Is Green Energy the Pathway to Sustainability? – An Explanation From the Perspective of Degrowth Theory

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Abstract

The discourse surrounding energy transition is intensifying due to insufficient global energy resources. Nonetheless, given that the capitalist economy prioritizes expansion and growth, it remains uncertain whether green energy solutions can genuinely pave the way towards sustainability and address the challenges of climate change, energy shortages, and food security concerns. Degrowth calls for a radical reorganization of politics and economics to reduce resource, energy consumption. This paper discusses the crisis of capitalism from multiple dimensions. It uses the Analytic Hierarchy Process (AHP) as an approach to explain degrowth and green energy. It also explores green energy in terms of three aspects of sustainable development: the profit-making industry, the high-efficiency paradox, and the re-challenge to the

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environment. Finally, it discusses the possible pathways for society to solve the global environmental crisis in the context of degrowth. These movements encourage critical thinking about the transition to green energy and offer a feasible pathway to sustainability without relying on growth ideology. This highlights the viability of the degrowth framework as a means to address a range of problems.

Keywords: Degrowth, green energy, sustainability, capitalism.

1 Degrowth: A Brief Summary

Degrowth is a concept proposed as a social and economic theory and introduced by André Gorz in 1972 as the most important tool to address climate change in a capitalist context [1, 2]. It was adopted as the "missile word" to critique the pursuit of growth in capital and social unsustainability [3]. Degrowth advocates reducing the scale of both production and consumption in order to minimize the impact of economic growth on the earth and society [4]. The goal of degrowth is to prioritize the maintenance of the ecological integrity of the planet, to create a more sustainable and more equitable society in which resources are more efficient, and to use the sufficiency principle as a way of life and the basic needs of citizens are met without harming the environment nor future generations [5].

Munasinghe [6] believes that the current values of pursuing economic growth are unsustainable and that we need to reduce our reliance on resource-intensive production activities to weaken human damage to the environment and alleviate social inequality. Nørgård [7] believes that degrowth focuses more on the rights and interests of the workforce, which enables laborers to have a legitimate right to rest and an equivalent salary and income, to have more time to rest, as well as to improve the life quality.

Nonetheless, implementing degrowth faces a multitude of difficulties, including economic constraints, political resistance, and societal acceptance. One of the main obstacles is the current economic system that prioritizes growth and expansion [8, 9]. Shifting to degrowth requires endeavors to restructure politics and economics to decrease energy consumption and diversify energy sources, which contradicts the dominant ideology of constant economic expansion [10]. Furthermore, social conservatism (to not change lifestyle) [11] and people's desire for better life quality (higher energy consumption per capita) [12] also serve as an obstacle to achieving degrowth. Degrowth calls for a fundamental shift in consumption habits and

lifestyle choices, which may face resistance and skepticism [13]. Additionally, addressing inequalities and ensuring social equity is a crucial aspect of degrowth, but it requires addressing structural issues and redistributing resources in a fair and just manner [14]. In addition, utilizing degrowth as an approach on a global scale to solve climate issues requires broad cooperation and coordination among governmental, non-governmental, and inter-governmental entities [15], as well as intensive educational efforts on population [16]. However, reaching a consensus and agreement among parties and states with different priorities and interests can be a complex and lengthy process [17].

There are several different options for dealing with environmental issues according to degrowth, including reducing the usage of fossil fuels [18], motivating the utilization of renewable energy [19], enhancing more sustainable agriculture and forestry practices [20], and decreasing the unnecessary scale of production. A few supporters of degrowth also advocate alternative economic models, such as cooperatives [21] and common-based peer production [22], which promote social and environmental sustainability over profit, rather than simply economic growth rates as a standard of performance. Many scholars have studied or applied degrowth theory in various contexts to solve problems, as shown in the table below.

2 The Crisis of the Capitalist Economic System

Property rights in business play a crucial role in a market economy where resources are privately possessed and controlled and allocated through market exchange, while the role of government is normally to a limited extent [33]. The traditional view of economics assumes that economic growth is infinite and that the rate of growth and the more money accumulated, the better, in order to make more profits for businesses [34]. Daly and Farley [35] argue that the traditional profit-seeking view ignores the real costs of economic growth, especially the damage to the natural environment and the impact on the quality of human life.

In addition, capitalists may adopt immoral or illegal tactics and means to obtain more profits [36], such as creating artificial scarcity through advertisement, adopting planned obsolescence, and achieving monopolization in order to stimulate consumption [37], speed up product turnover [38], and gain high profits by acquiring the right to set and control prices to increase gains for capitalists [39]. In a capitalist economy, as capitalists endeavor to stimulate consumption and pursue the growth of corporate profits, they often

Table 1 Summary of previous studies on degrowth theory

Author(s)	Context	Points
Ossewaarde and Ossewaarde-Lowtoo [23]	Exploring ecological economics	It questions the assumption that continuous economic growth is compatible with environmental preservation.
Vandeventer and Lloveras [24]	Researching organization and management studies (OMS)	It questions the sustainability and desirability of continuous economic growth, which is a fundamental assumption underlying traditional models. It also discusses how degrowth theory aims to improve ecological sustainability, social equity, and well-being improvement.
Hickel et al. [25]	Addressing the challenges posed by traditional economic growth	It emphasizes the importance of considering degrowth policies in the fight against climate breakdown and biodiversity loss and highlights the role of social movements, cultural change, and government action in advancing the principles of degrowth.
Keyßer and Lenzen [26]	Addressing climate change	It argues that degrowth scenarios can minimize key risks for feasibility and sustainability by reducing the reliance on high energy-GDP decoupling, large-scale carbon dioxide removal, and large-scale and high-speed renewable energy transformation.
Abazeri [27]	Engaging in decolonial feminist praxis	It questions the paradigm of growth, and it puts that prioritizing values such as care, solidarity, justice, and conviviality towards an "altogether new, qualitatively different world that will evolve through confrontation with the existing one."
Lorek and Fuchs [28]	Addressing sustainable consumption	It argues for the integration and exchange of insights on sustainable consumption and degrowth, and it proposes that by incorporating principles from degrowth theory, such as deliberate reduction in production and consumption to achieve sustainability and well-being.
Buch-Hansen and Koch [29]	Addressing maximum caps on wealth and/or income	It challenges the prevailing paradigm of continuous economic growth, prioritizes well-being over GDP growth, and calls for involving diverse stakeholders through inclusive forums.

(*Continued*)

Table 1 Continued

Author(s)	Context	Points
Hickel [30]	Addressing anti-colonial principles	It deals with the critiques and misrepresentations of degrowth theory, and calls for decolonization.
Barca [31]	Working on labor in the politics of socio-ecological revolution	It puts degrowth theory as an anti-colonial political movement to recognize the unequal exchange between high-income countries and expand understanding class relations beyond wage labor.
Corvellec and Paulsson [32]	Managing resources	It analyzes how resources are conceptualized and understood in degrowth scholarship, with a focus on resourcification and de-resourcification, and advocates for a transition away from the current growth-oriented economic model towards a more sustainable and equitable society.

overlook the negative consequences to society, such as the over-exploitation of labor rights. This focus on profit maximization can lead to a disregard for social and environmental well-being [40], taking public resources [41], and destruction of the natural environment [42]. The promise of growth, meant to benefit people in many countries, has been undermined by corruption, poverty, and even social unrest. As a result, the benefits have ultimately been enjoyed only by a select few wealthy individuals. For instance, a study revealed that a mere eight individuals possess the same amount of wealth as 50 percent of the global population of 7.4 billion. Similarly, in the United States, the richest 1 percent owns 34 percent of the wealth, while the richest 10 percent accounts for 74 percent of the total wealth, while the wealthiest 1% produce an equal amount of pollution that contributes to global warming as two-thirds of the world's population [43, 44]. According to the findings from CNN [45], the richest 10% of households in the US, with an income of approximately $178,000 or more, were identified as the source of 40% of the nation's human-caused, planet-heating pollution. It was also revealed that the income of the top 1% alone, comprising households earning over $550,000, was associated with 15% to 17% of this pollution. These statistics highlight the significant disparity in wealth distribution and underscore the dominance of capitalism in controlling a substantial portion of global wealth, and the passive effects they made. In an insane pursuit of maximizing private profits,

it is difficult for society as a whole to think beyond the individual perspective to consider the critical threats to the human perspective and to consider the public welfare undertakings that can enhance one of the most direct forms of human happiness.

3 Is Green Energy the Pathway to Sustainability?

"Green energy", such as solar, wind, and biomass, is an important means of reducing global carbon emissions, is normally environment friendly, serves as an alternative to traditional fossil fuels, and generates little pollution or waste in the process [46]. According to the data from the World Bank [47], in the United States, carbon emissions are 97% lower when using wind and solar energy to generate electricity compared to coal which is considered traditional. Bioenergy also has a much lower carbon footprint because it uses renewable biomass resources to produce energy rather than fossil fuels [48]. What's more, the utilization of renewable energy can improve the efficiency of energy consumption [49], reduce energy expenses [50], decrease the emission of contaminants [51], and improve the sustainability of the company which values as a vital stander to acquire positive WOM [52]. In addition, renewable energy can help companies respond to energy shortages and deal with fluctuating energy prices in a better way to enhance the potential and comprehensive competitiveness of their companies. The cost of renewable energy is decreasing rapidly, resulting in a rise in solar and wind projects. This trend is being driven by large international companies that have the capital and are meeting the high demand in the market. The development of new energy source techniques is progressing at an impressive rate. Projections for photovoltaic (PV) capacity in 2030 estimate it to be over 2,500 GV, which is 30 times higher than in 2006. Similarly, onshore and offshore wind capacity may exceed 1,500 GV, four times higher than in 2006. This indicates that green energy is becoming the primary focus of market attention [53].

3.1 Green Energy is the New Profitable Industry

New energy is a booming industry, and as global policymakers attach increasing attention to tackling climate change while the global demand for clean energy increases, the new energy industry has been on a rapid growth track, prompting the development that renewable energy technologies such as wind and solar are growing at an impressive rate, which can be clearly reflected in the stock market. In the case of China, the new energy industry has grown in

just 15 years, with its market capitalization exceeding 8 trillion yuan (about $1.15 trillion) by October 2022, accounting for 10% of the total A-share market capitalization [54]. The new energy industry has become a high-net-worth industry for companies to invest in for profit, and its development goal is no longer to solve the common ecological problems faced by mankind for sustainable development.

First, the primary goal of market competition is profit maximization. Reducing emissions has become a popular investment opportunity. A 2023 report highlights that renewable energy has become a focal point for investment [55]. This drives countries to view low-carbon energy as a lucrative sector, employing strategies such as squeezing margins to gain market share [56] and increasing subsidies to secure advantages in the green energy industry [57]. However, the capitalist pursuit of surplus value and short-term gains undermines the initial sustainability goals of the new energy sector [58]. High-profile scandals, such as those involving Exxon Mobil and Shell in the Amazon [59], and the biomass industry in the southeast of the U.S. [60], highlight the industry's lack of prioritization for social impacts over profits. Such actions, driven by the pursuit of economic dominance rather than sustainable development, present a challenge to the global green energy movement.

Second, due to the core technologies of green energy being in the period of patent protection, for example, semiconductor technology is crucially important for solar power generation [61]. However, many of these technologies are currently monopolized [62, 63]. As a result, advanced new energy technologies have become accessible only to a few companies that can profit greatly from them [64, 65]. In the technology sector, capitalists can use "commercial secrets" in the name of protecting private property to restrict the use of the technology to others and extract large amounts of revenue [58], at the same time imposing strict standards on the transfer and licensing of transnational green energy technologies that benefit themselves [66]. Under such criteria, the use of technology is not likely to be oriented toward solving the climate crisis, but rather toward generating profits, thus hindering progress in addressing global climate change.

Third, new energy is a new profit growth industry, under the environment of personalization of technology, the frontline workers, who occupy the majority, can only get a meager income. Daly [67] proposes that after a certain level of economic growth, people's happiness no longer increases. This is attributed to the unfair distribution of wealth caused by private ownership, where most of the money flows into the accounts of capitalists and widens

the gap between the rich and the poor. Moreover, the relentless pursuit of profit contradicts the fundamental principles of Marxism. It is important to note that the choices made by the wealthy, as consumers and investors, have a significant impact on carbon emissions, particularly in transportation and housing. According to the World Inequality Lab [68], just one percent of the world's wealthy population is responsible for half of all aviation emissions. For example, FlightRadar provides data that one in ten of all flights departing from France in 2019 was by private jet, and the carbon emissions they can generate in four hours are the emissions of the average EU per capita in a year.

3.2 The "High Efficiency" Paradox of Green Energy

The use of renewable energy can reduce dependence on fossil fuels, reduce energy costs, and improve the productivity of businesses [69]. For instance, solar power can reduce the use of fossil fuels such as coal and gasoline, and renewable energy is developing at an incredible rate, driven by market demand and international corporations' capital, and the cost of using renewable energy is gradually decreasing [70]. This can help reduce energy expenses during business and improve the productivity of enterprises. While improving efficiency helps to achieve, degrowth, it may also help to increase total emissions if new energy sources are used to support activities that generate high emissions, such as transportation or manufacturing.

There have been many instances in human history where resource use efficiency has increased due to technological innovation, but pollution has also grown [71]. For example, with the large-scale use of steam engines, the efficiency of coal use was improved, but the demand for coal in Britain did not decrease, but on the contrary, increased. The British economist Jevons found that when the efficiency of using a resource increases, the demand for that resource increases, and even if the overall consumption decreases, the relative consumption of it increases. This phenomenon is known as the Jevons paradox, also known as the Jevons effect [72]. When people see the high efficiency brought by technological progress, the technology will become a means to pursue short-term benefits, and also serve as a tool for capitalists to obtain capital to accumulate and then re-invest in activities to expand the scale of production, producing more products or services, this mode of production brings excess supply, which brings a considerable burden to the environment.

Although the current gradual development of new energy sources has reduced the demand for fossil energy, which has become increasingly high

in price, relieved the energy shortage, and achieved increased efficiency in the use of energy in some areas, the values driven by the pursuit of economic growth rates will prompt capitalists to invest their capital again to produce more products or increase services in order to obtain short-term gains above the social parity profit. If this cycle continues in the long term, this is certainly becoming an obstacle to the sustainability of the development environment.

3.3 Green Energy Launches New Challenges to the Environment

In the financing segment, carbon treatment capacity has also served as one of the assessment capabilities for investors to evaluate the development of companies and decide whether to fund them or not [73]. Therefore, companies increase the demand for renewable energy in order to achieve profits. In the degrowth framework, the capitalist system, which aims to maximize profits and permanent economic growth, is not sustainable and leads to problems such as social inequality, climate change, and resource depletion. This fervor for the blind pursuit of sustainability, which exceeds actual needs, has made new energy synonymous with sustainability so that using new energy means increasing the favor of capital markets. However, this feverish pursuit may lead to damage to the environment.

First of all, the process of the construction of equipment for renewable energy requires large amounts of rare metals, which include nickel, copper, iron, etc., together with rare earth metals, such as neodymium and praseodymium [74]. These raw materials are expensive to extract and consume large amounts of resources from exploration, mining, and transportation to processing, while the exploitation itself from the mine mountains can cause irreparable damage to the natural environment [75]. Second, when the production and infrastructure needed to support new energy sources has a high carbon footprint, it can increase the carbon emissions to the environment. For instance, the extraction and processing of the materials used in solar panels and wind turbines can be energy intensive and emit large amounts of carbon dioxide. Most of the stages of production are produced by cheap workforces in developing countries [76]. Faced with the surge of orders, on the one side, developing countries will be burdened with high levels of carbon emissions, and on the other side, the legitimate rest rights of labor in manufacturing plants in developing countries will not be assured and guaranteed. Lastly, when the enterprise equipment is converted to sustainability, the original equipment will be eliminated before its life span comes, resulting in large carbon emissions [77]. This is because environmental pollution is caused by

dismantling, transportation, and obsolescence. Africa, often considered one of the most serious third-world regions, has unfortunately become a dumping ground for unprocessable electronic equipment from Western countries. This has resulted in the accumulation of a large volume of electronic metal scrap. These electronic waste graveyards contain a significant amount of hazardous substances, including lead, mercury, cadmium, chlorine, and more. When these harmful substances are released into the environment, they can pose a threat to human health. For example, lead has the potential to damage the human nervous system, while mercury and cadmium can harm the kidneys and immune system. Additionally, E-waste graveyards contribute to water pollution and soil contamination.

Consequently, the entire life cycle of energy and its infrastructure both at home and abroad must be considered when assessing the environmental impact of energy, including emissions associated with its production, usage, and disposal. While in many cases the adoption of new energy sources can help reduce carbon emissions in the long term, the pursuit of maximizing profits can also be a source of high-polluting emissions.

4 Degrowth and Green Energy

Degrowth upholds the idea of shifting the focus of economic development to sustainable development rather than short-term economic growth. It is believed that its economic development in the state of existing demand by improving production efficiency and reducing resource consumption under the premise of satisfying the needs of people, rather than economic growth by expanding the scale of production to produce integrated products and consuming large-scale resources with the help of efficient energy. Green energy can be an obstacle to sustainable development in this respect. The problem is that the capital market values in the development of renewable energy are based on gaining profit, producers see it as a profit point and users see it as a tool for pursuing capital, and in this process, from production to end-of-life. There can be a huge drain on the natural environment and labor rights issues. Thus, we need to change the focus of economic development and see green energy as a way of production to meet the needs of the moment, rather than as a new point of profit growth, a tool to expand and reproduce, and an industry to exploit nature again.

Degrowth is the alarm bell for sustainable human development [78]. It is a conceptual restraint in the pursuit of capital accumulation, a reduction in the scale of production to meet human needs for a better life, a reduction in

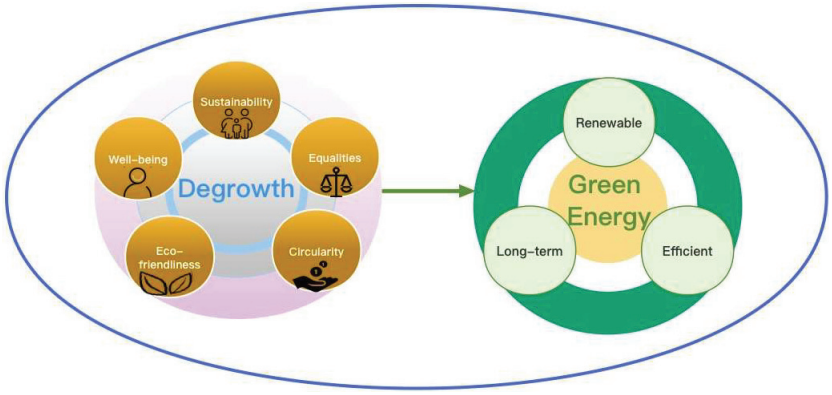

Figure 1 Green energy under degrowth theory.

unnecessary waste, and a focus on a common response to the energy crisis and climate change. In the new energy development, degrowth should apply to culture, consumption patterns, and taxation fields to achieve the goal of long-term economic sustainability.

To provide a clearer explanation, we have utilized the Analytic Hierarchy Process (AHP) method as a solution methodology in this study. AHP is an approach that helps break down, organize, and analyze complex problems by converting them into hierarchical structures with different levels, such as goals, criteria, and sub-criteria [58–60]. The steps involved in the Analytic Hierarchy Process (AHP) are as follows:

- Formulation of the aim of work: Evaluate the goals and main issues addressed by Degrowth and Green energy, and break down the top-level criteria into sub-criteria.
- Formation of the pairwise comparisons: Conduct pairwise comparisons by collecting data from an expert panel. Use expert judgment to compare the factors on a nine-point Saaty's scale, as shown in Table 2.
- Calculation of the Eigen values and Eigen vectors and determining the relative importance weights: Utilize the pairwise comparison matrices to derive the Eigen values and Eigen vectors. Further, analyze them to compute the relative importance weights of the factors.
- Evaluation of the consistency ratio: Calculate the consistency ratio (CR) to ensure the pairwise comparisons are consistent. The CR is calculated using the mathematical expression:

$$\mathrm{CR} = \mathrm{CI}/\mathrm{RI} \tag{1}$$

Table 2 Scales in pairwise comparisons [79]

Rating	Definition
1	Two characteristics are equally important
3	The preferred characteristics are moderately more important
5	The preferred characteristics are strongly important
7	The preferred characteristics are extremely important
9	The preferred characteristics are absolutely more important
2,4,6,8	Intermediate values between adjacent scale values

where CI represents the consistency index:

$$\mathrm{CI} = (\lambda_{\max}\mathrm{n})/(\mathrm{n}-1) \tag{2}$$

with $\lambda_{\max}$ being the maximum average value and the value of the random consistency index (RI) depends on the value of n. The CR value should be less than 0.10 to indicate a higher level of consistency.

In the data collection process, a decision group is formed, consisting of five experts, including a project manager, a financial expert, energy field professors, and two eco-environmental professors. Once the expert panel is determined, the next step involves data collection. The responses provided by the experts are gathered and compiled, as illustrated below.

Based on the assessment using the Analytic Hierarchy Process (AHP), the results in Table 4 indicate that for the concept of degrowth, the order of importance is environmental sustainability, economic viability, and social equity. Within the criterion of environmental sustainability (shown in Table 6), the most crucial factor is Ecosystem impact. For economic viability (shown in Table 7), the most significant criterion is lifecycle cost savings. Lastly, for social equity (given in Table 5), income distribution plays the most important role. On the other hand, when evaluating green energy in Table 8, the most vital factors are pollution reduction, cost savings, and resource use efficiency. Under pollution reduction in Table 9, the most critical criterion is air quality improvement. For cost savings (shown in Table 11), lifecycle cost savings is considered the most important aspect. Lastly, according to the result in Table 10, energy conversion efficiency takes precedence when evaluating resource use efficiency.

The assessment results suggest that degrowth emphasizes the importance of achieving environmental sustainability, economic viability, and social equity. By prioritizing the impact on ecosystems, considering the lifecycle cost savings, and focusing on income distribution, degrowth aims to promote a more sustainable and equitable society. In contrast, the evaluation

Table 3 Identification of degrowth and green energy criteria

Goals	Dimensions	Sub-criteria
Degrowth	**Social Equity**, is about fairness and justice in distributing resources and opportunities to ensure equal access for all individuals, regardless of their background or social status [82].	(1) Income Distribution: Fair wealth and income allocation [83]. (2) Access to Resources: The behavior and processes by which individuals or groups acquire the resources they need [84]. (3) Community Engagement: Collaborate and actively participate in the community [85].
	Environmental Sustainability, involves using resources in a way that meets present needs without compromising future generations [86].	(1) Carbon Reduction: The efforts to decrease the emissions of carbon dioxide [87]. (2) Ecosystem Impact: The effects or consequences of a particular action, event, or change on an ecosystem [88]. (3) Waste Reduction: The efforts and strategies implemented to minimize the amount of waste generated and disposed of [89].
	Economic Viability, refers to the financial sustainability of a project or business [25, 90, 91].	(1) Affordability for end users: Ensuring renewable energy is financially accessible for all [92]. (2) Return on Investment: Evaluating the profitability of an investment in green energy [93]. (3) Lifecycle Cost: Total cost of owning and operating green energy systems [94].
Green Energy	**Pollution Reduction**, is about evaluating the effectiveness of green energy initiatives in reducing various types of pollution, including air, water, and soil pollution [95].	(1) Air Quality Improvement: Actions to reduce air pollutants and enhance air cleanliness and safety [96]. (2) Water Quality Improvement: Efforts to enhance the quality and safety of water sources [97]. (3) Soil Quality Improvement: Strategies to maintain and improve soil health and fertility [98].

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Table 3 Continued

Goals	Dimensions	Sub-criteria
	Cost Savings, refer to assessing the economic viability of green energy projects by considering their cost-effectiveness compared to traditional energy sources [99].	(1) Operational Cost: Maximizing productivity and minimizing waste in operations [100]. (2) Lifecycle Cost: Total cost of owning and maintaining a product or asset [101]. (3) Financial Innovation: Development of new financial products or services to improve efficiency and accessibility [102].
	Resource Use Efficiency, involves assessing the efficiency of resource use in the production and deployment of green energy technologies, considering factors like material extraction, manufacturing processes, and overall lifecycle impacts [103].	(1) Material Efficiency: Maximizing material use and minimizing waste [104]. (2) Energy Storage: Storing energy for later use [105]. (3) Energy Conversion Efficiency: Efficiently converting input energy to useful output energy [104].

Table 4 Pairwise assessment matrix for categories of degrowth

Degrowth	Social Equity	Environmental Sustainability	Economic Viability	Relative Weight	Rank
Social Equity	1.00	0.33	0.33	0.1396	3
Environmental Sustainability	3.00	1.00	2.00	0.5278	1
Economic Viability	3.00	0.50	1.00	0.3325	2
Max. eigen value	3.0536	**CI**	0.0268	**CR**	0.0462

Table 5 Pairwise assessment matrix for "social equity" categories

Social Equity	Income Distribution	Access to Resources	Community Engagement	Relative Weight	Rank
Income Distribution	1.00	2.00	3.00	0.5171	1
Access to Resources	0.50	1.00	4.00	0.3586	2
Community Engagement	0.33	0.25	1.00	0.1243	3
Max. eigen value	3.1078	**CI**	0.0539	**CR**	0.0930

of green energy highlights the significance of reducing pollution, achieving cost savings, and optimizing resource use efficiency. By prioritizing air quality improvement, considering the lifecycle cost, and emphasizing energy conversion efficiency, green energy endeavors to address climate change and promote a more efficient utilization of resources.

Table 6 Pairwise assessment matrix for "environmental sustainability" categories

Environmental Sustainability	Carbon Reduction	Ecosystem Impact	Waste Reduction	Relative Weight	Rank
Carbon Reduction	1.00	0.33	0.50	0.1515	3
Ecosystem Impact	3.00	1.00	4.00	0.6301	1
Waste Reduction	2.00	0.25	1.00	0.2184	2
Max. eigen value	3.1078	**CI**	0.0539	**CR**	0.0930

Table 7 Pairwise assessment matrix for "economic viability" categories

Economic Viability	Affordability for End Users	Return on Investment	Lifecycle Cost	Relative Weight	Rank
Affordability for end users	1.00	3.00	0.25	0.2255	2
Return on Investment	0.33	1.00	0.20	0.1007	3
Lifecycle Cost	4.00	5.00	1.00	0.6738	1
Max. eigen value	3.0858	**CI**	0.0429	**CR**	0.0739

Table 8 Pairwise assessment matrix categories of green energy

Green Energy	Pollution Reduction	Resource Use Efficiency	Cost Savings	Relative Weight	Rank
Pollution Reduction	1.00	4.00	3.00	0.6144	1
Resource Use Efficiency	0.25	1.00	0.33	0.1172	3
Cost Savings	0.33	3.00	1.00	0.2684	2
Max. eigen value	3.0735	**CI**	0.0368	**CR**	0.0634

Table 9 Pairwise assessment matrix for "pollution reduction" categories

Pollution Reduction	Air Quality Improvement	Water Quality Improvement	Soil Quality Improvement	Relative Weight	Rank
Air Quality Improvement	1.00	2.00	3.00	0.5396	1
Water Quality Improvement	0.50	1.00	2.00	0.2970	2
Soil Quality Improvement	0.33	0.50	1.00	0.1634	3
Max. eigen value	3.0092	**CI**	0.0046	**CR**	0.0079

Both degrowth and green energy offer different perspectives and approaches to addressing environmental and societal challenges. While degrowth emphasizes a radical reorganization of politics and economics to reduce resource and energy consumption, green energy focuses on transitioning to renewable and sustainable energy sources. However, it is important to

Table 10 Pairwise assessment matrix for "resource use efficiency" categories

Resource Use Efficiency	Material Efficiency	Energy Storage	Energy Conversion Efficiency	Relative Weight	Rank
Material Efficiency	1.00	0.25	0.33	0.1243	3
Energy Storage	4.00	1.00	0.50	0.3586	2
Energy Conversion Efficiency	3.00	2.00	1.00	0.5171	1
Max. eigen value	3.1078	**CI**	0.0539	**CR**	0.0930

Table 11 Pairwise assessment matrix for "cost savings" categories

Cost Savings	Operational Cost Savings	Lifecycle Cost Savings	Financial Innovation	Relative Weight	Rank
Operational Savings	1.00	0.25	0.50	0.1429	3
Lifecycle Cost Savings	4.00	1.00	2.00	0.5714	1
Financial Innovation	2.00	0.50	1.00	0.2857	2
Max. eigen value	3.0000	**CI**	0.0000	**CR**	0.0000

note that both concepts have their limitations. Degrowth may face challenges in terms of its implementation and acceptance within current economic systems that prioritize growth. Green energy, on the other hand, needs to address issues related to lifecycle cost savings, ensuring that the production and disposal of renewable energy technologies are sustainable.

In conclusion, the assessment results highlight the importance of considering environmental sustainability, economic viability, and social equity in both degrowth and green energy. By prioritizing different criteria such as ecosystem impact, lifecycle cost, and income distribution for degrowth, pollution reduction, cost savings, and resource use efficiency for green energy, these concepts aim to contribute to a more sustainable and equitable future. However, further research and practical implementation are necessary to fully understand the potential of these concepts and address their limitations to achieve long-term economic and environmental sustainability.

4.1 Culture

Contemporary companies can exist as legal persons and benefit from some of the rights of people to protect their normal operations. Yet the natural environment is now often seen as a resource to be exploited by the market, e.g., privatizing water resources, mining rare earth minerals, destroying existing waterways to build power dams, piling up electronic waste, etc. Degrowth emphasizes the need to reduce damage to natural resources and

the natural environment while ensuring sustainable economic development. People should respect nature in terms of values, in the case of the Whanganui River, one of the rivers in New Zealand's North Island. These tribes consider the river not merely as a physical entity, but as a sacred mother and goddess. In recognition of the Whanganui River's significance, multiple rounds of negotiations between the tribes and the government resulted in the river being granted the same legal status as a natural person in 2017. Consequently, the river is now legally regarded as a distinct and autonomous entity under the law [106]. This is a result of the importance people attach to the environment, recognizing and respecting nature, and protecting it with the tools available to them.

Furthermore, the capital market should abandon the idea of climate models to predict economic growth, i.e. by analysing the impact of climate change on economic activity and hence using data and simulations of future climate to predict future economic growth. This prediction model, which establishes economic development in a competitive relationship with environmental protection, becomes a tool that capitalists will try to exploit for short-term benefits. Consequently, this concept of competition should be reversed so as to shift to a development mindset that protects and nourishes the environment.

4.2 Economy

Society is prompting businesses and the general public to reconsider their consumption patterns. Degrowth advocates for a transition from consumerism to consumption patterns that prioritize meeting basic needs and promoting the well-being of the masses, such as investing in infrastructure, providing energy subsidies, and offering affordable air travel. This shift may involve reducing the emphasis on acquiring non-essential material wealth and instead promoting sustainable models, such as the sharing economy. First, companies consider the purpose of investment and the role of social and environmental impact when investing, and try to extend the life of equipment built by companies through maintenance, recycling, donations, etc. Second, the capital market is reducing the excessive promotion and touting of commodities. Green energy has become the "favorite" of capital, financing to investment, enterprise equipment construction to equipment replacement, and green energy has become a means of corporate publicity. Therefore, the capital market should reduce excessive interference in demand and reduce the sense of artificial scarcity of consumer markets. Third, develop sharing and social relations and build a sharing economy model. Social relations and

sharing can improve social cohesion and satisfaction, making people feel part of society rather than isolated individuals. This helps build a harmonious, equal, and sustainable society. On the one hand, when people form shared communities, it increases social participation and public engagement and enhances social cohesion and a sense of sustainability. On the one hand, putting sharing and social relations at the forefront of economic development through the degrowth proposal may include increasing the development of the sharing economy and supporting the sharing of resources and services, such as shared vehicles, shared private charging pads, and shared office space.

4.3 Policy

The degrowth framework proposes that the capitalist system, which aims to maximize profits and achieve permanent economic growth, is structured to prioritize short-term gains in an unsustainable development model. This approach leads to issues such as social inequality, climate change, and resource depletion [107]. In terms of policy, the government should adjust taxes and expenditures, adjust capital accumulation, and adjust the industrial structure to play the role of the visible hand in market regulation.

Firstly, the government can include the offshore carbon emissions of multinational companies when regulating the carbon footprint behavior of enterprises, such as offshore material extraction, offshore manufacturing companies, and pollution waste transfer, and unify the carbon emission taxation. Secondly, the government should set the scale of development of enterprises to prevent individual enterprises from expanding reproduction in pursuit of relatively high profits. For instance, the government can set the annual production capacity of enterprises, limit capital investment, and establish the rate of scrapped fixed assets. Additionally, the government should participate in adjusting the industrial structure by reducing the scale and proportion of industries with high pollution and emissions, such as private jets, the advertising industry, the beef industry, and the fossil fuel industry. This adjustment can be achieved through measures like enterprise qualification approval, expansion approval, and contract formulation.

5 Conclusion

Although new energy has appeared to be the doorway to sustainable development in recent decades – as a “solution” to climate change and the energy crisis – it has become a tool for capitalists to make high profits. However,

given the profit-seeking nature of the capital market, the new energy industry has become a profitable and gain-making tool for capitalists, using the technologies of the field and the high production efficiency they bring as a new way to pursue profits. The fact that it has launched these challenges to natural resources, cheap workforce, and pollution emissions is exactly the problem that makes new energy unsustainable. What causes these problems are the growth of capital markets and the failure to balance human activities and nature to achieve sustainable development. Therefore degrowth is like a strong medicine to make consumers and capitalists awaken from values in terms of culture, economy, and policies, not to solely rely on new energy to solve the climate crisis, but to jointly promote the concept of sustainable development by social culture, the government administration, and the capital market, and to improve production efficiency and meet the demand of people without increasing additional supply, so as to emphasize the relationship between economic development, environmental protection, and sustainable development.

In conclusion, the concept of degrowth calls for a radical reorganization of politics and economics to reduce resource and energy consumption, as well as the demand for material goods. It challenges the ideology of growth-based development and highlights the need for sustainable development that prioritizes social and environmental well-being over short-term economic growth. The discussion on green energy within the context of degrowth raises important questions about the true costs of economic growth, the negative consequences of a capitalist economy on society and the environment, and the need to address climate inequity. By shifting the focus from profit-driven growth to meeting human needs and achieving long-term economic sustainability, degrowth offers a feasible pathway to address global environmental crises and promote social welfare.

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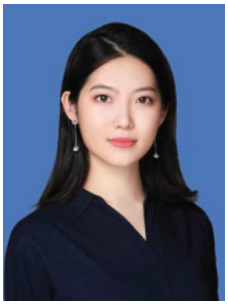
Biographies



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