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EDITED BY
Guoxiang Li,
Nanjing Normal University, China

REVIEWED BY
Rui Alexandre Castanho,
VALORIZA - Research Centre for Endogenous Resource Valorization, Portugal
Eric Hittinger,
Rochester Institute of Technology (RIT), United States

*CORRESPONDENCE
Dariusz Pieńkowski,
darpie_xl@wp.pl

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What goes around comes around. Supply and demand side of climate change at the example of Norway

Dariusz Pieńkowski *

Poznań University of Life Sciences, Poznań, Poland

Norway is widely acknowledged as an environmentally advanced economy, with a significant proportion of renewable energy resources. Nevertheless, it is evident that Norway's economic achievements and capacity to invest in sustainable energy resources have been largely supported by its trade in non-renewable resources. The utilisation of these resources has been associated with the emission of greenhouse gases, which has considerable ramifications for climate change and is also contributing to the melting of Norwegian glaciers. The objective of this research is to examine the issue of moral responsibility and the socio-economic costs associated with the management of natural resources, as well as the socio-economic impacts on a global scale. It is observed that actions intended to yield immediate and localised benefits may, in fact, result in adverse outcomes for those responsible for their implementation. The responsibility on the supply side is not only determined by moral considerations, but also by the socio-economic consequences that can be quantified for the perpetrators. Norway provides an illustrative example of the challenges posed by the consequences of glacial melting, which introduce additional risks and challenges to the use of hydropower. The loss of these resources is comparable to the destruction of tropical forests and has significant consequences, as they are considered the green lungs of the world and a reservoir of biodiversity.

KEYWORDS

Norway, supply and demand side responsibility, glaciers, sustainability, climate change

Introduction

In their article on Norwegian energy policy in the Financial Times, Wilson and Milne (2024) posed a thought-provoking question regarding the extent to which Norwegian politics is characterised by hypocrisy: *How big a hypocrite is Norway on energy matters*? One of the aforementioned authors adopted a markedly more reserved stance in posing this question in 2016, within the pages of the same magazine: *Norway: Environmental hero or hypocrite?* (Milne, 2016). These articles build upon a number of previously discussed positions on the subject since that time, and the level of criticism is becoming increasingly severe (Hockenos, 2018; Meydel and Catania, 2021; Ralls, 2016; The Week, 2021; Worley, 2023).

To illustrate the increasing level of criticism, Worley (2023) presented a report on an inaugural address delivered at the Scandinavian country's principal development conference in 2023. In her address, Nakate denounced the hosts' oil and gas drilling operations in the Arctic, citing the detrimental impact these activities have on the environment and on the rights of indigenous communities. Moreover, Greenpeace Nordic and Young Friends of the Earth Norway (Natur og Ungdom) are regularly involved in legal proceedings concerning the development of oil wells (Greenpeace International, 2023). Furthermore, the analyses conducted by Norwegian governmental agencies that challenge the consensus on climate change, such as the one presented by Statistics Norway (Statistisk sentralbyrå) (Dagsvik and Moen, 2023), as well as the denial by the public reported in some research (Krange et al., 2019; Norgaard, 2006) are contributing to an intensification of the debate (Hertwich, 2023).

A noteworthy aspect of this critique is the comprehensive and officially endorsed climate change policy, which is financed by the considerable profits generated from the sale of Norwegian non-renewable energy resources. These issues are referenced in the discourse as an energy paradox or Norwegian hypocrisy (Hockenos, 2018; Meydel and Catania, 2021; Ralls, 2016). Consequently, Norway represents an intriguing case study for research focusing on the responsibilities and role of developed countries with respect to climate and energy policy on a number of different dimensions of sustainability, including economic, social, ecological and ethical. The prioritisation of economic considerations tends to frame the problem in terms of a paradox, whereas the focus on political considerations is typically situated within an ethical discourse and described as hypocrisy.

The objective of this paper is to examine the complex and interrelated dimensions of sustainability, with a particular focus on the supply and demand sides of the energy market. A principal aspect of comprehending climate change from the perspective of non-renewable resource utilisation is to elucidate the influence of supply and demand on consumer behaviour. This is in accordance with the well-documented debate surrounding Say's Law and its critique by Keynes, which was based on the Malthusian perspective (Béraud and Numa, 2019; Cottrell, 1998; Jonsson, 1995; O'Leary, 1942; Smith, 2020). In Keynesian terms, these laws can be broadly categorised under the assumption that supply creates its own demand (Kent, 2005). Keynes contested this law from the perspective of market disequilibrium, proposing that increased demand could be achieved through government intervention in order to restore equilibrium. In essence, his perspective is that demand creates its own supply, rather than the other way around.

The present discussion of these two market phenomena emphasises the various factors that distinguish them from one another, thereby diminishing the opposition between Keynes and Say. For example, Jonsson (1995) proposed that Keynes had misinterpreted Say's perspectives and that, in fact, there were similarities between the two scholars' stances on this matter. An intriguing conclusion can be drawn from the observations of Colander (2001), who posits that 'just as in the short run one cannot separate out supply and demand influences, in the long run one also cannot separate them out. The process works through supply, but demand plays a central role in those supply decisions' (p. 8). These considerations are of paramount importance in establishing moral obligations with regard to both the supply and demand of non-renewable resources.

In light of the postulates of sustainable development (United Nations, 2017) and the concept of moral growth as presented by Daly (1973), Daly (1997) and other economists (Fioramonti, 2024; Powelson, 2000), the conclusions of these discussions, despite the numerous variables that determine the role of supply and demand, imply a need to recognise moral responsibility on both sides. This is particularly the case given that contemporary marketing is a highly sophisticated technology for influencing human behaviour and analysing human needs, drawing on the insights of psychology, sociology and neuroscience. A case in point is the success of tobacco companies, which have promoted smoking despite the well-documented harmfulness and inconvenience to their customers. It is evident that there have been numerous instances in the history of market development where marketing successes have not always been aligned with the needs or availability of superior products (Pieńkowski, 2024). Conversely, contemporary social and economic measures to reduce smoking have had a significant impact on the demand for tobacco products, despite efforts by the tobacco industry to hinder progress (WHO, 2019).

It is crucial to recognise that addressing the adverse effects of non-renewable resource consumption requires not only influencing the demand side but also reducing the supply. Consequently, reducing the supply of these resources represents a crucial element in addressing the consequences of such consumption, alongside modifying consumption patterns and implementing demand-side policy measures.

This study analyses the case of Norway and a few other selected countries with a significant supply of non-renewable fuels, elucidating the multifaceted dimensions of sustainable development and evaluating the circumstances in individual countries from the vantage point of global interdependencies. The argument presented is that the assumption that economic growth is a prerequisite for sustainable development is erroneous. In terms of climate change, Norway's sustainability lags behind that of many other European countries, despite its progress in utilising renewable energy sources. Furthermore, the issue of non-renewable resource supply from a global perspective represents only one aspect of the challenge facing Norway. The environmental consequences of this extraction could also result in significant costs for the country itself.

The production of non-renewable energy resources gives rise to climate change, which will inevitably impose costs on the country, regardless of the location where these resources are consumed. Moreover, despite Norway's advanced utilisation of renewable energy resources, its total greenhouse gas (GHG) emissions and energy consumption *per capita* remain unparalleled by numerous other European countries. Consequently, it is challenging to acknowledge Norway's elevated ranking in climate change mitigation. For example, even Poland, which has a relatively high proportion of non-renewable energy in its energy mix, is ranked higher in terms of lower total GHG emissions *per capita*. The responsibility paradox exemplifies the ethical quandaries inherent in environmental stewardship. It is more probable that heightened ecological responsibility will occur in developed countries, despite their role in precipitating climate change on both the demand and supply sides.

The establishment and maintenance of the current welfare state in Norway has been attributed to a number of key socio-economic and political factors. These include the political commitment to solidarity and redistribution, the efficiency, loyalty and competence of the bureaucracy, and the favourable circumstances related to the oil resources in the 1970s (Leonardsen, 2012). It is evident that the mere discovery of rich natural resources is an insufficient condition for economic success. To illustrate this assertion, one might consider the cases of countries such as Nigeria or Venezuela, which are rich in oil reserves and have been discussed in the context of the resource curse or the Dutch disease (Moti, 2019; Papyrakis and Pellegrini, 2019). However, the primary focus of this paper is on the socio-economic factors associated with the utilisation of energy resources on the demand and supply sides, with a particular emphasis on their implications for climate change.

Norway is not only a significant exporter of environmentally detrimental resources, but also faces considerable challenges in pursuing sustainable economic growth due to its high levels of consumption. The country continues to be constrained by the typical challenges faced by developed countries that have made significant progress in environmental sustainability but rely on financially intensive technological solutions. Unfortunately, it also continues to exhibit a relatively high level of energy consumption, which has limited its progress in combating climate change. Furthermore, it is a major supplier of energy resources that contribute to environmental degradation.

Sustainable development, moral growth and melting glaciers

The definition of sustainable development sets out a series of overarching principles that guide socio-economic development. These principles dictate that development must 'meet the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987, p. 43). In the current period, these needs have been translated into 17 goals to be pursued globally. All of these goals are interdependent and relate to a number of key areas, including poverty, hunger, health and wellbeing, education, gender equality, drinking water and other water resources, energy, decent work and economic growth, reducing inequalities between countries, industry and innovation, sustainable cities and communities, responsible consumption and production, climate action, sustainable land use, peaceful and inclusive societies, and partnership for these goals.

The scope of the subject matter is extensive, and the principal methodology is a global perspective that arises from the sharing of responsibility for influencing development conditions in terms of socio-economic and environmental interdependence. These considerations are typically grouped into three dimensions: social, economic and environmental. For example, energy consumption can be viewed from an environmental perspective, with consideration given to its impact on natural systems. From such a perspective, it does not matter whether coal is consumed in China or the US, because in addition to the direct local consequences of that consumption, it also has consequences that often transcend the borders of the emitters. The pivotal environmental concern is the total amount of energy consumed on a global scale. From an economic standpoint, however, energy efficiency considerations can be evaluated in relation to production. Finally, the social dimension pertains to the distribution of energy among individuals within a society, the proportion of energy consumption in different regions of the world, or future generations.

It is therefore evident that a moral dimension and a broad global perspective for local action are standard, not only in the realm of social or political considerations, but also in economic action, which has hitherto been considered only from the perspective of selfish motives. In a notable contribution to the discourse on sustainable development, Daly (2015) addressed the concept of 'Depletion of moral capital as a limit to growth'. He wrote that 'the undermining of moral restraint has sources on both the demand and supply sides of the market for commodities […] A corollary is that self-restraint or abstinence in the interests of any higher claims than immediate gratification by consumption is bad for sales, is therefore bad for production, employment, tax receipts, and everything else. The growth economy cannot grow unless it can sell' (Daly, 2015). Daly was influenced by Mill's perspective on the stationary state. He advocated for a steady-state economy and qualitative change.

Other theoretical frameworks place even greater emphasis on the limitations of economic growth, proposing a reduction in growth as a means of achieving sustainability. Kallis et al. (2018) highlight the concept of degrowth, which originated in France at the beginning of the 21st century. The authors define degrowth as 'radical political and economic reorganization leading to drastically reduced resource and energy throughput' (Kallis et al., 2018, p. 292). The review of the degrowth paradigm concluded with the assertion that there is no empirical evidence to suggest that the throughput of matter and energy can be decoupled from economic growth. Although it is conceivable that a scenario could be envisaged in which sufficient decoupling could be achieved to enable economic activity to be sustained within environmental limits, this is not a realistic proposition in physical terms. It is therefore recommended that economies be stabilised without growth through a reduction in working hours, investment in green technologies as an offset to environmentally damaging sectors, redistribution of wealth, and growth in relational goods to compensate for the decline in material goods.

This approach differs from the conventional neoclassical economic perspective, which is based on the assumption of independent, perfectly informed, rational, and self-interested consumers (Pieńkowski, 2024). Relational goods are non-material common goods 'that depends on the relations put into action by subjects toward each other and can be enjoyed only if they orient themselves accordingly' (Donati, 2019, p. 242). The positive outcomes observed can be attributed to a number of factors, including social interactions based on mutual agreements, a non-instrumental motivation, reciprocity, complete sharing, reflexivity, and historical time relations (Donati, 2019). The advent of the new consumer is characterised by a shift in focus from the individual to the social entity, whereby the utility of the consumer is determined by their social interactions. This can result in a notable enhancement in happiness levels even in the absence of economic growth. This is a further substantial body of contemporary development concepts, which have been defined by the achievements of the economics of happiness and wellbeing, as discussed by Fioramonti (2024). In the new socio-economic order, consumption and production are more dependent on and regulated by moral virtues.

In the contemporary era, the concept of corporate social responsibility (CSR) has emerged as a pivotal criterion for evaluating the moral standing of business entities. This evaluation pertains to their credibility and accountability for driving social and environmental development. Furthermore, policy instruments are already being developed with the objective of compelling companies to report on their prosocial activities, with a view to facilitating the evaluation of such activities. By way of illustration, the ESG (Environment–Society–Governance) directive (Directive (EU) 2022/2464, 2022) in the EU, the measures such as Corporate Social Responsibility (CSR) defined by ISO 2600 (ISO, 2018) or Fair Trade movement (Pieńkowski, 2022) may be cited as examples. The concept of corporate social responsibility (CSR) extends beyond the financial bottom line to encompass a company's broader moral responsibilities towards its employees, consumers, suppliers, and the environment or local communities. The strategy encompasses the view of labour resources through the lens of not only the establishment of optimal health and safety standards and fair remuneration systems, but also the creation of a conducive workplace environment, the provision of support for professional and personal development, and the facilitation of assistance in challenging life circumstances. Similarly, relationships with suppliers or customers are based on the aforementioned factors, namely trust-building, fair prices, complete information and decisions that increase producers' environmental responsibility. The consistency of action is of crucial importance in socially responsible-oriented strategies, as it is linked to responsibility in all areas of a company's social and environmental impact (Carroll, 2016; Victoria University, 2023). In other words, a single periodic action or selective implementation, for example of philanthropic activities, is not the sole criterion for evaluation, particularly if the company in question behaves irresponsibly in other areas, for example, with regard to environmental activities. In contrast, the Fair Trade movement places emphasis on the moral obligations of consumers in developed countries towards producers in developing countries. As a consequence of the certification process, consumers elect to pay a premium for products in order to provide support to producers who are unable to secure prices as a result of unequal trade relations between developing and developed countries. These examples serve to illustrate that market actors on both the supply and demand sides are subject to a moral obligation that informs business and consumer decisions, as well as government action in terms of appropriate regulation.

Therefore, it addresses the issue of development, which, while considering economic growth to a varying extent, indicates the necessity to consider its distribution or impact on natural or social systems. From a moral standpoint, it highlights both the responsibility of the supplier for the product or service placed on the market and the responsibility of the consumer in terms of their choices.

The aforementioned Daly and the degrowth economists have invoked a global approach from an ecological perspective, inspired by the work of Georgescu-Roegen (1971) and his two laws of dynamics, to justify the limits to growth. The first law of the conservation of matter and energy dictate that 'the total quantity of matter and energy has not been altered' (Georgescu-Roegen, 1971, p. 5), states that the total quantity of matter and energy remains constant. The second law of thermodynamics, on the other hand, posits that the entropy (degree of disorder) of an isolated system increases in accordance with the following metabolic and energetic processes. Therefore, the economic processes involved in the transformation of matter and energy are irreversible and result in the disorganisation of matter and energy. The implication for the economic processes is that there are absolutely limited possibilities for the transformation of matter and energy. It follows that constraints are defined by two factors: the availability of matter and energy, and the capacity to process them in the global ecosystem. A significant consequence of this perspective is that constraints must be considered in terms of the global impact of individual state actions. Climate change provides a clear example of this, with the emissions of GHGs from numerous states contributing to a global phenomenon.

As an illustration, the most recent projections of the melting of mountain glaciers as a consequence of global warming indicate that if temperatures increase by 4°C, glaciers will lose approximately half of their mass by 2100 in comparison to 2015 (Rounce et al., 2023). This is equivalent to an approximate sea-level rise of 15 cm. The regions most vulnerable to the effects of glacial retreat are those with the smallest mass of glaciers, including Central Europe, Scandinavia, the Caucasus and the Middle East, which will experience almost complete deglaciation. One of the co-authors from the University of Oslo presented a series of significant potential consequences of glacial melting for Scandinavia (Torgersen, 2023). These consequences include flooding of land areas, but also problems for hydroelectric power generation, which will be exposed to a lack of water flow due to the loss of glaciers. Increased land instability, resulting in more frequent landslides and rock falls or new sources of GHG such as methane gas, are also indicated (Kleber et al., 2023; Torgersen, 2023).

According to calculations conducted by the International Energy Agency (IEA, 2024b), the average CO_2 emissions per terajoule of energy supply in 2021 was 54.8 tonnes, with total GHG emissions from global energy supply reaching 34,535.2 Mt CO_2 eq from a total energy supply of 617,950,232 TJ. The combustion of coal, peat and oil shale resulted in the emission of 15,172.9 Mt CO_2 eq, while natural gas and crude oil emitted 7,553.1 Mt CO_2 eq and 10,991.4 Mt CO_2 eq, respectively. The remaining emissions were attributed to the combustion of biofuels and waste. Coal, peat and oil shale constituted 27.2% of the total supply (168,145,398 TJ), natural gas 23.6% (145,989,141 TJ) and oil 29.5% (182,226,123 TJ). During the same period, Norway supplied 2.9% of the global natural gas supply, 2.2% of the global crude oil supply, and negligible quantities of coal. The Norwegian supply is equivalent to approximately 461 Mt CO2 eq. The domestic emissions from the utilisation of the aforementioned energy sources account for approximately 8% of Norway's supply (IEA, 2024b). The issue is further compounded when one considers that a mere 0.07% of the world's population is directly and indirectly responsible for almost 1.5% of global GHG emissions. Regardless of the economic benefits these actions may bring to the country, they are associated with an irreversible loss of the country's natural assets and pose serious challenges to its economy, significantly reducing profits from the trade in non-renewable resources in the long term.

The aforementioned consequences illustrate the extensive impact of glacial melting on both the environment and the economy. Investments in hydropower, currently one of the primary sources of renewable energy in Scandinavia, may become less profitable in both the short and long term as climate change progresses. The profitability of water runoff is particularly high during the melting periods, but over time this source of energy will simply cease to exist. Furthermore, it is important to acknowledge that exceeding certain water levels and debris flows, particularly in conjunction with weather-related events, can result in damage to hydropower infrastructure (Li et al., 2022). This phenomenon has already been observed in Norway, as evidenced by the Hafslund Eco's Braskereidfoss hydropower plant in 2023 (Patel, 2023). This represents a significant challenge, particularly given the uncertainty surrounding it (Farinotti et al., 2019; Laghari, 2013; Schaefli et al., 2019; Wasti et al., 2022). It is evident that investments in the Scandinavian countries, which derive over 90% of their power from hydropower, as exemplified by Norway in 2022 (IEA, 2022), or over 40% in Sweden in the same year (IEA, 2024d), are particularly noteworthy. For example, Schaefli et al. (2019) posited that energy production from Swiss hydropower plants in the Alps is likely to decline by the middle of this century. The author of the Sierra Club highlighted these concerns in his article entitled *The electricity is melting. As glaciers see diminishing returns, is hydropower worth it?* (Musselman, 2021).

The paradox of the process is exemplified by the proposal of a Swiss engineer to construct a hydroelectric power station in the Alps, which would be powered by water obtained by heating Alpine glaciers with nuclear energy (Jorio, 2019). The availability of non-renewable energy resources, such as fossil fuels, can present significant challenges to the production of energy from renewable sources. It is therefore evident that the utilisation of energy derived from the melting of glaciers as a consequence of climate change should be regarded as a non-renewable energy resource. The application of disappearing glaciers is as constrained as the utilisation of fossil fuels. Alternatively, the utilisation of glaciers should be treated in a manner analogous to the utilisation of tropical forests, where timber and other resources are harvested within the range of the ecosystem's biocapacity.

However, it should be noted that hydropower cannot be regarded as inherently unsustainable source of energy. Furthermore, the natural seasonal changes associated with glacial functioning that increase water runoff are a sustainable source of energy. These analyses indicate that not all methods of acquiring this energy are equally sustainable. The irreversible melting of glaciers due to climate change must be regarded as a non-renewable source of energy. This phenomenon also poses a threat to hydropower infrastructure that utilizes energy sources in a sustainable manner.

In a competitive global setting, international competition appears to be a typical strategy and an unavoidable consequence of the unequal distribution of the Earth's ecosystem resources. In light of the demands of sustainable development, there is a growing emphasis on greater global solidarity in the distribution of wealth. This is not only determined by ethical considerations pertaining to the moral dimension, which should favour sustainable development, but also by shifts in the social and economic dimensions of sustainable development. The gains previously associated with capital accumulation can also be rapidly dissipated. Furthermore, the psycho-social determinants of wellbeing must be considered, as the loss of welfare resulting from living in a more vulnerable environment has a detrimental impact on the perception of complacency regarding the living conditions of people in developed countries. Such developments have the potential to exacerbate existing sentiments of nationalism and separatism, which could in turn give rise to social unrest and conflict. This is particularly the case given that these sentiments have been shaped by the global pandemic of the coronavirus (2019-nCoV) and other crises (Bieber, 2018; 2022; Wang, 2021). Therefore, despite the absence of empirical evidence indicating that mass migrations or military conflicts are probable direct consequences of environmental crises (Mearns and Norton, 2009; Piguet et al., 2011), numerous adverse social and economic consequences are at least precipitated. These risks are either initiated or exacerbated by environmental factors (Carleton and Hsiang, 2016; Munck et al., 2011; O'Brien and Leichenko, 2000; Schaeffer, 2003).

The most recent estimates are notably pessimistic in comparison to previous projections. Forster et al. (2023) indicate that at current levels of greenhouse gas emissions (total emissions were estimated at 41 billion tonnes per year), with a probability of 50%, the Earth's average temperature will rise by 1.5°C in just 6 years (250 billion is the cut-off figure in this case). A probability of a similar magnitude indicates that an increase of 2°C will be achieved within a 28-year period.

Research method

The study was primarily based on data that had been compiled from a variety of sources, as presented in Table 1. The selected indicators were classified into three principal categories, which reflected the fundamental dimensions of sustainable development. The indicators were selected on the basis of their suitability for assessing energy market behaviour in terms of their links to social systems and the environment. These factors are, to a certain extent, interdependent; however, their grouping serves to highlight the various dimensions of sustainable development.

To illustrate, the gross domestic product (GDP) provides an indication of a country's economic strength from a global standpoint. However, the GDP *per capita* provides insights into the social dimension of the indicator and the welfare of specific societies from a global perspective. The consumption of energy serves as an indicator of the impact an economy has on the environment. Moreover, energy consumption *per capita* serves as an indicator of social welfare. The latter indicator also identifies certain moral criteria that justify high energy consumption in a country with a correspondingly larger population. The energy intensity and GHG emissions per GDP were proposed as economic indicators, with the objective of demonstrating the efficacy of an economy in terms of energy input and GHG output relative to disparate economic activities. The production of fossil fuels illustrates the potential risks associated with the supply of non-renewable resources to the climate from a global perspective. Such resources are deemed to exert an environmental impact. Conversely, the *per capita* production of fossil fuels represents the social dimension, exemplifying the resource abundance of a specific country and the prospective welfare generated by profits derived from these resources. Furthermore, the indicators can be perceived from the perspective of moral arguments, typically with the criteria of distributive disproportions in the allocation of global natural resources. It is evident that

TABLE 1 Main indicators and sources used for the comparison for 2022.

Indicator	Definition	Database
GDP	GDP: PPP in constant 2021 international $	World Bank (2024)
GDP *per capita*	GDP: PPP in constant 2021 international $ *per capita*	World Bank (2025)
Energy use	Total energy produced in or imported to a country, minus that which is exported or stored [TJ]	IEA (2024a)
Energy use *per capita*	Total energy produced in or imported to a country, minus that which is exported or stored [TJ] per 100 persons of population	IEA (2024a) Population data source for EU: World Bank, 2024
Share of renewables in final energy consumption	Share of renewable energy in total final energy consumption [%]	World Bank (2025) Data for 2021; EU for 2020
Energy intensity	Primary energy use per GDP measured at purchasing power parity in international-$ at 2017 [MJ/$2017 PPP GDP]	World Bank (2025) China, Nigeria, Russia, Saudi Arabia, and Iran for 2021
GHG	Greenhouse gas emissions include carbon dioxide, methane and nitrous oxide from all sources, including land-use change measured in tonnes of carbon dioxide-equivalents [toe]	Ritchie et al. (2023)
GHG *per capita*	Greenhouse gas emissions *per capita* include carbon dioxide, methane and nitrous oxide from all sources, including land-use change measured in tonnes of carbon dioxide-equivalents [toe]	Ritchie et al. (2023) Population data source: World Bank, 2024
GHG per $1,000 GDP	Greenhouse gas emissions include carbon dioxide, methane and nitrous oxide from all sources, including land-use change, measured in kilogramme of carbon dioxide-equivalents per $1,000 GDP: PPP in constant 2021 international $ [kgoe/$1,000]	Ritchie et al. (2023) GDP data source: World Bank, 2024
Fossil fuel production	Fossil fuel production in Terajoule [TJ]: coal, crude oil, natural gas	IEA (2024a)
Fossil fuel production *per capita*	Fossil fuel production (coal, crude oil, natural gas) in Terajoule [TJ] per 100 persons of population	IEA (2024a) Population data source: World Bank, 2024
Ecological debt/reserve	Biocapacity–Ecological footprint [gha *per capita*] Ecological footprint - a measure of how much area of biologically productive land and water an individual, population, or activity requires to produce all the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management practices (demand for natural resources) Biocapacity–the capacity of ecosystems to regenerate what people demand from those surfaces (supply of natural resources) Global hectares (gha)– a biologically productive hectare with world average biological productivity for a given year	Global Footprint Network (2024) Data for EU estimated from the average of members

Source: own elaboration.

high production or consumption *per capita* can be indicative of two opposing indicators. For example, elevated levels of energy consumption *per capita* are indicative of a higher standard of living. However, this is accompanied by an increased environmental burden, particularly if the energy is derived from fossil fuels. Finally, the share of renewables in final energy consumption represents the environmental dimension of an economy, reflecting the extent of green investments. Table 1 presents the selected indicators, their definitions and the sources of the data employed in the research.

In addition, the aforementioned indicators can be classified as either supply- or demand-side indicators. For instance, GHG emissions and fossil fuel production are representative of supply-side indicators from the global perspective, whereas energy use is illustrative of the demand-side of an economy.

The rationale for the classification is that certain economies exert a greater environmental impact, irrespective of their level of economic development and social conditions. For example, GHG emissions are a primary driver of climate change. From an environmental perspective, it is imperative that GHG emissions are limited, regardless of population size or the socio-economic, political, and cultural factors of specific emitters. It is therefore necessary to evaluate the indicators in question in terms of their absolute value in order to assess their impact on climate change.

In order to facilitate a meaningful comparison with Norway, a number of relevant global suppliers of non-renewables, including natural gas, oil and coal, have been selected for analysis. It should be noted that the countries in question represent a diverse range of levels of development, cultural norms and political structures. The most developed countries were selected for inclusion in the study, namely the United Kingdom (United Kingdom), Germany and the United States of America (US). Additionally, Poland was chosen due to its prominent coal mining sector, as well as Saudi Arabia and the Russian Federation, classified in the latest World Bank statistics as high-income economies. Furthermore, China and Iran, classified as upper-middle income economies, and Nigeria, categorised as a lower-middle income economy (World Bank, 2025), were included in the comparison. In accordance with the United Nations (UN) broader taxonomy, Norway, the US, the United Kingdom, Germany and Poland were classified as developed countries, whereas the remaining countries were categorised as developing countries, with the Russian Federation being placed in the group of countries in transition (UN, 2024). Additionally, the average in the European Union (EU) were presented to show the situation in the region.

Results and discussion

In March 2024, Norway was the sixth largest producer of natural gas worldwide and a significant oil-producing nation on the global stage (GEM, 2024). The estimated value of the production in 2022 was approximately NOR 2.5 billion (SSB, 2024). In 2022, the average citizen in this country received approximately NOR 452,967 from oil and gas production alone, whereas the average salary in Norway was recorded at NOR 637,800. This sector constitutes a substantial proportion of the nation's wealth, and it is noteworthy that this represents one of the most significant gains on a *per capita* basis across the globe. Norway is often held up as a model for a nation that employs its economic standing in a relatively equitable and efficacious manner to foster sustainable development. A case in point is the distribution of revenues from the petroleum sector based on the Government Pension Fund Global, which was created in 1990. The current value of the fund in 2023 is estimated to be approximately $1.5 trillion, which equates to approximately $300,000 *per capita* (Management of Revenues, 2025). Moreover, the country's advanced ecological policy and its status as a European leader in renewable energy are further exemplifications of its commitment to sustainable development. Additionally, Norway has one of the highest shares of renewables in final energy consumption among developed countries, with hydropower being a significant contributor to its energy mix (Table 2).

The relatively high supply of fossil fuels in Norway represents only one of the country's challenges. Furthermore, Norway exhibits a relatively high level of energy consumption *per capita* and a relatively low level of energy efficiency when compared to other EU countries, including newer members such as Poland, which joined the EU in 2004. A sustainable energy transition necessitates an increase in the utilisation of renewable resources and energy efficiency, in addition to a reduction in energy consumption. These issues are frequently highlighted in the context of the challenges identified by the rebound effect. The economic and technological availability of energy frequently results in an increase in energy use, and further complications are introduced by the ever-increasing consumption of energy (Brockway et al., 2017; Freire-González, 2017; Greening et al., 2000; Pieńkowski, 2012; Sorrell, 2009). The current debates acknowledge the existence of multiple dimensions of the effect, including direct and indirect microeconomic rebound effects, as well as macroeconomic rebound (Brockway et al., 2017). These are associated with alterations in income and energy prices, consumer and producer behaviour, and the macroeconomic dependence of numerous other sectors and the economy as a whole on specific energy resources. Consequently, modifications in the utilisation of particular energy sources have extensive direct and indirect socio-economic consequences.

Notwithstanding the aforementioned, Nigeria, the country with the lowest GDP *per capita* among those analysed, has the highest proportion of renewable energy sources (i.e. over 80% in 2021) (World Bank, 2024). The principal sources of renewable energy are biofuels and waste, which present certain challenges in terms of side-effects such as air pollution (IEA, 2024c). Furthermore, Nigeria has considerable untapped potential for other renewable energy sources, including solar, wind, and hydroelectric power (IRENA, 2023). These renewables account for approximately one-fifth of the country's electricity generation, with hydropower representing the majority (99%) (IEA, 2024c). However, despite Nigeria's very low energy efficiency, the average Norwegian consumes almost fourteen times more energy and produces seven times more GHG than the average Nigerian. Furthermore, Norway's total fossil fuel supply is twice that of Nigeria. The low economic and social indicators selected to exemplify the distribution of natural resources in Nigeria are indicative of a number of disadvantages. Nevertheless, the low GHG emissions should be viewed in the context of the potential ecological benefits.

It is evident that economic growth is accompanied by an environmental burden and an increase in consumption, which in turn results in elevated GHG emissions. Domestic emissions *per capita* are greater than those observed in numerous developed countries, with Germany and the UK serving as illustrative examples in the research. Even the most significant consumers of coal in their energy mixes, such as Poland, have lower emissions *per capita*. Concurrently, Poland, which has an economy with a similar level of efficiency to Norway, produces a considerably higher quantity of GHG per GDP due to the substantial proportion of coal in its energy mix. Despite Norway's status as a global leader in renewable energy and economic efficiency, its energy consumption *per capita* remains high. While these factors contribute to a high standard of living for the average Norwegian, they also result in a considerable environmental burden on both the supply and demand sides of GHG emissions (Figure 1).

From an ecological perspective that encompasses the entire planet, Norway's role in GHG emissions on the demand side remains

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TABLE 2 GDP, energy use, intensity and production, GHG emissions, share of renewables, fossil fuels production, and ecological debt/reserve for selected fossil fuels suppliers.

Dimension	Economic			Social				Environmental				
Country Variable	GDP [billion]	Energy intensity	GHG per $1,000 GDP	GDP *per capita* [thous.]	Fossil fuel production per 100 persons	Energy use per 100 persons	GHG *per capita*	GHG [mln]	Energy use [mln]	Fossil fuel production	Share of renewables	Ecological debt/reserve *per capita*
Norway	495.72	3.21	145.99	90.84	154.83	19.38	13.30	72.56	1.06	8,449,424	61.4	1.3
US	24276.13	4.17	247.22	72.84	24.06	27.27	18.01	6,001.57	90.98	80,187,435	10.9	−4.1
UK	3581.81	2.04	113.67	52.84	4.47	9.44	6.01	407.14	6.41	3,031,984	12.2	−2.6
Germany	5273.57	2.47	140.21	62.93	1.74	13.55	8.82	739.39	11.36	1,462,136	17.6	−2.9
Poland	1598.25	3.13	229.07	43.41	5.12	11.42	9.94	366.11	4.32	1,884,818	15.2	−2.6
Saudi Arabia	1845.31	5.81	439.55	57.35	78.61	27.85	22.28	811.11	10.14	28,622,259	0.1	−5.0
Russia	5613.80	8.46	407.85	38.26	39.39	23.56	15.87	2,289.57	33.82	56,819,399	3.5	1.9
China	29672.08	6.30	469.93	21.01	7.80	11.26	9.87	13,943.69	159.08	110,168,512	15.2	−2.8
Nigeria	1239.12	6.57	343.34	5.55	1.77	1.42	1.95	425.44	3.11	3,951,669	80.3	−0.4
Iran	1372.53	9.32	681.48	15.33	18.00	13.82	10.56	935.35	12.24	15,935,326	0.9	−2.4
EU	24033.10	2.66	139.10	53.66	1.40	12.20	7.47	3343.11	54.64	6,266,549	21.12	−1.7

Source: own elaboration based on the sources presented in Table 1.

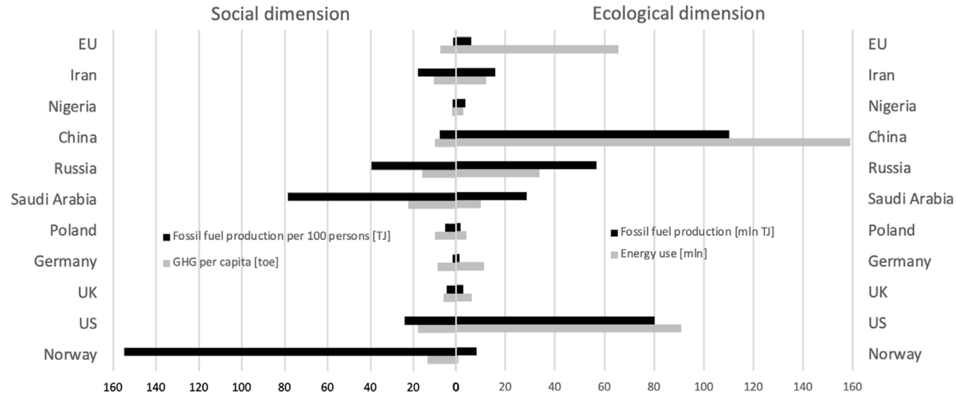

FIGURE 1
A comparative analysis of selected ecological and social indicators of energy supply and demand. Source: own elaboration based on the sources presented in Table 1.

relatively minor (Figure 1), particularly when the ratio of population to territory is taken into account. This is effectively demonstrated by the concept of the ecological footprint (Global Footprint Network, 2024). Only Norway and Russia exhibit a positive ratio between their respective ecosystem supply (ecosystem biocapacity) and their demand for ecosystem services (ecological footprint), with estimated values of 1.3 gha *per capita* and 1.9 gha *per capita* in 2022, respectively. Conversely, Nigeria's deficit is only marginally negative, at −0.4 gha *per capita*. The largest deficits are observed in Saudi Arabia and the US, with respective values of −5.0 gha *per capita* and −4.1 gha *per capita* in the same period. The indicator demonstrates the extent of resource exploitation under territorial management, with negative values indicating environmental burdens and debts incurred from other countries and future generations.

In terms of the global determinants of climate change, the major suppliers of fossil fuels, namely China and the US, exert a considerable influence. As is the case with Norway and Nigeria, the analyses conducted in this area are particularly susceptible to the contextual criteria employed to evaluate the circumstances in these regions. China's economy is less efficient in its use of energy, yet the country consumes approximately twice the amount of energy as the US. However, the average Chinese citizen emits approximately half the amount of GHG as the average American. Thus, from a global social perspective, the US is the primary beneficiary of the world's energy resources, whereas from an environmental standpoint, China is the most significant consumer and polluter. China's ecological situation is dire, yet the country's ecological deficit is more favourable than that of the US. The US economy displays a relatively low level of energy efficiency, particularly in comparison with its relatively high economic performance as reflected in GDP *per capita*. This is accompanied by markedly elevated levels of energy consumption and GHG emissions *per capita* in comparison to the other countries included in the research. Furthermore, the accessibility of renewable resources does not align with the country's economic performance, as is the case with numerous other developed European countries.

Saudi Arabia, which has a fossil fuel supply that is three times greater than that of Norway, provides an illustrative case study of a nation exhibiting less sustainable patterns of energy production and consumption. Despite a relatively high level of economic development, as reflected in GDP *per capita*, the country demonstrates a relatively low level of energy efficiency. Furthermore, there is a conspicuous absence of investment in renewable energy sources. In comparison to the UK, which has maintained a similar level of GDP *per capita*, the aforementioned country has an economy that is almost three times less energy-efficient, produces close to four times more GHG, and uses three times more energy *per capita*. The country is wholly reliant on fossil fuels, and there are only slight indications of sustainable energy use. Iran and Saudi Arabia exhibit comparable patterns of energy production and consumption. However, Iran's inferior economic performance is also reflected in its lower energy consumption and GHG emissions *per capita* in comparison with those of Saudi Arabia.

Figure 2 presents a visual representation of the various dimensions of sustainability, wherein the selected countries are ranked according to the indicators utilized in the research. The black colouring indicates negative consequences of a higher ranking, including fossil fuel supply, GHG emissions, GHG emissions per GDP, energy intensity and energy use. A comparative analysis of Norway with EU countries (including the former member state, the UK) reveals a notable discrepancy in performance, particularly with regard to environmental outcomes. Furthermore, there are countries with a considerably lower level of socio-economic development that demonstrate a greater degree of relevance to climate change, particularly in regard to *per capita* GHG emissions, energy use or the share of renewables (e.g. Nigeria).

The grey colours (dark and light) represent the most preferred high values, although the dark grey balloons can be interpreted differently from the perspective of different dimensions, as discussed above referring to the rebound effect. The most desirable patterns of development offered by the indicators analysed in the study, can be characterized by high economic growth (GDP), low both energy use and fossil fuel production, and a structure of energy use as indicated by greenhouse gas (GHG) emissions. The latter is complemented by the share of renewables. The ecological debt/reserve is a metric that indicates the relationship between growth and a country's available resources, thereby providing a comprehensive assessment of the country's ecological status.

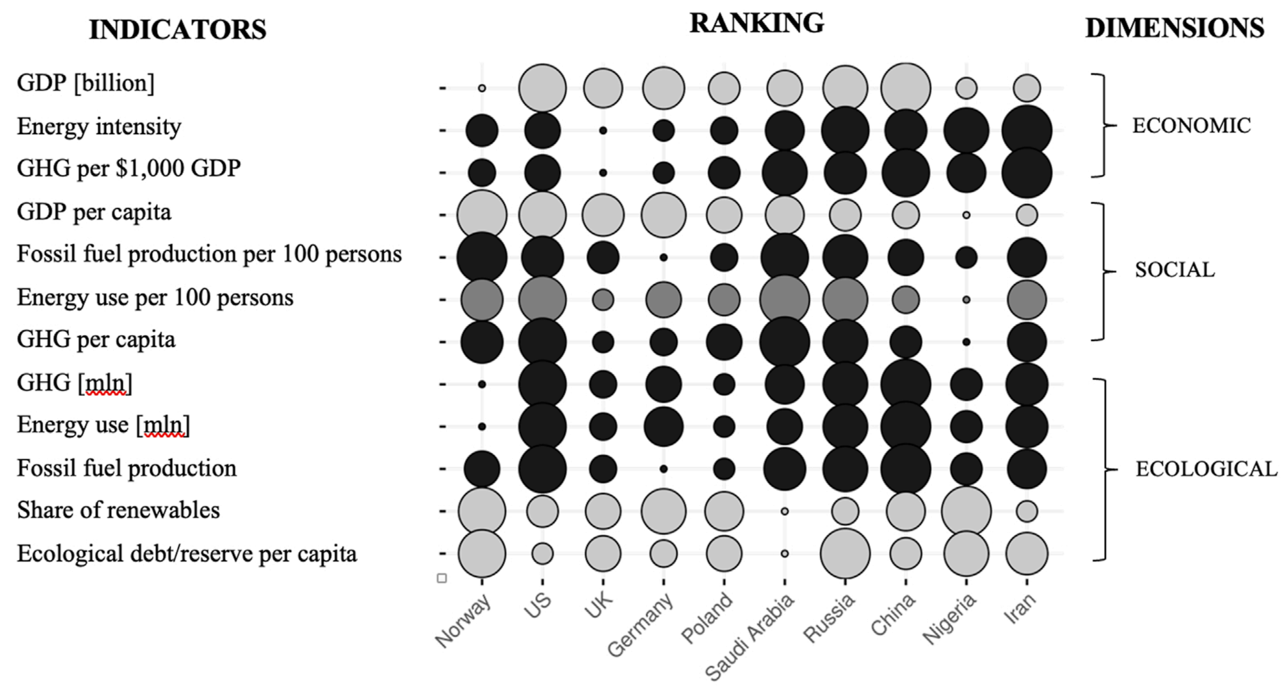

FIGURE 2
The ranking of countries based on a set of selected sustainability indicators. The dimensions of the balloons are indicative of the relative position of each country on a scale of 1 (the lowest position and the smallest balloons) to 10 (the highest position and the largest balloons). The utilization of colours serves to denote the less preferred (black) and most preferred (light grey) high values. Source: own elaboration based on the sources presented in Table 1.

Conclusion

Norway is currently regarded as a model for successful socio-economic and ecological transformation in line with sustainable development principles. The moral implications of these outcomes are a subject of considerable debate, particularly in light of contemporary approaches to development. While there is considerable support for its socio-economic development, it is important to note that as welfare and wellbeing have increased in Norway, the country has fallen into the trap that afflicts many developed countries, characterised by high levels of energy consumption and associated GHG emissions. It is undoubtedly appropriate to invest significantly in a low-carbon economy. However, it is also important to recognise that Norway will not be immune to the long-term consequences of its supply of non-renewable energy resources, which could have significant ecological and socio-economic costs.

In light of the aforementioned considerations, it is imperative to examine the findings of the research in question as follows.

1. In terms of climate change, Norway's sustainability performance is less advanced than that of many other European countries, despite its progress in utilising renewable resources and its robust economic performance.
2. The utilisation of energy resources and the emission of GHG remain unacceptably unsustainable when compared to the climate impact of many developing countries. It is therefore erroneous to propose that economic growth is a prerequisite for pursuing a more environmentally sustainable trajectory.
3. From a global perspective, it is imperative that the supply and demand of non-renewable resources be subjected to ethical scrutiny. These resources will inevitably result in costs borne by both sellers and buyers.
4. The disappearance of Norwegian glaciers may occur much earlier than that of large glaciers in other parts of the world. It is only in the short to medium term that the use of such resources can be envisaged.

The following recommendations stem from the aforementioned conclusions and indicate pivotal courses of action that are interconnected.

1. Education is a crucial component in fostering awareness regarding the interdependence of global change and local action. It is also imperative to underscore the responsibility of suppliers of non-renewable resources in this regard. Paradoxically, such action appears to be rather evident in the policies of numerous societies. For instance, in the context of drug distribution, greater emphasis is typically placed on suppliers than on the demand side. In the context of trade involving non-renewable resources, the prevailing moral norms system appears to place a greater emphasis on the consumers of these resources.
2. The development of international agreements is of paramount importance in the effort to significantly reduce the use of non-renewable resources. Furthermore, it is essential to provide

support to international financial institutions in countries that are particularly dependent on these resources.

3. The establishment of mechanisms to support the financing of investments in the utilization of renewable resources is predicated on international agreements. These mechanisms are implemented through the taxation of suppliers of non-renewable resources, thereby accounting for the social costs associated with the utilization of these resources. Concurrently, these measures are intended to diminish the competitiveness of these resources, irrespective of the extent to which these costs are transferred to consumers.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: World Bank Open Data. Retrieved 20 May 2025, from: https://data.worldbank.org, SSB. (n.d.). Extraction and related services. Statistisk Sentralbyrrå. Retrieved 8 August 2024, from: https://www.ssb.no/en/energi-og-industri/olje-oggass/statistikk/olje-og-gassutvinning-og-utvinningstjenester, WHO (n.d.). Global Health Observatory data repository: Healthy Life Expectancy at birth (HALE). WHO. Retrieved 13 September 2019, from http://apps.who.int/gho/data/view.main.HALEXv?lang=en, IEA. (n.d.-a). Energy mix [Countries & Regions]. International Energy Agency. Retrieved 20 May 2025, from https://www.iea.org/countries. Ritchie et., 2023 and Global Footprint Network (2024).

Author contributions

DP: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Resources, Validation, Visualization, Writing – original draft, Writing – review and editing.

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The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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