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Renewable energy incentives on the road to sustainable development during climate change: A review

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This review is dedicated to the analytical literature concerning the dynamics of different approaches to renewable energy promotion. Examples of major types of green energy incentives, including carbon tax, Feed-in Tariffs, and investments in research and development are covered in the paper, as well as the barriers and limitations to such practices and the contradictions existing in the field of renewable energy. The dynamics of the means of green energy promotion over this period have been addressed. This review analyzes energy considerations and the importance of raising public awareness on the issue. The evidence collected through the literature analysis, has proven that despite of a significant amount of work done in the field in the transition to the renewable energy sources, including the implementation of various incentives, controversial aspects remain that demand attention both from economists and policymakers. Modern best practices in the field of green energy incentives can be based on government initiatives or stem from the private sector. The most widely used policies for renewable energy promotion discussed in the reviewed studies are tax incentives; however, at the same time, numerous countries are providing fossil fuels subsidies to minimize the level of inequality. Finally, the outlook of different practices concerning financing of the transition from traditional energy sources to renewable ones is presented.

KEYWORDS

green energy, renewable energy transition, carbon tax, incentives, renewable energy

Introduction

Environmental issues are in at center of economic policies of numerous countries, especially regarding the transition from traditional fossil fuels energy to green energy. The tendency for choosing environmentally responsible ways of achieving business goals is to develop actions being promoted by governments, business associations, and international

organizations. Green energy is a key element for responsible operations in numerous industries, including the energy sector itself. This paper is dedicated to the analysis of theoretical and practical basis of green energy incentives and the means of their promotion in most economically developed countries. This article represents a comprehensive review of data collected over the years by a range of authors on the variety of green energy incentives and their effectiveness and efficiency.

The novelty of this paper is found in its analysis of modern best practices in the field of green energy incentives could stem from government initiative or the private sector. For example, numerous countries provide fossil fuels subsidies to minimize the level of inequality with significant support from scientific community. This paper confirms the results of a controversial attitude toward green energy and an overall level of wellbeing interconnection being postulated by proponents of renewable energy.

In agreements at the global level in 1992 and 1997 at the United Nations Conference on Climatic Change and the Kyoto Protocol environmental issues were brought to the business agenda. In these agreements, reached through discussion, each country was to take measures to reduce the CO_2 emissions, promoting the corresponding policies and stimulating individuals and organizations to choose renewable energy over fossil fuels. This process of gradual conversion to renewable (green) energy is denoted in the literature as the transition to renewable energy, and has been thoroughly studied over the last 2 decades, with scholars studying a diverse range of its aspects, including various policies, their advantages, costs, and barriers (Bahar et al., 2013; Al-Badi et al., 2019; Bersano et al., 2020; Cábelková et al., 2020; Bielecki et al., 2021; Cábelková et al., 2021; Renewable Energy, 2021; Bölük and Kaplan, 2022).

The incentives tend to vary from one country to another both in their essence and their efficiency. In this article, a review of works in this field are presented.

Moreover, in the recent literature, renewable energy transitions have been considered, not only in terms of environmental responsibility; other important possible benefits of green energy use have also been considered. The opportunities and benefits created through the process of renewable energy transition include but are not limited to increased standards of living ensuring energy security and even the provision of higher level of cost-efficiency and affordability relative to traditional energy sources. However, for their part, fossil fuel proponents have argued that subsidies for fossil fuels reduce inequality and accelerate overall economic development (Piscitello and Bogach, 1997; Economic Commission for Latin America and the Caribbean, 2020; Castaneda et al., 2018; Crowe and Li, 2020; Elavarasan et al., 2020; Frattolillo et al., 2020; Ganowski et al., 2020; Genys and Krikštolaitis, 2020; Greco et al., 2020; Candila et al., 2021).

Renewable energy incentives

In the reviewed literature, renewable energy incentives can be divided into three groups: 1) incentives stemming from policies, 2) incentives based on market interactions, and 3) energy efficient finance. The first group of incentives include measures that are usually proposed by policymakers and implemented only after governmental approval, such as subsidies, tax incentives, accelerated depreciation, and so on. Incentives from the second group, on the contrary, are caused by relationships between market participants; finally, the third group is associated with improvements in the field of efficient use, distribution, and storage of energy. Moreover, some scholars distinguish two types of renewable energy policies in the first group: demand-pull incentives, consisting of initiatives aimed at renewable energy use growth, and supply-push incentives, which includes policies targeted at business environment enhancement (Bhuiyan et al., 2022; Khan et al., 2022; Li et al., 2022).

The first research in this field was performed in the 1990s and represents the results of the initial international discussions of environmental issues, mainly global warming. The financial incentives for grid-connected wind power systems and off-grid photovoltaic systems are in the focus of this publication. Its results relate to the examination of the collective experience in the field (capacity, installation costs, and sufficiency of infrastructure) and presenting concise description of each country's approach to addressing the issue.

Early work on tax incentives as a significant element in financial incentives offered a comprehensive analysis of 10 common incentives (direct and indirect) in the field of taxation policy. According to this work, the most frequently types of tax incentives as for 2005 were conventional fuel taxes, investment tax incentives, import duty reductions, and accelerated depreciation; the least-used tax incentives were R&D credits, production and property tax credits, and excise tax reductions. Moreover, the aspects of administrative efficiency, credibility, enforceability, size, use, and predictability of different measures of green energy promotion were discussed, as these aspects could be used to develop the further formation of comprehensive renewable energy policies and strategies (Howarth et al., 2017; IRENA, 2019; Irfan et al., 2021).

More recent discussions concerning renewable energy promotion incentives were based on the experience of ASEAN countries, especially their use of feed-in tariffs (FIT) as a price-based instrument, represented by long-term purchase agreements for renewable energy. According to previous researchers, the combination of FIT with other incentives (soft loans and tax incentives) provides the highest performance in terms of the growth of renewable power and effective administrative schemes ensuring the cost-efficiency of renewable energy power procurement (Malik et al., 2019; Neagu et al., 2020; Makholm, 2021; NCSL, 2021).

Scholars have found that all incentives targeted at renewable energy promotion can be divided into two main groups: financial and regulatory. The former incentives include such incentives as FIT, reverse auctions, tax policies, and net metering, and the latter consisted of establishing clean energy standards, cap and trade, and carbon pricing. These two groups of incentives function the most efficiently in combination. Moreover, the following groups of barriers have been identified: 1) infrastructure barriers, 2) technical barriers, 3) economic barriers, 4) financial barriers, 5) market barriers, and 6) public acceptance and environmental barriers (Lee and Callaway, 2018; Khan et al., 2019; Lehtveer and Fridahl, 2020; Machalek et al., 2021).

Study has focused on OECD countries' experience in the promotion of renewable energy policies. The role of government in the development and further stimulation of green incentives is highlighted in this paper, and two ways of governmental regulation of energy policy are presented: direct and indirect. Direct instruments are targeted at creating incentives for renewable energy use and production (facilities installation financing through grants and subsidized loans, FITs, etc.), indirect instruments disincentivize the production and consumption of fossil fuel energy (by imposing taxes for fossil fuel use and regulating the level of emission of power plants). Moreover, the question of the incentives' influence on CO_2 emission is raised, as well as the trade implications of the examined renewable energy stimulation policies (Norouzi et al., 2020; Qadir et al., 2020; Pina et al., 2021).

For 2020, the fiscal and financial incentives are generally more efficient than those in the energy industry, as they decrease the installation and operational costs of power plants. FIT, according to the reviewed authors, are only effective for bioenergy and solar types of renewable energy. Furthermore, direct investments and loans, which were considered valid practices 2 decades ago, are no longer perceived to be effective instruments of renewable energy policy stimulation (Yumashev et al., 2020; Tamashiro et al., 2021; Weiss et al., 2021).

Studies have been conducted of stakeholders' participation in the process of renewable energy policymaking with respect to the overview of factors affecting the renewable energy. Raising public awareness of the essence, benefits, and costs of renewable energy installment and operations was proven to be an effective measure for combating existing misconceptions and reluctance both on the individual and corporate levels. Finally, the influence of the COVID-19 pandemic on the global pattern of energy use has been studied, and it was found that during the lockdown period, the consumption of fossil fuels has decreased significantly; this topic has been also covered in the reviewed literature (Sen and Ganguly, 2017; Raugei et al., 2020; Sediqi et al., 2022; Sovacool et al., 2020).

However, it has been found that the measures, planned capacities, and costs of renewable energy for the decade 2030s are not sufficient to limit world temperature growth to 2°C. Furthermore, the positive effect of pandemic on the dynamics of fossil fuels use has been observed, as well as its negative consequences, such as a fall in deal-making in the renewable energy sector, as well as the overall level of investment. Finally, statistics on different sources of renewable energy dynamics and renewable energy statistics by region have been investigated. Another finding worth mentioning is that developing countries have tended to outpace developed ones in terms of level of investment in renewable energy development (Mikhaylov, 2015; Baboshkin et al., 2022).

The formulation, essence, costs, and benefits of traditional financial incentives for green energy promotion have been considered, such as VAT, personal tax incentives, and accelerated depreciation, as well as less common direct measures, including rebates, grants, and performance-based incentives as supporting measures. While the former group of incentives can be considered to be relatively simple in terms of implementation, they may on the other hand only be applicable to entities that have tax burden, as the latter group of renewable energy incentives provides the direct cash inflows and does not require payout. Finally, a third group of incentives examined is concerned with enhancement of liabilities and consists of subsidized revolving loans and green banks, providing financing through public-private partnerships to entities involved into green energy production and loan guarantees (Zhelykh et al., 2021; Barykin et al., 2022; Dinçer et al., 2022).

The findings support the idea of different renewable energy policy systems being chosen by different countries, such that different measures are undertaken for green energy goals achievement. Investment in R&D is a key aspect of the successful transition of an economy to renewable energy. R&D investment projects are divided into two groups according to their level of uncertainty or risk level. Innovative projects with a comparatively low level of risk can be financed through subsidies, and in that case fiscal incentives are applicable. R&D projects with higher levels of risk are supposed to be supported with the following mechanisms: economic subvention, technology-specific public procurement, and non-reimbursable financing for joint ventures. While R&D investment is a rather short-term measure, long-run development of renewable energy sector requires a wider range of instruments and a deeper interconnection between linked areas of energy industry, such as renewable energy distribution, storage, and end-use (Li et al., 2020; Guneser et al., 2022; Sendstad et al., 2022; Tobajas et al., 2022; Umar et al., 2022).

Research has been conducted on the comparative analysis of the efficiency of different measures of fiscal policy targeted at the promotion of renewable energy sources with respect to the type (policy, market-based incentives and energy efficiency finance), potential drawbacks and benefits, and examples of countries where the given incentives have been used according to the case studies provided. As shown by the previous works, the most

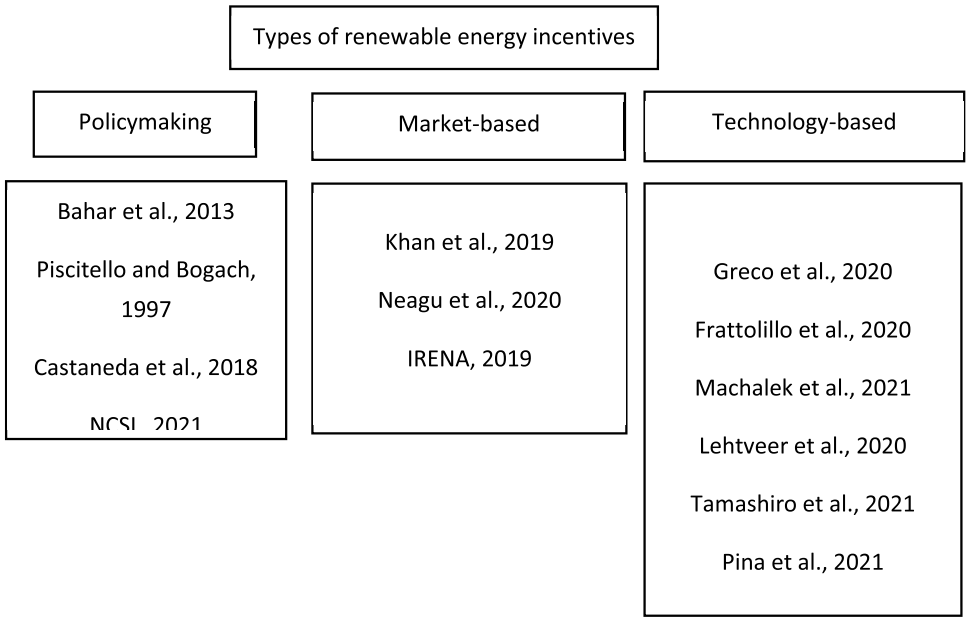

FIGURE 1
Types of renewable energy incentives covered in the literature. Source: prepared by the authors.

common incentives (tax exemptions and subsidies) are only effective on condition of correct targeting; moreover, these incentives are associated with high costs, which are carried by taxpayers, not the entities that are polluting the environment. Voluntary agreements between government and private investors must be thoroughly planned and controlled during both negotiation and execution. According to previous research, emission trading schemes (ETC) are more oriented toward the long run, and their results are less predictable than previously described measures (Varyash et al., 2020; Alwaelya et al., 2021; Bhuiyan et al., 2021).

Financial incentives are in the center of attention of the scholars who are working in the field of green energy, and the process of renewable energy financing is crucial for the successful transition. Previous study has provided an analysis of the African experience in renewable energy financing. The results presented in the article have several important outcomes: 1) the involved entities' perception of risks, stemming from the transition to renewable energy, is higher in rural and urban areas than in solely urban areas; 2) smaller local firms have greater concern about the safety of the process and the overall development of the area, compared to larger; and finally, 3) the two-hand model of renewable energy service companies has been proposed as an efficient instrument of for the stable socio-economic development of semi-urban and rural areas through renewable energy production. Another previous work was concerned with the financing of renewable energy transition, and its authors proposed a concept of adaptive market hypothesis applied to the capital markets, serving as financing sources for green energy promotion. Moreover, the influence of behavioral effects, pricing and market organization, and structural policies on the financing and implementation of renewable energy policy has been studied. Finally, crucial aspects, such as 1) the diversity of investors pool, 2) the level of competition in the existing system that is supposed to be changed as a result of the renewable energy transition, 3) the structural constraints on the financial market, and 4) the consideration of suitable instruments for different groups of investors.

Carbon taxes are a widely used instrument for renewable energy incentives, and authors have presented differing approaches to the treatment of this issue. Authors have proposed that, instead of payment of carbon tax, companies, producing fossil fuel energy may be obliged to invest a fixed portion per each unit of energy produced into development of renewable energy. The main advantage of this alternative to the traditional carbon taxes, according to the authors, is the evolutionary and gradual transition of fossil fuel producers into companies that produce green energy without requiring sudden industry shifts and thus, severe job losses.

Figure 1 presents the main directions of renewable energy incentives in the literature. As can be seen in the diagram, three main groups of incentives have been identified in the major representative literature.

The importance of renewable energy transition

The importance of the renewable energy transition has seen exponential growth over the last decade, provoking arguments between traditional fossil fuels energy proponents and the supporters of green energy. The evidence collected through a literature analysis has shown that despite a significant amount of work done in the field of the transition to the renewable energy sources, including the implementation of various incentives, controversial aspects remain that demand the attention of both from scientists and economists and policymakers.

For instance, according to the literature review, modern best practices in the field of green energy incentives may be based on government initiative or stem from the private sector. The most widely used policies for renewable energy promotion were revealed in the reviewed studies to be tax incentives. However, at the same time, numerous countries provide fossil fuels subsidies to minimize the level of inequality with significant support from scientific community. This results in a controversial attitude toward green energy and the overall level of wellbeing interconnection being postulated by renewable energy proponents. In other words, the described conflict between opposite views reflected in existing energy policies can impede global action toward renewable energy transition (United Nations, 2020; Hoang et al., 2021; Sediqi et al., 2022).

Another contradiction, that has been found is the one between a widely accepted concept of the generally positive effects of renewable energy and still observed doubts in green energy efficiency, affordability, security, and level of employment. Some scholars consider renewable energy transition to be an absolute virtue in modern society and a goal that should be achieved for the stimulation of economic development, as well as increasing wellbeing in society.

Another noteworthy aspect discovered in this review is that the trends in the list of incentives implemented differ from year to year. For instance, FiT was a widely used instrument for green energy promotion in the 2000s; however, nowadays are now not considered to be efficient in the long run, so they are losing their universality and prevalence. The most widespread up-to-date measures of renewable energy promotion are focused on the long run efficiency and include technical, socio-economic, and psychological aspects of green energy.

The psychological perspective is of particular importance over previous decades, as demonstrated through studies, providing evidence of the significance of raising public awareness concerning environmental issues and the effects of traditional energy sources on the future state of the environment.

Conclusion and future work

Different types of green energy incentives (policy-based, market-based, and technology-based ones) have been considered, with the particular attention being paid to the dynamics of the practices application. The literature on the financial, economic, and psychological aspects of the transition to renewable energy sources has been investigated. In particular, the possible threats and opportunities of green energy development covered in the studied literature have been clarified. Finally, the propositions of alternative ways of renewable energy transition, including financing, have been shown.

The field of renewable energy retains its significance and importance in terms of remaining present on the global agenda, especially as the discussion relates to global action toward green energy. Although much research has been performed on this topic in recent decades, particular areas still demand attention from scientific society.

For instance, study of the methods of efficiency evaluation of different types of green energy incentives can be augmented, as well as the study of observed differences between the most widely used incentives in countries being clustered together in relation to the characteristics such as whether the country is an exporter or importer of traditional energy, the level of education and its availability, and the geographical peculiarities of the area. The further comparative analysis of these factors affects the level of green energy strategy development and of the efficiency in its successful implementation should be performed.

Another topic that should be considered in a more comprehensive analysis that can benefit the global renewable energy transition discussion is to provide a deeper understanding of social and psychological barriers common in the majority of considered countries and detailed analyses of each country's specific patterns in behavior regarding the initiatives connected to the choice of type of energy being used. Furthermore, the possibility of transition to green energy sources on the domestic (household) level can be assessed based on the data obtained through such analysis.

Thus, this paper provides the recommendations for green energy policy formulation based on global best practices in the field. The main propositions include the following: 1) the designed incentives should align with other high-level policy goals; 2) profound market, economic, and financial research is required; 3) private sector and financial institutions should be engaged for a diversified pool of capital; 4) a stable environment should be provided for policy implementation; 5) raising public awareness concerning environmental issues and renewable energy use as part of a solution should be ensured (the topic has been extensively studied); 6) constant control and monitoring of costs and efficiency of green energy incentives should be exercised; and 7) tax incentives and other forms of renewable energy incentives should be provided to non-taxable and/or low income entities.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, and further inquiries can be directed to the corresponding author.

Author contributions

Conceptualization, NT; methodology, JA and IV; writing—original draft preparation, NT and OL; writing—review and editing, LK, SB, and OK.

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Conflict of interest

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

Reviewer HD has declared a past co-authorship with author SB to the handling editor and reviewer SY has declared a past co-authorship with author SB to the handling editor.

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