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# Advanced approaches towards policymaking for net zero emissions

Farooq Sher

**Abstract**

This study highlights the extensive use of and full reliance on nonrenewable sources like fossil base fuels results in availability shortage, increased economy, depletion in the carbon sink, $CO_2$ emission high, environmental pollution, drastic change in climate and mismanagement of waste. To overcome this problem, renewable resources together with nuclear advanced approaches resulted in fewer carbon sources and are used to decarbonize GHG/$CO_2$ emissions, carbon storage technology and lower carbon pricing to achieve net-zero carbon sustainability in the environment. The proposed policies and their implementation occurrence at national and international levels also resulted in carbon-free production and enhanced consistency. On implementation of environmentally friendly policies, the problem could be solved by global contribution of government, stakeholders, public sectors, engagement policy coherence and integration towards making and implementing policies via advanced approaches for achieving net-zero carbon emissions.

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**Keywords**

Environment, Advanced renewable energy approaches, Emissions, $CO_2$ capture, Clean technologies, Sustainable practices, Circular economy and net zero.

## Introduction

In this current era, the demand for natural resources for various purposes increased because of increase in population as a result a huge drastic change in climate (melting of glaciers, sea level rise and increase in global warming etc.) has been shown. The main reason for to change in climate is extensive use of natural resources like fossil fuels has not only led to environmental pollution, loss of biodiversity, energy production inadequacies, and greenhouse gas emissions but also significantly impacted geographical layout, economic growth rate, and global relations as well [1]. Many developed countries including Asia (China), United States (USA), New Zealand, Brazil and European Union (EU) have taken substantial steps towards low-carbon transformation or conquer the rise in global temperature below 1.5 °C (i.e., to prevent irreversible environmental damage) as a part of a global movement to achieve carbon peak, carbon emission, and carbon neutrality by the years 2030, 2050, and 2060, respectively [2].

Globally, achieving net zero carbon emissions involves a variety of policies and strategies. The Paris Agreement sets international targets for limiting global warming, with countries committing to Nationally Determined Contributions (NDCs). European Union (EU) leads with its European Green Deal and legally binding European Climate Law targeting Net-Zero by 2050, supported by initiatives like "Fit for 55″ package [3]. United States rejoined Paris Agreement, focusing on clean energy investments and methane emission reductions [4]. China's 14th Five-Year Plan emphasizes green development, aiming for significant renewable energy expansion by 2060 [5]. UK's Climate Change Act and Net Zero Strategy outline comprehensive measures for all sectors, including a ban on new internal combustion engine vehicles by 2030 [6]. Japan's Green Growth Strategy promotes green innovation [7], and South Korea's Green New Deal invests in green infrastructure [8]. These policies reflect a global commitment to sustainable development and climate resilience.

This study offers to provide a new vision of net-zero low-carbon policies from the perspective of natural resources, which means providing cost-effective approaches and new concepts approach for net-zero carbon emissions by analyzing, to exploring the intricate relationship between resource constraints and the pursuit of carbon neutrality, carbon pricing, challenges and future direction, carbon-free technologies, shedding light on critical importance and estimating the factors responsible for these harmful gases. The significant importance of a net-zero carbon emission policy enhances the use of renewable resources instead of nonrenewable resources. This study also highlights the limitations and

challenges faced by renewable and nonrenewable resources.

## Technological innovations for carbon neutrality

### Renewable energy integration by a rapid shift away from fossil fuels

The increase in $CO_2$ emissions by rapidly shifting from fossil fuels to renewable sources [9] is of great importance. Renewable resources are a conventional method in contrast to nonrenewable resources, resulting in less carbon sources and low or net-zero carbon emissions in the environment. Net-zero carbon is decarbonization or absorption that refers to an environment in which the maximum or corresponding volume of gases is absorbed from a polluted environment via a carbon sink, by employing carbon offsetting strategies and reducing emission means [10]. Furthermore, the above-mentioned renewable is followed by electrolysis [11], thermolysis, photo-electrolysis, biophotolysis, dark-fermentation [12], photo-fermentation, gasification, pyrolysis and combustion [13] advanced approaches towards policy-making in net-zero carbon for a sustainable environment as shown in Table 1. The limitations and challenges for renewable resources operating conditions. By studying operating conditions (i.e., temperature) the biomass process is more environmentally friendly as compared to water splitting process among the advanced renewable approaches.

### Energy efficiency measures

The energy efficiency process is considered environmentally beneficial like reducing GHG emissions. Utilizing a small amount of energy to give the product (work done) with a small amount of and without GHG emissions in the environment by following two ways of energy efficiency process i.e., directly (combustion of fossil fuels) and indirectly (electricity generation). A special report of Intergovernmental Panel on Climate Change (IPCC) has highlighted mitigation targets to make energy efficiency measurements in tackling climate change due to the limitations i.e., shortage of time and rise in GHG emissions in the environment [21]. All renewable resources approach is the pathway to reduce GHG emissions and enhance energy production capacity. This revolutionized source is quite similar to a coal-fired plant. However, it is predictable, consistent, ability to store more energy in contrast to coal power plants, carbon-free, reliable and more energy production than nonrenewable resources such as coal [22]. To achieve determined net-zero carbon, where electricity storage is essential if electrification is not possible, use direct hydrogen base fuel or ammonia to reduce GHG emissions and replace fossil fuel resources [23].

## Market-based instruments and economic incentives

Environmental law and policy developed instruments for dealing with concern environmental challenges like carbon sink enhancement, energy transition and green

**Table 1**

**$CO_2$ reduction pathway to decarbonize by use of advanced renewable approaches.**

| Advanced renewable approaches | | Advanced renewable approaches process | Sources | Operating conditions | Possible policies | Reference |
|---|---|---|---|---|---|---|
| Water splitting | | Electrolysis | Electricity/wind power | Up to 30 bar/50–900 °C | Low emission of $CO_2$; High production of $H_2$ | [14] |
| | | Thermolysis | Heat | Temperature >2500 °C | Produce liquefied hydrogen for low-emission usage | [15] |
| | | Photolysis | Solar | Ambient condition | help to ease a future circular economy | [16] |
| Biomass process | Biological | Biophotolysis | Microorganism metabolism | Ambient condition | Invest funds for cleantech-based projects | [17] |
| | Thermo-chemical | Gasification | Biomass | Temperature 250–350 °C | Low raw material costs Requires less energy | [18] |
| | | Pyrolysis | Biomass like sawdust | Temperature 20–600 °C | remove GHGs, carbon capture and storage (CCS) technology | [19] |
| | | Liquefaction | Wet waste biomass i.e. sludge waste, algae, or forest residue | Temperature 250–350 °C | Directly conversion of waste-to-energy, reduction of $CO_2$ | [20] |

transportation. For these challenges and global issues, this law developed a policy instrument i.e. market-based instruments are referred to as economic instruments, new environmental policy and price-based policy instruments. Therefore, future legal and policy suggestions could proceed towards policymakers. Market-based instruments are organized for carbon pricing mechanisms, trading emission permits, subsidizing low-carbon technologies, economy, and allowances for research and development to provide incentives for polluters to reduce or diminish negative environmental externalities as shown in Figure 1. The first agreement passed in 2005 EU and China were the first who adopt this policy in their industries like energy, cement and textile, etc. At the end of 2017, 19 market-based instruments were in operation that helped to reduce 7 billion tons of greenhouse gases and reduced 15% global carbon emission of the world [24].

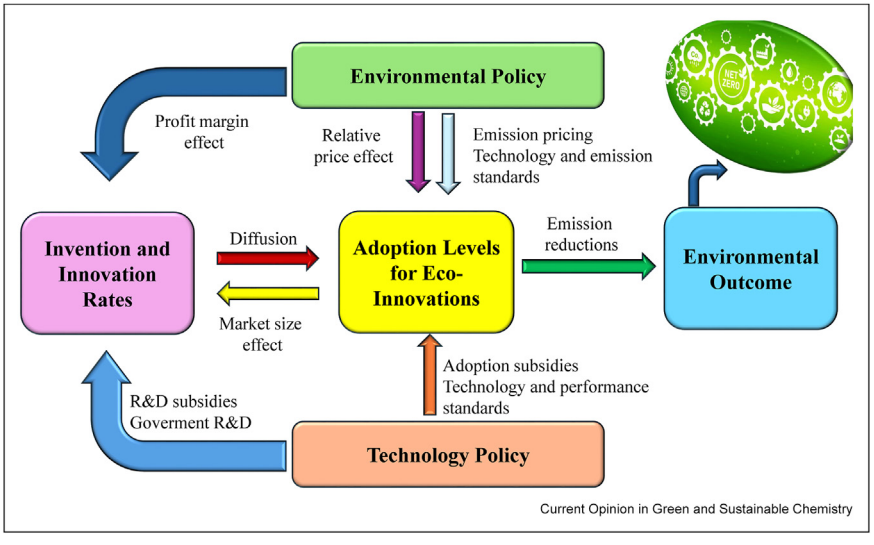
## Carbon pricing mechanisms

Employing various contexts i.e. theoretical, daily based concepts and policy discussion give the concept of carbon pricing. By following this concept two policies originated for carbon pricing mechanism. One is a carbon tax on carbon leakage, household use and long-haul air travel etc. The second is carbon emissions trading refers to some fees and gives permits for carbon emission traders to follow up on the emission targets. Using advanced renewable approaches, the carbon pricing mechanism devoted economic incentives and control the global problems as well. To promote the advanced approach towards making policy diminishes fossil fuel extraction and reduces carbon tax on its import as well [25]. Replacing firewood and fossil-based fuels with biogas and biohydrogen reduced GHG emissions of carbon footprint from the environment [26]. Enhance financial support for research and development for carbon capture storage and develop alternative technology approaches like carbon-based technologies and subsidize as well to achieve net-zero carbon emission globally. Promote less carbon emission products at national and international levels as well [27].

## Green bonds and climate finance initiatives

To reduce or eliminate GHG emissions, decarbonization policies are developed towards net zero emission. In 2021, twenty-sixth session of Conference of the Parties (COP26) was held in Glasgow to complete the Paris Agreement, aiming for USD 100 billion in green finance for three years and creating a process including time limits, modalities, and methodologies targets for 2050 climate finance to stabilize the global temperature to 1.5 or below 2°. According to the finance survey, this amount is not good enough to achieve target goal, the estimated cost will be about 3–4 USD trillion [28]. To overcome the global economic challenges, a green bond and climate finance initiative instrument approach is developed that is referred to as green climate finance as well. Green bonds are a fixed-income financial instrument approach for sustainable environmental-based projects. The government should be issuing finance and refinance bonds for a green environment project. On issuing these bonds corporations, municipalities, researchers and other government sectors can attract to it especially environment-sustainable projects, accelerating the transition towards a net-zero or low-carbon economy. Moreover, climate finance initiative is a wide range of financial instruments, policies and mechanisms that raise funding to solve climate change issue. Initiatives aimed at reducing greenhouse gas emissions, enhancing resistance to the effects of climate change and assisting with adaptation can be supported by grants, loans, subsidies,

**Figure 1**




Demonstrated Environmental policy, adoption of economic policy and technology policy strategies to neutralize carbon emission [23].

and private and governmental investments. These programs are essential to accelerating global climate action, especially in developing nations where the demand for climate funding is greatest [29].

## Collaborative governance and stakeholder engagement

To achieve net-zero emissions by advanced renewable approaches for sustainability of the environment making policies by collaborative governance and stakeholder engagement. It includes not only public and private partnerships but also added community-based initiatives, international cooperation and agreements and inclusive decision-making processes.

### Undertaking environmental, economic and social impact of climate change policies

It is most important to tackle environmental, economic and social adaptation. These are affected and are responsible for $CO_2$ emissions [30]. Decreasing $CO_2$ emissions could be done by adopting advanced adaptations towards policy like high quality energy efficient buildings, Flexible zero-carbon mobility [31], zero emissions circular goods, sustainable natural ecosystem, abundant clean energy and economy. By utilizing renewable advanced approaches, a net-zero-emission economy could be possible [32] and reduced cost [33]. High-quality energy-efficient buildings result in energy-efficient and digitally connected buildings, clean air for cities and shared places and appliances [34]. Maintaining a sustainable natural ecosystem and abundant clean energy by reforestation and carbon sink provide for agriculture, limited bioenergy supply primarily from waste and residue, zero-carbon power generation, low-emission fuel from sustainable biomass and synthetic or synthetic sources as shown in Figure 2 [35].

### International cooperation and agreements

Another way is that the government should take notice or initiative towards adopting prioritized investment in renewable energy [37], enhance natural resource management [38], encourage eco-friendly projects, policy integration, arranging environmental education or awareness programs [39], checking urbanization challenges and creating economic incentives by implementing carbon pricing [40] to reduce carbon emissions and dependence on fossil fuels, leading to cleaner and more sustainable energy systems. Achieving net-zero carbon emissions is only possible through global collaboration of government, the public, or businessmen by following policies for a sustainable environment [41].

## Policy coherence and integration policy

Policy coherence and integration policy including aligning environmental policies with economic objectives, mainstreaming sustainability across sectors, harmonizing regional and national policies, together the addressing interconnected environmental challenges could enhance advanced approaches towards achieving net zero carbon emissions by aligning environmental policies with economic [42].

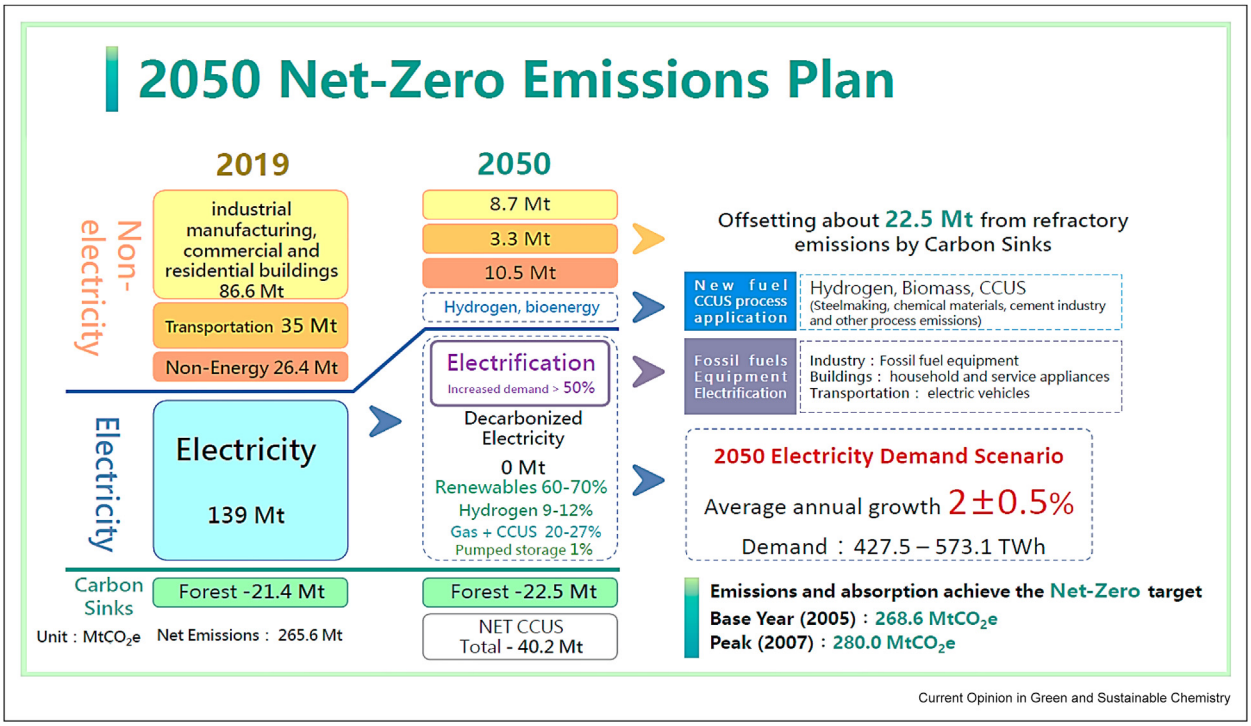
### Aligning environmental policies with economic objectives

GHG are negative externalities and become a risk factor for the environment and have an impact on public and economic policies as well. In 21st century, development of the economy is directly linked with environmental sustainability [43]. The reduction in carbon emissions and greenhouse gas emissions can be eliminated, as the decline in economic activity and less consumption of energy base products by an increase in economic policy. To improve resource efficiency and security, World Economic Forum proposed thinking as an approach to policy making [44]. The lack of investment in green technology and less demand for clean energy promoted highly polluted products resulting in not only a huge effect on the economy but also environmental polices decline. In this regard, investing the uncertainty effect of World Uncertainty Index (WUI) on environmental degradation in US based on Autoregressive Distributed Lag (ARDL) bounds testing approach for intensifying $CO_2$ emission in the long run [45]. Environmental Policy Integration (EPI) is organized for incorporation of environmental concerns into nonenvironmental policy areas. The aim and objective of Environmental Policy Integration (EPI) involving various environmental policy domains, coherences and synergy ensured decision-making processes into economic policies, social, urban planning and infrastructure development by enhancing policy effectiveness and societal prosperity [46].

### Addressing interconnected environmental challenges

Addressing interconnected environmental challenges requires various approaches that integrate various strategies across the sector for achieving net zero carbon emissions. One of them is renewable energy transition approach that reduces GHG emissions or eliminates carbon emissions and enhances energy security by shifting away from nonrenewable to renewable resources. Reduce energy consumption and carbon emissions by improving energy efficiency in appliances, industries, transportation and infrastructure. Implant electrifying sector for transportation and heating purposes by use of an electrifying approach to reduce reliance on fossil fuels and increase renewable resources as well. Internalize the environmental cost of carbon by the implementation of carbon pricing mechanisms such as cape-and-trade or carbon taxes system that could incentivize individual and business as well. Moreover, sustainable agriculture, food systems (Figure 3), reforestation and afforestation approaches could help to minimize carbon emissions from the atmosphere by adopting sustainable agriculture practices and protecting and restoring forests [47].

**Figure 2**




Monitored global $CO_2$ emission and projected emissions policy from 2000 to 2030 by transportation sector concerning Announced Pledges Scenario (APS) and Net Zero Emissions (NZE) scenario by 2050 [36].

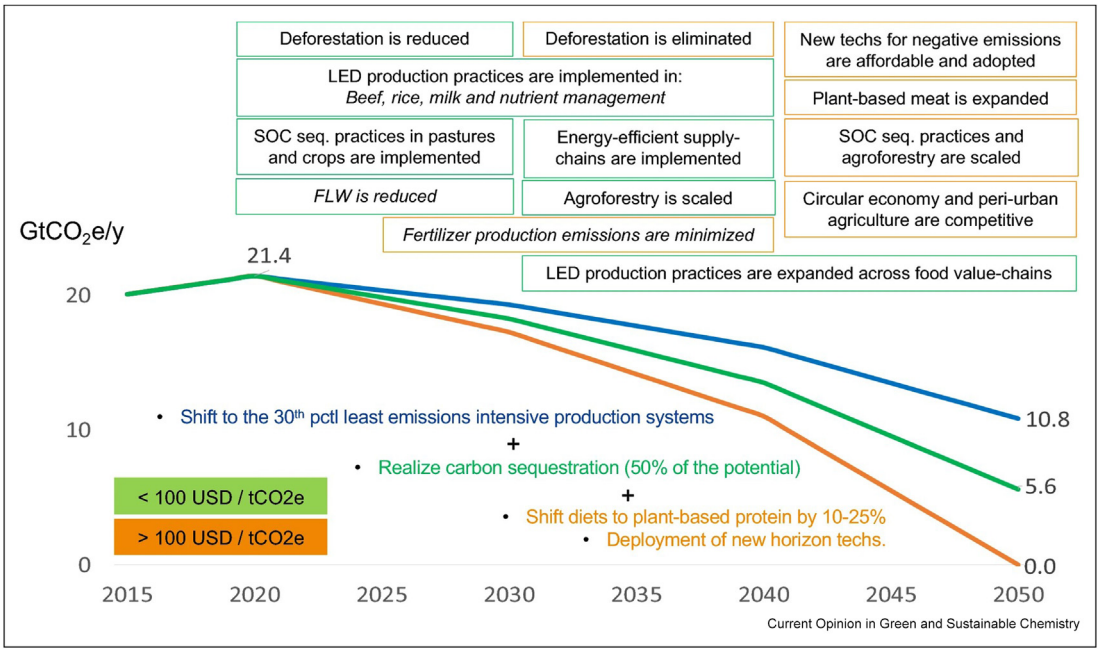
## Challenges and future directions

To achieve net-zero carbon emissions facing various challenges and future directions including equity and social justice considerations, technological and economic transition challenges, political will and policy implementation barriers (Figure 4), international cooperation and climate diplomacy as well. Moreover, various advanced approaches towards policymaking to achieve carbon neutrality goal by 2050 should focus on land use, trading system, climate policy, transportation, etc. For this purpose, emission trading system (ETS) law taxes the aviation industry and should cancel out free emission allowances by 2030. At national or international level, Carbon Border Adjustment Mechanism (CBAM) should be applied to import high carbon emission products or cement, iron, aluminium, steel, etc. Secondly, allow carbon rights or quotas for importers as well if they cannot pay carbon tax or duty [49] vehicle sales should be banned in 2035. In 2025, new emission trading mechanism for road transportation and construction should include fuel suppliers. The renewable energy directive should be revised to increase the proportion of renewable energy from 32 to 40% by 2030. Amendment on energy tax system required for heat emitting home appliances, aviation, fishing, and electricity supply as well. Should focus on natural-based management, prohibition of deforestation solutions, conservation of forests, and reforestation by adopting Land Use, Land-Use Change and Forest Conservation Act (LULUCF) [50].

## Conclusion

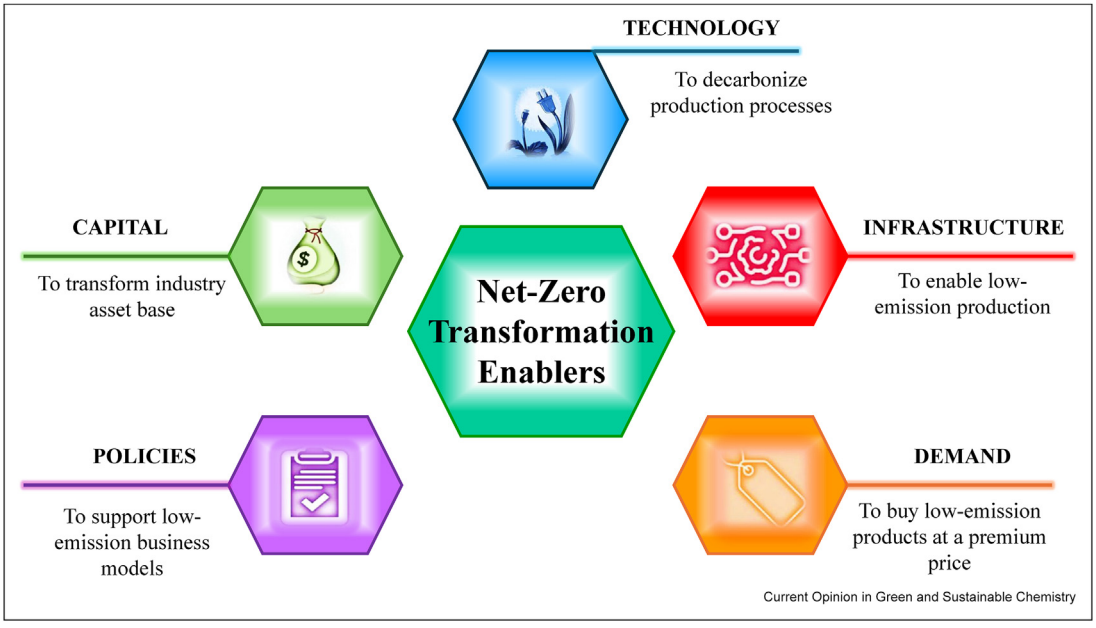
This review concluded that $CO_2$ emissions and energy production are cointegrated. Hence, most of the countries are reliant on non-renewable sources that cause largest responsibility for high $CO_2$ emissions/GHG and nearer to global temperature 1.5–2 °C. The intense increase in $CO_2$ emissions could be reduced by using renewable resources approaches because these indirect $CO_2$ emissions effectively lead to achieving sustainable net-zero carbon emissions in the environment. This study highlights the importance of advanced renewable approaches that are responsible for the decline of atmospheric carbon emissions in climate towards policymaking. Policymaking considers by use of renewable technological innovations based on advanced processes, consistent, enhanced reliability, carbon-free

**Figure 3**




Roadmap for food systems to achieving net zero emissions by 2050 [48].

**Figure 4**




Overview of challenges that need to be enabled for achieving industry net zero transformation.

production, increased energy storage, high purity, and recovery rate, and improved waste management properties for carbon neutrality. Market-based instruments and economic incentives approach reduce 15% $CO_2$ by 2017. The problem could be solved by global contribution of government, businessmen and public sectors, engagement policy coherence and integration towards making and implementing policies via advanced approaches for achieving net-zero carbon emissions.

## Declaration of competing interest

The authors declare that they have no known competing financial interests that could have appeared to influence the work reported in this article.

## Data availability

Data will be made available on request.

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