY2019/20 compared to FY2018/19, despite the population growth and ongoing development investments.

Policy reforms have been introduced to support waste-to-energy and waste management programs, as well as air pollution management initiatives to reduce vehicle emissions and enhance solid waste management. In September 2021, a public-private partnership was established to construct the first waste-to-energy plant in Egypt.

In terms of green finance, Egypt made history as the first country in the Middle East and North Africa to issue a sovereign green bond in 2020. The bond, valued at $750 million, aims to finance environmentally-friendly projects in the transportation and energy sectors. Furthermore, Egypt has allocated 40% of its total public investments in 2022/2023, equivalent to EGP 410 billion, to green investments.

However, when compared to its fair share, Egypt's climate efforts have received a rating of "highly insufficient" by the Climate Action Tracker. This rating suggests that significant improvements are needed in Egypt's

(1) The Climate Change Laws of the World. Egypt National Climate Change Strategy (NCCS) 2050,2023, UK, p (12-18)

climate policies and actions by 2030 to align with the goals of the Paris Agreement.[1]

There are several reasons contributing to this poor rating. Although Egypt launched its "2050 National Climate Change Strategy" in May 2022, the strategy lacks an overall emissions reduction goal. In addition, the updated Nationally Determined Contribution (NDC) submitted by Egypt to the UNFCCC in July 2022 includes emissions reduction targets for the electricity, transport, and oil & gas sub-sectors, but it does not encompass an economy-wide emissions target. Furthermore, the agriculture and land use sectors are excluded from mitigation actions in the NDC, and there is a lack of transparency in the document.

Egypt has not set a net-zero emissions target, which is in line with the international scientific consensus aiming to prevent severe climate damages. The consensus suggests reducing greenhouse gas emissions by approximately 45% from 2010 levels by 2030 and/or ensuring that any ongoing emissions are balanced by removals, ultimately reaching net-zero emissions around 2050.

Although Egypt has pledged specific emissions levels for the electricity, transport, and oil & gas sectors by 2030, Climate Action Tracker estimates that these targets would still result in an increase in emissions from around 350 MtCO2e at present to 507-522 MtCO2e in 2030. This represents a 65% and 140% increase in emissions for the electricity and transport sectors, respectively, by 2030 compared to current levels.

Finally, the main polices and project that can be enhance the decoupling process in Egypt, China, and Europe can be summaries in the following table:

(1) Climate Action Tracker, Egypt,2023

Table (6): Decoupling policies in Egypt, China, and Europe

Policy Area	Egypt	China	Europe
Renewable Energy	Limited investments and targets	Significant investments and ambitious targets	Extensive investments and ambitious targets
	- Renewable energy capacity: 6% (2020)	- Renewable energy capacity: 31.8% (2020)	- Renewable energy capacity: 34.7% (2020)
	- Benban Solar Park: Largest solar park in the world (1.5 GW)	- Three Gorges Dam: Largest hydropower project in the world (22.5 GW)	- Offshore wind farms in the North Sea
Energy Efficiency	Some measures in place, but limited impact	Comprehensive measures and standards	Extensive measures and strict standards
	- National Energy Efficiency Action Plan	- National Energy Conservation Program	- Energy Performance of Buildings Directive
Pollution Control	Ongoing efforts, but challenges remain	Strong regulations and emission controls	Stringent regulations and emission controls
	- Air Quality Monitoring Network	- Air Pollution Prevention and Control Action Plan	- Industrial Emissions Directive
Circular Economy	Growing focus on waste management	Promoting circular economy practices	Strong emphasis on circular economy
	- National Waste Management Program	- Circular Economy Promotion Law	- Circular Economy Action Plan
Sustainable Transport	Improvements in public transportation	Investments in electric vehicles and transit systems	Extensive public transport and sustainable mobility strategies
	- Cairo Metro: Expanding metro network	- Electric Vehicle Subsidies and Incentives	- Bicycle-friendly cities and car-free zones
International Commitment Air Quality Improvement	Signatory of international agreements	Signatory of international agreements and climate commitments	Active participant in global climate action
	- Paris Agreement	- Paris Agreement	- European Green Deal
	Measures in place, but air pollution persists	Stricter emissions standards and controls	Stringent measures and air quality targets
	- National Air Quality Monitoring Program	- Ultra-low Emission Zones in cities	- National Air Pollution Control Programs
Forest and Ecosystem Restoration	Efforts to combat desertification and restore ecosystems	Large-scale afforestation and ecosystem restoration programs	Emphasis on forest conservation and restoration
	- Great Green Wall Project	- Grain for Green Program	- Natura 2000 network for biodiversity conservation
Policy Effectiveness	Mixed results, further progress needed	Significant progress, ongoing improvements	Extensive policies and notable achievements

Source: prepared by authors.

12. Conclusion

In conclusion, the efforts made by China, Egypt, and EU countries in implementing decoupling strategies to address environmental challenges have yielded positive outcomes, albeit with varying degrees of success. China has made significant progress in reducing air pollution and transitioning to renewable energy sources. Egypt's initiatives in renewable energy and waste management are commendable, but further improvements are needed in their climate policies. EU countries, as a group, have adopted ambitious decoupling measures and achieved notable progress in reducing greenhouse gas emissions.

However, it is clear that worldwide efforts are required to accelerate decoupling and achieve sustainable development goals. The behaviour of decoupling in different countries and regions highlights the need for stronger policy measures, increased transparency, and the inclusion of key sectors in decarbonization efforts. EU countries' policies serve as a promising example for other nations to follow, demonstrating that ambitious targets and comprehensive decoupling strategies can lead to significant progress.

Future research should focus on identifying specific areas for improvement and exploring potential solutions to overcome the challenges faced by countries and regions in achieving decoupling and meeting international climate targets. Collaboration and knowledge sharing among nations can facilitate the adoption of effective policies and accelerate global decoupling efforts.

13. Results

EU countries, as a group, have shown significant progress in decoupling from carbon-intensive practices. Through ambitious policies such as the European Green Deal, EU countries have made substantial investments in renewable energy, improved energy efficiency, and implemented carbon pricing mechanisms. These efforts have resulted in notable reductions in greenhouse gas emissions and increased renewable energy deployment.

However, challenges remain in meeting the more stringent climate targets outlined in the Paris Agreement.

China has implemented a comprehensive set of policies to reduce air pollution and achieve decoupling from carbon-intensive practices. The National Air Quality Action Plan, substantial investments in renewable energy, and vehicle emission controls have contributed to a significant decrease in pollution exposure. The country has demonstrated a commitment to transparency by making the environmental data publicly available. However, China's emission projections indicate the need for further improvement to align with the 1.5°C temperature limit.

Egypt has implemented policies to address environmental degradation, despite its relatively lower greenhouse gas emissions. Notable efforts include investments in renewable energy projects and the establishment of the Benban solar park. However, Egypt's climate targets and policies, as evaluated by the Climate Action Tracker, are deemed "highly insufficient." The absence of an economy-wide emissions reduction target, exclusion of key sectors from mitigation actions, and lack of transparency in the Nationally Determined Contribution (NDC) have contributed to this rating.

14. Recommendations:

To address environmental degradation in Egypt, it is crucial to implement a comprehensive and integrated approach. Here are some recommendations to consider:

1. Encourage sustainable land-use practices to prevent soil erosion, and degradation.

2. Promote water conservation practices at all levels, including improving irrigation systems, promoting drip irrigation, and enhancing water management and recycling.

3. Encourage the investment in renewable energy sources, such as solar and wind power, to reduce the use of fossil fuels.

4. Enhance waste management systems to reduce pollution, promote recycling programs, encourage waste separation at the source, and invest in waste-to-energy facilities to convert waste into useful energy.

5. Promote environmental literacy in schools, universities, and communities, emphasizing the importance of sustainable practices and conservation.

6. Strengthening environmental regulations, impose taxes & penalties for negative environmental externalities and promote positive ones by subsidies.

7. Encourage public national & International Cooperation by boosting partnerships between government agencies, private sectors, international organizations, NGOs, and civil society to support decision-making processes related to environmental issues

15. References

1. Cohen, G., Jalles, J. T., Loungani, P., & Marto, R. The long-run decoupling of emissions and output: evidence from the largest emitters. Energy Policy, 118, (2018).

2. Egyptian Environmental Affairs Agency. Egypt's first biennial update report to the United Nations Framework Convention on Climate Change, August 2021.

3. Fischer-Kowalski M (2011) Decoupling natural resource use and environmental impacts from economic growth: a report of the working group on decoupling to the international resource panel. UNEP United Nations Environment Programme, International Resource Panel, Paris.

4. Gaber, R., & Nour El-Din, M. (2021). Enhancement Of Water Security by Decoupling Water Use from Economic Development in Egypt. Journal of Al-Azhar University Engineering Sector, 16(60).

5. Gregor Erbach and Ulrich Jochheim; Graphics: Ville Seppälä. China's climate change policies, European Parliamentary Research Service, 2022.

6. Hamdy Abdelaty, Daniel Weiss, Delia Mangelkramer. "Climate Policy in Developing Countries: Analysis of Climate Mitigation and Adaptation Measures in Egypt", Sustainability, 2023

7. Henrique Morgado Simões and Branislav Stanicek; Graphics: Ville Seppälä. Egypt's climate change policies, European Parliamentary Research Service, 2022.

8. International Energy Agency, CO2 Emissions in 2022, China,2023

9. Khan, S., & Majeed, M. T. Drivers of decoupling economic growth from carbon emission: Empirical analysis of ASEAN countries using decoupling and decomposition model. Pakistan Journal of Commerce and Social Sciences (PJCSS), 14(2), (2020)

10. Lacis, A. A., Schmidt, G. A., Rind, D., & Ruedy, R. A.. Atmospheric CO2: Principal control knob governing Earth's temperature. Science, 330(6002), 2010.

11. Li, J., Hou, L., Wang, L., & Tang, L. (2021). Decoupling analysis between economic growth and air pollution in key regions of air pollution control in China. Sustainability, 13(12), 6600.

12. OECD Environment Programme. Indicators To Measure Decoupling of Environmental Pressure from Economic Growth.

13. Rosa María Regueiro-Ferreira a , Pablo Alonso-Fernandez. Ecological elasticity, decoupling, and dematerialization: Insights from the EU-15 study (1970–2018),journal of Ecological Indicators, Volume 140, july 2022, 109010.

14. Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley, IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535

15. The Climate Change Laws of the World. Egypt National Climate Change Strategy (NCCS) 2050,2023, UK.

16. The European Council, Climate change: what the EU is doing, Belgique, 2021.

17. United Nations Environment Programme. International Resource Panel. (2011). Decoupling natural resource use and environmental impacts from economic growth. UNEP/Earthprint.

18. Wu Y, Zhu Q, Zhu B (2018) Comparisons of decoupling trends of global economic growth and energy consumption between developed and developing countries. Energy Policy 116:30.

Websites:

1. Climate Action Tracker website: https://climateactiontracker.org/

2. Our world in data website: https://ourworldindata.org/co2-gdp-decoupling/

3. https://www.climatewatchdata.org/