Renewable and Non-Renewable Energy Consumption and Economy: A Systematic Literature Review for Greece

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Abstract
Recent research has increasingly explored the nexus between energy consumption and economic growth, with a particular focus on energy economics. Key factors driving this growing interest include environmental protection, the expansion of renewable energy sources, and recurrent energy crises, all of which have stimulated interdisciplinary investigations, particularly within the field of economics. This study conducts a systematic literature review of research related to Greece over the period 1994–2023, examining the relationship between energy consumption—both renewable and non-renewable—and economic growth. The paper categorizes and presents the methodologies employed, the thematic areas explored, the broader research classifications, the volume of studies, and the evolution of research in this domain. Special emphasis is placed on methodological approaches, including econometric techniques as well as emerging research trends that shape the field. Additionally, the study documents Greece's legislative trajectory in renewable energy and compares findings with corresponding European studies. Identified research gaps include the need for longitudinal analyses and comparative policy assessments. The conclusions underscore the pivotal role of renewable energy in economic development and policymaking, offering insights and directions for future research.

Keywords: Energy economics; Greece; growth; renewable energy sources

JEL Classification: O13; P18; P28

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1. Introduction

In recent years, the relationship between energy consumption and economic growth has garnered increasing scholarly attention. Moreover, increasing emphasis has been placed on examining the impact of renewable energy consumption on national economies. This paper conducts a systematic literature review to synthesize existing research on this topic, highlighting commonly employed methodologies and key thematic issues. The systematic literature review of this paper focuses on the case of Greece for the period from 1994 to 2023.

The selected timeframe is deliberate, corresponding to the introduction of renewable energy legislation in Greece. In more detail, in Greece, the use of energy from renewable energy

sources was presented for the first time in its legislative framework in 1994 with the Law 2244/1994. This legislation marked the first steps toward the promotion of renewable energy sources in Greece by establishing a legal framework for producing electricity from renewable sources. This legislation encouraged the development of renewable energy projects through a feed-in pricing mechanism, providing long-term contracts and guaranteed prices for electricity generated from renewable sources. The legislative framework in Greece has evolved since 1994 through successive legislative amendments (according to the directives of the European Union). Basic laws regarding the transition to renewable energy sources are Law 2773/1999, which aimed to encourage the use of renewable energy sources and increase energy efficiency, Law 3468/2006, which focused on the promotion of electricity generation from renewable energy sources, Law 3851/2010, which incorporated the European Union Renewable Energy Directive into Greek law and set a target for Greece to reach 18% of final consumption of energy from renewable sources by 2020 and introduced mechanisms to promote energy efficiency and the use of renewable energy sources in various sectors, Law 4414/2016 which further amended and updated the legal framework for renewable energy sources in Greece and the legislation and continuous amendments in the period from 2018 until today.

This study aims to provide a comprehensive review of research on the relationship between energy consumption and economic growth in Greece, identifying key parameters considered by scholars and highlighting existing gaps in the literature. According to Linnenluecke et al. (2020), a systematic literature review can help overcome constraints and assist in various aspects of the research process, such as establishing a framework and delineating a research problem, seeking theoretical support, rationalizing a problem and new lines of research, distinguishing what has been done from what needs to be done, identifying the main results (and methodologies used in previous studies), and avoiding fruitless research.

This study makes a significant contribution by offering a systematic and comprehensive review of literature specifically focused on Greece, an area that remains underexplored in existing scholarship. By targeting the period from 1994 to 2023, it aligns the literature review with significant legislative shifts in Greece concerning renewable energy, thereby offering insights into the practical effects of these policies over nearly three decades. This time frame is especially crucial because it corresponds to the introduction and subsequent developments in renewable energy legislation in Greece. Furthermore, by analyzing the various methodologies and parameters considered by other researchers, this paper sets the stage for future studies by identifying gaps and areas of potential exploration. Additionally, the study serves as a precedent for other countries looking to examine the impact of their renewable energy policies over a specific time frame.

The research questions for this study encompass a multifaceted exploration of the relationship between energy consumption from renewable sources and economic growth in Greece that spans from 1994 to 2023. Additionally, they aim to investigate the influence of legislative frameworks, particularly starting from law 2244/1994, on the dynamics of renewable energy consumption and its impact on Greece's economy. The study also seeks to uncover the prevalent methodologies employed by researchers studying the energy consumption-economic growth nexus in Greece within this specific timeframe, as well as the parameters and variables predominantly considered in these studies and their impact on the findings and conclusions. Moreover, the study seeks to pinpoint any deficiencies within the existing literature concerning the interplay of Greece's renewable energy consumption and its economic ramifications. It places a particular focus on suggesting ways in which forthcoming research can rectify and fill these voids. Furthermore, this investigation will undertake a comparative examination, contrasting the findings of studies conducted within the Greek context with those of various

European countries. This endeavor will enhance our understanding of the existing knowledge in this field. These research questions have been thoughtfully formulated to align seamlessly with the central aims of the paper, facilitating a thorough exploration of the subject through a systematic literature review.

2. Methodology and Data

According to Munn et al. (2018), a systematic literature review systematically compiles and analyzes relevant studies globally. It verifies existing practices, identifies inconsistencies, and highlights emerging trends. Additionally, it assesses methodological limitations, proposes directions for future research, and synthesizes findings to inform decision-making.

To conduct this systematic literature review, a structured search was performed across major academic databases, including ScienceDirect, Scopus, and Springer. Google Scholar was additionally utilized to expand the scope of relevant studies. The inclusion criteria for selecting papers were as follows:

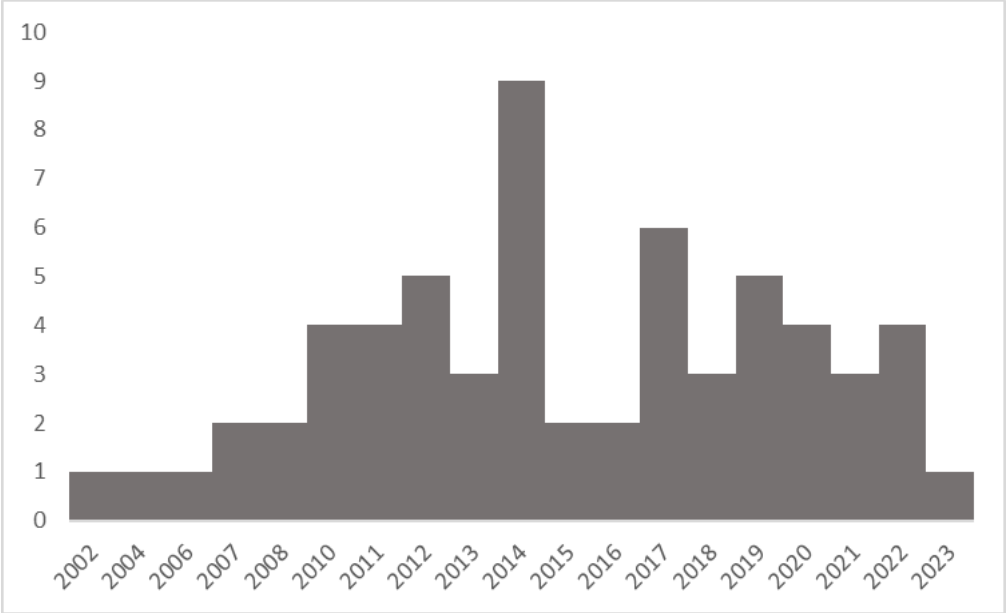
- the relevance of the papers to the subject being examined;
- the date the papers were published;
- the country it refers to (papers were included that did not refer exclusively to the case of Greece, but also referred to it by comparing it with other countries);
- the scientific field (papers in the field of energy in general, economics, econometrics and finance, social sciences and business, management and accounting were included).

The search process employed a predefined set of keywords—'Energy consumption,' 'Economy,' and 'Greece'—combined using the Boolean operator 'AND' to refine the results. The search was restricted to studies published between 1994 and 2023. This query yielded 5,406 results in ScienceDirect, 4,749 in Springer, and 5,870 in Scopus.

Traditional literature reviews and systematic reviews differ in several key characteristics (Munn et al., 2018). Unlike traditional reviews, which often provide a narrative synthesis without a standardized approach, systematic reviews adhere to a predefined protocol. Systematic reviews also incorporate an explicit, transparent, and peer-reviewed search strategy, which is not customary for traditional reviews. Additionally, systematic reviews use standardized data extraction forms, while traditional reviews do not. A mandatory critical appraisal, particularly the assessment of the risk of bias, is a hallmark of systematic reviews, but is absent in traditional reviews. Finally, the synthesis of findings from individual studies and the generation of 'summary' findings are specific to systematic reviews, whereas traditional literature reviews might not necessarily provide such a synthesis.

Following a rigorous selection process, 62 studies were ultimately included in the analysis. Although the initial query retrieved over 10,000 articles from ScienceDirect, Springer, and Scopus, the final selection was refined based on strict inclusion criteria. Eligible studies had to either focus specifically on Greece or include Greece as a case study in comparative analyses. Additionally, only research that directly examined the relationship between energy consumption and economic growth was considered. Further filtering was conducted based on methodology, publication in peer-reviewed journals, and relevance to the thematic scope of this systematic review. As a result, the final selection reflects the most pertinent and high-quality contributions to literature within the defined scope of this study. Figure 1 illustrates the number of papers per year. The majority of the papers included in this study were published in 2014. Additionally, a significant number of papers were published in recent years, specifically from 2017 to 2023. Furthermore, ***Figure 1*** exclusively represents the distribution of the 62 papers included in this review, which either focus specifically on Greece or incorporate Greece as a case study within a broader comparative analysis.

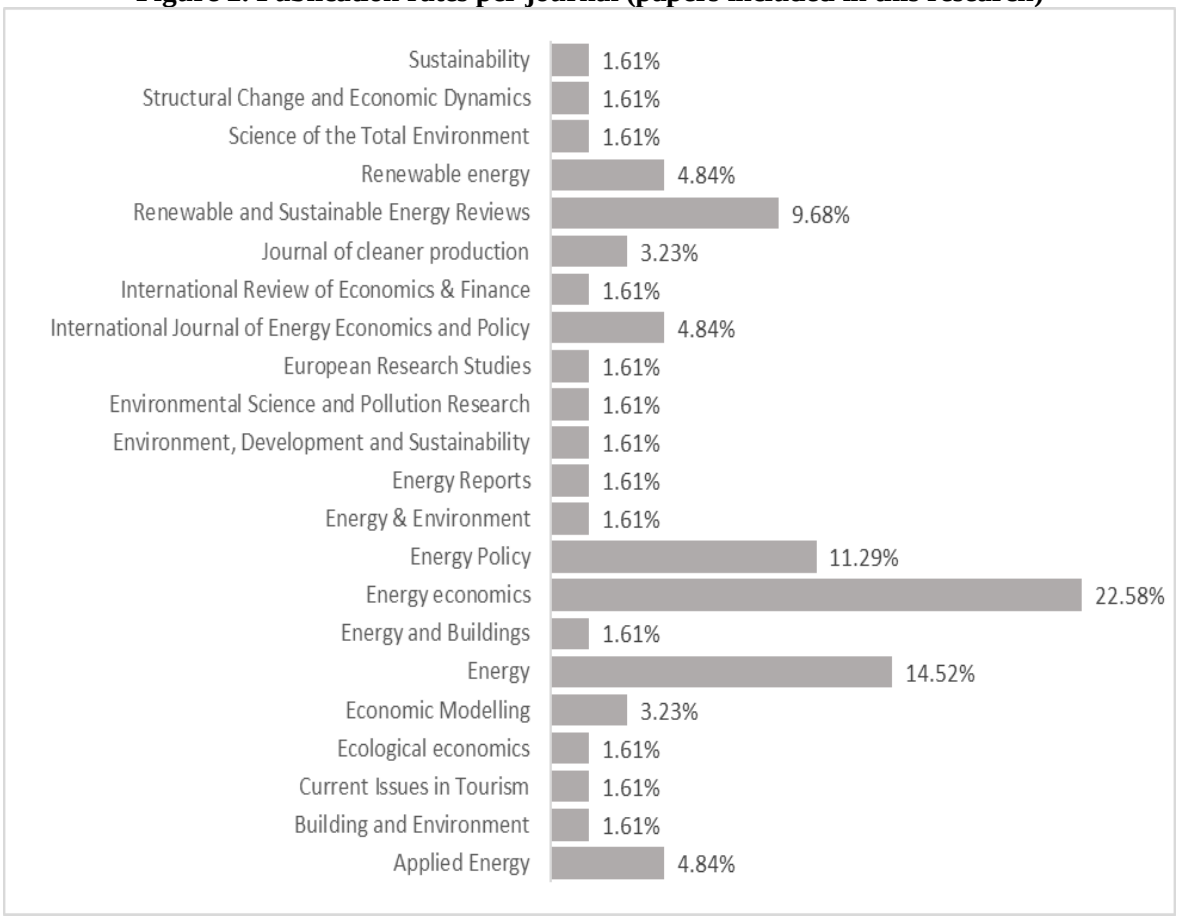
Figure 1. Number of published papers per year (papers included in this research)



Source: Authors' construct

Figure 2 presents the publication rates per journal, taking into account the papers included in the study. The majority of papers have been published in 'Energy Economics', while a significant percentage of papers have been published in 'Energy' and 'Energy policy'.

Figure 2. Publication rates per journal (papers included in this research)



Source: Authors' construct

3. Results

This section presents the findings of the systematic literature review by categorizing relevant studies according to methodological approaches and thematic focus. The objective is to systematically analyze existing research on the relationship between energy consumption and economic growth, with a particular emphasis on Greece. The analysis is structured into six primary categories: (1) grouping results based on research methods, (2) the relationship between economic growth and energy consumption, (3) an integrated literature review on Greece's energy dynamics, (4) energy economics and efficiency, (5) renewable energy and ecological economics, and (6) findings in environmental science.

3.1 Grouping Results on Research Methods

3.1.1 Literature Review on Granger Causality & Causality Analysis Techniques in Energy Economics

The study of causality in energy economics has employed diverse methodological frameworks to examine the relationships between variables. Aydin (2019) employed the Panel Causality Test, a methodology that assesses causality across panel data sets. Building upon previous causality analyses, Ozcan & Ozturk (2019) utilized the Bootstrap Panel Causality Test, which enhances inference reliability through data resampling. Analyzing the long-term interdependencies between CO2 emissions, GDP, and energy intensity, Hatzigeorgiou et al. (2011) employed a multivariate cointegration and causality approach, offering insights into the structural dynamics of the Greek energy sector. Saboori et al. (2014) ventured into a bi-directional relationship approach to discern the ties between economic growth, energy consumption, and CO2 emissions within the transport sector of OECD countries. In a more nuanced technique, Troster et al. (2018) employed Granger-Causality in Quantiles Analysis, allowing for the causality examination across different quantiles of the distribution, thereby capturing potential nonlinearities in the data. Tsani (2010) focused on Greece's energy scenario, harnessing causality analysis techniques to unearth the intricate ties between energy consumption and economic growth. Lastly, Wang et al. (2019) embraced the Granger Causality Test Approach, a widely recognized method, to decipher the causality dynamics in their study parameters. Taken together, these studies provide a comprehensive overview of the methodological approaches employed to investigate causality in energy economics, highlighting both their applicability and limitations.

3.1.2 Literature Review on ARDL & its Variants in Energy Economics

The Autoregressive Distributed Lag (ARDL) model and its variants have found widespread application in energy economics to discern the intricate relationships between energy consumption, economic growth, and CO2 emissions. Acaravci & Ozturk (2010) investigated the relationship dynamics in Europe, using the ARDL framework to capture both short-term and long-term equilibriums. Similarly, Fuinhas & Marques (2012) utilized the ARDL bounds test approach to uncover the energy-growth nexus across various European nations spanning over four decades. A more specialized variant, the Dynamic Autoregressive Distributed Lag, was adopted by Alola & Alola (2018) to enhance the model's responsiveness to time-varying relationships. This dynamism was also evident in the study by Alola et al. (2019), which encapsulated the multifaceted impact of trade policies, growth trajectories, and energy consumption patterns on Europe's ecological footprint. Expanding on these applications, Gozgor et al. (2018) and Saint Akadiri et al. (2019) introduced the Panel Autoregressive

Distributed Lag (P-ARDL) model, which integrates cross-sectional insights to offer a more comprehensive analysis of panel data. Hondroyiannis et al. (2002) contributed to this discourse by focusing on Greece, utilizing the ARDL methodology to elucidate the interrelationship between energy consumption and economic growth.

A broader methodological integration is evident in the work of Kahouli (2017), who not only employed the ARDL model but also incorporated the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests alongside the Vector Error Correction Model (VECM) to provide a more comprehensive analytical framework. Katrakilidis et al. (2014) further enriched the discourse, focusing on the dynamic interplay of CO2 emissions, energy consumption, and growth within Greece. Collectively, these studies underscore the versatility and robustness of the ARDL methodology and its variants in investigating multifaceted relationships within energy economics.

3.1.3 Literature Review on Methodological Approaches in Energy Economics

The field of energy economics has adopted a wide range of analytical methodologies to explore the intricate relationships among energy consumption, economic growth, and environmental sustainability. Panel Vector Autoregression (PVAR) offers an integrated analysis of multiple time series across various countries, as demonstrated by Antonakakis et al. (2017)., In several studies, Apergis et al. heavily leaned on the Panel Cointegration Technique, reinforcing the interconnectedness of renewable energy with economic growth in a long-term equilibrium (Apergis & Danuletiu, 2014; Apergis & Payne, 2010; Koçak & Şarkgüneşi, 2017; Salim et al., 2014; Ucan et al., 2014). These studies collectively established the co-movements of diverse energy sources and growth trajectories.

Further advancing this methodological exploration, Apergis and Payne (2012) employed a panel error correction model to simultaneously assess both short- and long-run relationships between renewable and non-renewable energy sources and economic growth. This nuanced approach is mirrored in the work of Belke et al. (2011) which tapped into the cointegration relationship between energy consumption and growth. Complementing these is Bölük & Mert (2014), which addressed the dynamics between both fossil and renewable energy consumption, GHGs, and growth within the EU context.

A notable methodological shift is evident in the work of Chang (2015), employing a Panel Threshold Regression, introducing non-linearities to understand potential regime switches in the energy-growth nexus. This departure towards more flexible panel models, as discussed by Dogan et al. (2017), highlights the field's evolution. Further, Huang et al.'s (2008) adoption of the Dynamic Panel Data Approach underscores the time-varying nature of these relationships.

In addition to these panel studies, several country-specific investigations have provided deeper insights into energy demand at the microeconomic level. Hondroyiannis (2004) and Polemis (2006) focused on Greece's residential electricity demand, and road energy demand respectively, demonstrating the importance of micro-level investigations alongside broader multi-country analyses. Together, these studies epitomize methodological diversity and rigor underpinning contemporary research in energy economics.

3.1.4 Literature Review on Decomposition & Divisia Index Techniques in Energy Economics

Decomposition analysis has received considerable attention in energy research due to its ability to systematically break down aggregated data into its fundamental components, thereby revealing the key determinants influencing energy trends and consumption patterns. Hatzigeorgiou et al. (2008) delved into Greece's CO2 emissions between 1990 and 2002,

providing a meticulous comparison between the Arithmetic Mean Divisia Index (AMDI) and the Logarithmic Mean Divisia Index (LMDI) techniques. Their work stands as a testament to the versatility of Divisia Index Techniques in emission analyses, allowing for precise attributions to be made to specific contributing factors.

Diverging from the Divisia paradigm, Roinioti & Koroneos (2017) adopted the IDA Methods, an integral part of decomposition studies, emphasizing the importance of understanding the intricate interplay between energy, economy, and the environment. Their methodology underscored the need for robust techniques that capture the dynamic, non-linear relationships inherent in energy systems.

Adding another dimension to decomposition research, Salim et al. (2014) employed the STIRPAT model. This model, an extension of the IPAT identity, integrates stochastic components to enhance explanatory power and analytical precision. Unlike conventional decomposition techniques, the STIRPAT model allows for the assessment of non-linear relationships and interactive effects among key drivers such as population, affluence, and technology, thereby providing a more comprehensive framework for understanding environmental impacts. An acronym for 'Stochastic Impacts by Regression on Population, Affluence, and Technology,' this model serves as a contemporary, stochastic reformulation of the IPAT identity, adding nuance and statistical rigor to the classic methodology.

In essence, the selected literature showcases the methodological richness of decomposition techniques and their adaptability in addressing various facets of energy economics, from emissions analysis to the broader socioeconomic implications.

3.1.5 Literature Review on Dynamic Models & Simulation in Energy Economics

The realm of energy economics has witnessed a surge in the application of dynamic models and simulations to fathom the intricate interrelationships between energy variables and macroeconomic indicators. Huang et al. (2008) revisited the nexus between energy consumption and GDP growth, leveraging a dynamic panel data approach. Their methodological framework provided a holistic view, considering both cross-sectional heterogeneity and temporal dynamics, emphasizing the causality nuances across countries and over time.

A more multifaceted approach is evident in Olanrewaju et al. (2012) research, where they amalgamated the strengths of IDA (Input-Driven Analysis), ANN (Artificial Neural Networks), and DEA (Data Envelopment Analysis). This integration allows for a more robust analytical framework by leveraging IDA's capability to identify key input-driven variables, ANN’s proficiency in modeling complex non-linear relationships, and DEA’s efficiency in benchmarking and comparative performance assessment. The combined application of these methodologies enhances predictive accuracy and provides a more comprehensive understanding of the multifactorial dynamics governing energy systems. This combination showcases the importance of integrating diverse analytical tools to capture the non-linear, multifactorial dynamics governing energy systems.

Omri & Kahouli (2014) investigated the causal relationships between energy consumption, foreign direct investment, and economic growth. They innovatively employed dynamic simultaneous-equations models, showcasing the interconnectedness and reciprocity of these variables, thereby adding a new dimension to the causality discourse.

Lastly, Shahbaz et al. (2020) ventured into the arena of advanced econometric techniques, employing both Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least

Squares (FMOLS). These methods, known for their robustness against endogeneity and serial correlation, enabled them to obtain insights with greater precision and reliability.

Collectively, these studies underscore the growing sophistication and precision in methodological choices within energy economics, echoing the domain's complexity and the necessity for dynamic analytical paradigms.

3.1.6 Literature Review on Econometric & Regression Techniques in Energy Economics

The application of econometric and regression techniques in energy economics has been a prevalent trend, allowing scholars to elucidate intricate associations and underpin policy directives. Apergis & Payne (2010) delved into the connection between natural gas consumption and economic growth across 67 countries utilizing panel data analysis. This methodology is adept at handling both cross-sectional and time series data, offering insights into inter-country variations and temporal changes. Similarly, Polemis (2006) employed panel data econometric techniques, offering empirical evaluations of road energy demand determinants in Greece and other energy-related aspects, underscoring the efficacy of these techniques in handling multifaceted datasets.

Balaras et al. (2007) undertook a comprehensive assessment of the European residential buildings, emphasizing the Hellenic building stock, its energy consumption patterns, emissions, and potential savings. Their work provides a detailed portrayal of the building sector's energy profile and its implications. Menegaki (2011), through a random effect model, embarked on a study of growth and renewable energy in Europe. The model's flexibility in handling unobserved heterogeneity makes it apt for such investigations, shedding light on the neutrality hypothesis in the context. Osobajo et al. (2020) combined regression analysis and panel cointegration tests, emphasizing the statistical relationships in the energy domain. Their combination affords an exploration of both short-term fluctuations and long-term equilibria. Pirlogea & Cicea (2012) provided an econometric perspective of the relation between energy consumption and economic growth in the European Union, demonstrating the intricacies of this connection in a regional context. Meanwhile, Saidi & Hammami (2015) exploited the dynamic panel data model, which factors in lagged dependencies and temporal dimensions, to advance our understanding of energy economics.

Collectively, the reviewed literature accentuates the paramount role of econometric and regression techniques, such as panel data analysis, cointegration methods, and dynamic panel models, in elucidating complex phenomena in energy economics. These methodologies have significantly influenced policy deliberations by providing empirical insights into the impact of energy consumption on economic growth, environmental sustainability, and market dynamics.

3.1.7 Integrated Review on Advanced Panel Data Techniques in Energy Economics

Advanced panel data methodologies have become a cornerstone in the energy economics literature, shedding light on the intricate dynamics between energy consumption, economic growth, and environmental implications. Antonakakis et al. (2017) took the lead with the Panel Vector Autoregression (PVAR) approach, adeptly exploring the interconnectedness of energy consumption, CO2 emissions, and economic growth. This methodology, consistently chosen across multiple studies including by Apergis and Payne, emphasizes its robustness in capturing multifaceted relationships and potential feedback loops in energy-economy matrices.

Causality, an integral part of understanding directional relationships, has been rigorously examined using various methods. Aydin's (2019) Panel Causality Test and Ozcan & Ozturk's (2019) Bootstrap panel causality, both offer unique lenses to ascertain causative pathways within the energy landscape. Complementing these, Chang's (2015) Panel Threshold

Regression introduces a perspective on non-linearities and regime shifts, illuminating the thresholds where energy and economic variables interact dynamically.

The work of Dogan et al. particularly in 2017, underscore the richness of these methodologies by ensuring they remain robust to heterogeneity and cross-sectional dependence, a vital consideration given the varied nature of global energy scenarios. This spirit of comprehensiveness is mirrored by Mahadevan & Asafu-Adjaye (2007), as they integrate long-term equilibrium and short-term dynamics using the Panel Vector Error Correction Model (VECM).

A diverse array of methodologies, ranging from non-parametric techniques to specialized models, graces the landscape of energy economics. Key among these is the Environmental Kuznets Curve Approach, which has been embraced by Bilgili et al. (2016). This approach provides invaluable information on the relationship between environmental degradation and economic growth, particularly discerning potential turning points in pollution levels as economies mature.

The non-parametric domain received notable attention from Ivanovski (2021), as they discerned the effects of both renewable and non-renewable energy consumption on economic growth. Their research, highlighted in the Journal of Cleaner Production, illuminates the nature of these relationships without the constraints of specified functional forms. Additionally, Dergiades et al. (2013) provided a balanced view by considering both parametric and non-parametric causality tests to better understand the energy-economy linkage, particularly in the Greek context.

Techniques like the VAR/VEC approach adopted by Georgantopoulos (2012) for Greece enhance our understanding of energy consumption patterns, while Apergis & Danuletiu's (2014) foray into Panel Cointegration Technique extends the exploration of long-term relationships between panel datasets in energy consumption.

In their study, Ozcan et al. (2020) utilized the Generalized Method of Moments (GMM) and panel Vector Autoregressive Regression (PVAR) to investigate the relationship between energy consumption, economic growth, and environmental degradation in OECD countries. Incorporating specialized models, Shafiei & Salim (2014) and Koçak & Şarkgüneşi (2017) employed the STIRPAT Model, an empirical model keenly focused on analyzing environmental impacts based on population, affluence, and technology variables. Lastly, as a special mention, Mahadevan & Asafu-Adjaye's (2007) deployment of the Panel Vector Error Correction Model (VECM) and Apergis & Payne's (2012) utilization of the Panel Error Correction Model serve as pivotal references. These techniques focus on both long-term equilibrium and short-term adjustments, capturing the intricacies of the energy-economy nexus.

3.2 Relationship Between Economic Growth and Energy Consumption

The relationship between energy consumption and economic growth has been a central topic in academic research, with numerous studies investigating its complexities and implications. While earlier studies primarily focused on linear associations, recent research has expanded to include nonlinear dynamics, sector-specific influences, and policy-driven variations. This growing body of work has contributed to a deeper understanding of how energy consumption patterns interact with economic growth across different regions and time periods. Acaravci & Ozturk (2010), as well as Antonakakis et al. (2017), highlight the intricate relationship between energy consumption, CO2 emissions, and economic growth in Europe, indicating the potential environmental implications of growth-driven energy demands. Apergis and Danuletiu (2014)

further emphasize this, suggesting that renewable energy can foster economic growth. This positive correlation between renewable energy consumption and economic growth was also supported by Bhattacharya et al. (2016) in 38 prominent nations.

Apergis & Payne's (2010, 2011, 2012) series of studies extends this discussion, uncovering the role of both natural gas and electricity in the growth paradigm. Their findings underscore the significant influence of both renewable and non-renewable energy consumption on growth dynamics, a sentiment echoed by Aydin (2019) in his assessment of OECD countries.

Some studies have explored asymmetrical relationships. For instance, Baz et al. (2021) delve into the non-linear impacts of fossil fuel and renewable energy consumption on economic growth, suggesting varied effects based on energy sources. Meanwhile, Belke et al. (2011) and Bölük & Mert (2014) provide insights on the cointegration relationship, emphasizing that energy consumption and economic growth are intertwined in the long run.

Chang (2015) introduces the financial dimension, linking financial developments and income to energy consumption, suggesting that economic structures can influence energy demands. Dergiades et al. (2013) and Dogan & Aslan (2017) narrow their focus to Greece and the EU, respectively, demonstrating the region-specific nuances of this relationship. On the broader scale, Gozgor et al. (2018) provide evidence from the OECD countries, suggesting a generalized positive correlation between energy consumption and growth. Such a positive relationship is also evident in studies focusing on specific regions or countries, such as Gyimah et al. (2022) in Ghana and Hondroyiannis et al. (2002) in Greece. Recent studies like Ivanovski et al. (2021) have also adopted non-parametric methodologies to unearth the nuanced effects of both renewable and non-renewable energy consumption on growth, while Radmehr et al. (2021) employ spatial modeling techniques to analyze the nexus among renewable energy consumption, CO2 emissions, and economic growth in the EU.

Several studies such as Saboori et al. (2014) and Shahbaz et al. (2020) extend this conversation to include CO2 emissions, framing the discussion in the broader context of sustainability. Tsani (2010) provides a causality analysis for Greece, suggesting that the nature of the relationship between energy consumption and economic growth may be bidirectional in some cases. Wang et al. (2019) finally underscore the multifaceted influences on energy consumption, pointing to energy prices, urbanization, and economic growth as major determinants.

In summary, the literature overwhelmingly underscores a significant relationship between energy consumption and economic growth. However, nuances emerge based on energy type (renewable vs. non-renewable), geographical focus, and the inclusion of external factors like CO2 emissions, financial development, and energy prices.

The implications of urbanization on energy consumption have garnered interest in academic research, given the rapid growth of urban settlements worldwide and its potential energy ramifications. Salim & Shafiei (2014) provide an insight into the relationship between urbanization and energy consumption, focusing on both renewable and non-renewable sources in OECD countries. Their empirical findings suggest that as countries urbanize, the energy mix consumed tends to shift. The study gives weight to the idea that the process of urbanization inherently influences the types and volumes of energy sources demanded.

Wang et al. (2019) expanded this perspective by examining the tripartite effects of energy prices, urbanization, and economic growth on per capita energy consumption. Their extensive analysis across 186 countries underscores the multi-dimensionality of the issue. The research highlighted that urbanization, alongside energy prices and economic growth, is a significant factor that can drive energy consumption patterns. Their findings emphasize the importance of

understanding the interplay of these factors, particularly in the context of globally increasing urbanization trends. Sufyanullah et al. (2022) shift the discussion to integrate environmental considerations, specifically focusing on carbon dioxide emissions.

By exploring the interrelationship between urbanization, energy consumption, economic growth, and carbon emissions, the study provides a comprehensive perspective on the environmental consequences of urban development. The findings underscore the critical role of sustainable urban planning and energy policies in mitigating the adverse effects of rapid urban expansion. Effective urban planning strategies, such as the integration of renewable energy sources, improvements in energy efficiency, and the promotion of smart city technologies, can contribute to reducing carbon emissions while supporting economic growth. Additionally, the study highlights the necessity for policy interventions that encourage sustainable infrastructure development and resource-efficient urban environments to balance economic and environmental priorities. The empirical results suggest that urbanization has a direct bearing on carbon emissions, primarily driven by the energy consumption patterns prevalent in urban areas. This not only underscores the environmental challenges posed by rapid urbanization but also the importance of sustainable urban planning and energy management.

In conclusion, the literature underscores the strong correlation between urbanization and energy consumption while also revealing the multifaceted nature of this relationship, which includes economic growth, energy prices, and environmental considerations. However, significant research gaps remain, particularly in understanding the long-term effects of urbanization-driven energy consumption on climate resilience and sustainability. Future studies should explore the effectiveness of policy interventions in mitigating the negative environmental impacts of urbanization while ensuring sustainable economic growth. Additionally, comparative analyses across different urban models could provide deeper insights into best practices for energy-efficient urban planning and policy formulation. As cities continue to grow, understanding these dynamics becomes paramount in driving sustainable energy policies and practices.

3.3 Integrated Literature Review on Greece's Energy Dynamics

The intricate dance between energy consumption, economic growth, and environmental impact in Greece has been the focal point of numerous research undertakings. By weaving together findings from seminal works, a tapestry emerges, revealing the depth and nuances of Greece's energy landscape.

Starting with the built environment, Balaras et al. (2007) mapped out the Hellenic building stock, emphasizing the energy consumption patterns, emissions, and potential savings opportunities therein. The significance of residential buildings in this energy narrative is evident, serving as microcosms of the larger energy and economic trends.

Diving deeper into these economic ripples, Dergiades et al. (2013) and Fuinhas and Marques (2012) dissected the energy-economic growth interplay, not just within Greece but also in comparison with Mediterranean counterparts. Georgantopoulos (2012) further sharpened this focus, zeroing in on electricity consumption, a significant component of Greece's energy matrix. These works collectively showcased the symbiotic relationship between energy use and the economic trajectory of the nation.

An inevitable outcome of this consumption is its environmental footprint. Here, Hatzigeorgiou et al. (2008; 2011) played a pivotal role by demystifying CO2 emissions trends. They charted the course of emissions with respect to Greece's GDP and energy intensity, offering insights

into the environmental toll of economic growth. But it wasn't all dire – Roinioti and Koroneos (2017) highlighted the hopeful narrative of decoupling CO2 emissions from economic growth during the nation's economic downturn, suggesting resilience and adaptability.

Grounding the discussion in the domestic sphere, Hondroyiannis (2004) and Santamouris et al. (2013) painted a detailed picture of residential electricity demand and its shifts, particularly during the financial crisis. The economic downturn's ripple effects also touched the roads, as shown by Polemis (2006), with the transport sector reflecting the broader energy and economic oscillations.

In conclusion, Greece's energy dynamics, as portrayed by these studies, is a complex mosaic of consumption patterns, economic tides, and environmental outcomes. This research-rich tapestry underscores the intertwined destinies of Greece's economy, its energy appetite, and the resultant environmental footprints, serving as a compass for future policy directions and sustainability endeavors.

The interplay between renewable energy consumption, CO2 emissions, and economic growth is a multifaceted one, drawing attention in contemporary policy and academic circles. Acaravci & Ozturk (2010) emphasize a linkage between energy consumption and CO2 emissions in the European context, reinforcing the idea that energy choices significantly impact emissions. A similar ethical conundrum surrounding the balance between economic growth, emissions, and energy consumption is presented by Antonakakis et al. (2017). Yet, the argument for renewables finds significant backing. Apergis & Payne (2010) underscore that OECD countries exhibit a positive relationship between renewable energy consumption and economic growth, a sentiment echoed by Ozcan & Ozturk (2019) and Ozkan et al. (2024) for emerging economies. Bilgili et al. (2016) explore the immediate repercussions of renewable energy consumption on emissions, suggesting dynamic benefits. However, Hatzigeorgiou et al. (2008) offer a detailed decomposition of Greece's CO2 emissions from 1990-2002, shedding light on intricate factors beyond energy consumption. The overarching narrative, as elucidated by studies like Koçak & Şarkgüneşi (2017) and Saint Akadiri et al. (2019), is that renewable energy, especially in the EU context, could be a pivotal strategy towards sustainable economic growth. The synthesis of these works underscores the urgency of policy interventions in favor of renewables to achieve a sustainable balance between growth and environmental well-being.

In recent years, an increasing number of researchers have been taking into consideration environmental protection and renewable energy sources. ***Table 1*** presents a selection of papers studying the relationship between the economy and energy consumption in Greece. These articles are arranged in ascending order by year and demonstrate that recent studies referred to renewable energy sources and environmental protection.

Table 1. Case Studies of Greece.

Title	Author(s)	Year	RES/ Environmental protection	Citations
Energy consumption and economic growth: assessing the evidence from Greece	Hondroyiannis, Lolos, Papapetrou	2002	No	562
Estimating residential demand for electricity in Greece	Hondroyiannis	2004	No	283
Empirical assessment of the determinants of road energy demand in Greece	Polemis	2006	No	127
CO2 emissions in Greece for 1990–2002: A decomposition analysis and comparison of results using the Arithmetic Mean Divisia	Hatzigeorgiou, Polatidis, Haralambopoulos	2008	Yes	256

Title	Author(s)	Year	RES/ Environmental protection	Citations
Index and Logarithmic Mean Divisia Index techniques				
Energy consumption and economic growth: A causality analysis for Greece	Tsani	2010	Yes	409
CO2 emissions, GDP and energy intensity: a multivariate cointegration and causality analysis for Greece, 1977–2007	Hatzigeorgiou, Polatidis, Haralambopoulos	2011	Yes	221
Electricity consumption and economic growth: analysis and forecasts using VAR/VEC approach for Greece with capital formation.	Georgantopoulos	2012	Yes	32
Energy consumption and economic growth: parametric and non-parametric causality testing for the case of Greece.	Dergiades, Martinopoulos, Tsoulfidis	2013	Yes	193
Financial crisis and energy consumption: A household survey in Greece	Santamouris et al.	2013	Yes	143
The electricity consumption and economic growth nexus: Evidence from Greece.	Polemis, Dagoumas	2013	Yes	116
On the dynamic linkages between CO2 emissions, energy consumption and growth in Greece	Katrakilidis, Kyritsis, Patsika	2014	Yes	2
The decomposition of CO2 emissions from energy use in Greece before and during the economic crisis and their decoupling from economic growth	Roinioti, Koroneos	2017	Yes	140

Source: Authors' construct

3.4 Energy Economics and Efficiency

The relationship between energy consumption, economic growth, and environmental impacts has been a focal point in the recent energy economics literature. Antonakakis et al. (2017) discuss the ethical implications arising from the interplay between energy consumption, CO2 emissions, and economic growth. A notable observation from studies such as Apergis & Danuletiu (2014), and Apergis & Payne (2010, 2011) is the positive correlation between renewable energy consumption and economic growth, especially in OECD countries. These sentiments find resonance in Gozgor et al.'s (2018) study on the OECD nations and Bhattacharya et al.'s (2016) investigation across 38 leading countries.

Furthermore, the Environmental Kuznets Curve approach, revisited by Bilgili et al. (2016), underscores the dynamic relationship between renewable energy and CO2 emissions. Country-specific studies, like Hondroyiannis (2004) and Polemis & Dagoumas (2013), explore Greece's energy economics, shedding light on its unique energy-consumption-growth nexus. Omri & Kahouli (2014) introduce an intriguing dimension by interlinking energy consumption, economic growth, and foreign direct investments through simultaneous-equations models. On the energy efficiency front, Olanrewaju et al. (2012) adopt an integrated IDA–ANN–DEA approach to optimize energy consumption in the industrial sector, emphasizing the importance of efficiency in energy economics.

Overall, these studies collectively accentuate the nuanced interdependencies of energy policies, environmental considerations, and economic imperatives, underscoring the need for balanced strategies in the modern economic landscape.

3.5 Renewable Energy and Ecological Economics

The exploration of renewable energy's impacts and its nexus with economic growth has drawn considerable academic attention. Alola & Alola (2018) examined the influence of agricultural land use and tourism on renewable energy consumption among Mediterranean countries, suggesting significant external factors at play. The study by Fareed & Pata (2022) elucidates the dynamics of renewable and non-renewable energy consumption in the top renewable energy-consuming nations, linking it directly with their income levels. In a non-parametric approach, Ivanovski et al. (2021) determine the varying effects of renewable and non-renewable energy consumption on economic growth, highlighting the evolving nuances of energy sources. Furthermore, studies like those of Koçak & Şarkgüneşi (2017) and Menegaki (2011) provide insights into the symbiotic relationship between renewable energy consumption and economic growth, especially in specific regions like the Black Sea and Balkan countries, and Europe, respectively. The role of institutional quality in influencing renewable energy consumption was notably explored by Uzar (2020), suggesting the broader implications of governance and policy-making.

Transitioning to ecological economics, the causal relationship between energy consumption and GDP growth was revisited by Huang et al. (2008) through a dynamic panel data approach. Their findings offer an ecological perspective to traditional economic models, shedding light on sustainability concerns. Additionally, Alola et al. (2019) provide a comprehensive look at the ripple effects of trade policy, fertility rate, and energy consumption patterns on Europe's ecological footprint. Lastly, Katrakilidis et al. (2014) specifically delve into the linkages between CO2 emissions, energy consumption, and Greece's economic growth, emphasizing the importance of sustainable practices in an interconnected global ecosystem.

3.6 Findings in Environmental Science

The environmental implications of energy consumption, economic growth, and policy strategies have been a focal point in recent studies. Alola et al. (2019) investigated the intertwined dynamics of trade policies, economic growth, fertility rates, and energy consumption, uncovering their collective impact on Europe's ecological footprint. This comprehensive study emphasizes the multi-faceted determinants of environmental outcomes. Similarly, Osobajo et al. (2020) explored the relationship between energy consumption, economic growth, and CO2 emissions, highlighting the complex interplay between development and sustainability. Offering regional insights, Sadiq et al. (2023) underscored the role of globalization in determining energy consumption patterns, economic growth trajectories, and carbon emissions in South Asian countries, suggesting that regional developmental patterns have significant environmental implications.

Focusing on building and construction, Balaras et al. (2007) conducted an empirical assessment of the European residential buildings, especially within the Hellenic building stock. Their study elucidated the energy consumption levels, emission rates, and potential energy savings, positioning buildings as pivotal in environmental science debates. Hatzigeorgiou et al. (2011) provided a time-series analysis for Greece between 1977-2007, revealing the causal relationships between CO2 emissions, GDP, and energy intensity. Such insights are crucial for policy formulations aiming to balance economic growth with carbon mitigation. Lastly, Somoye et al. (2022) offered a fresh perspective on Nigeria, analyzing the impact of renewable energy consumption on its economic growth through a non-linear ARDL approach, emphasizing the potential of renewable energy in driving sustainable economic advancements.

4. Conclusions

The evolution of Greece's energy policy and its confluence with economic growth over the period from 1994 to 2023 provides a rich tapestry of insights that have broader implications for both policymakers and scholars. This systematic literature review, guided by a structured methodology encompassing bibliometric analysis and thematic categorization, has attempted to untangle the intricate relationship between renewable energy consumption and Greece's economic dynamics during this significant era.

This study yields several key takeaways that collectively offer a comprehensive understanding of Greece's journey toward renewable energy adoption. Firstly, the legislative framework, notably the laws implemented from 1994 onwards, has played a pivotal role in shaping the trajectory of renewable energy consumption in Greece. These laws not only provided the groundwork for the increased adoption of renewable energy sources but also underscored the country's commitment to sustainable economic growth.

Furthermore, researchers have utilized a diverse array of methodologies, including Granger Causality, ARDL, Decomposition, and Dynamic Models, among others, to unravel the intricate relationship between energy and economic growth in Greece. The plurality of these methodologies highlights the complexity of the issue, emphasizing the necessity for multifaceted approaches to comprehensively grasp it.

Comparing research findings from Greece with studies in other European countries reveals that, while some commonalities exist, Greece's unique socio-economic and geopolitical context has sculpted its distinctive path in renewable energy adoption. Factors such as the country’s heavy reliance on imported fossil fuels, economic crises that have influenced energy policy decisions, and its geographical advantages for renewable energy, particularly solar and wind power, have played a crucial role. Additionally, Greece’s commitments to European Union directives and funding mechanisms have shaped its transition strategy differently compared to other nations with more stable economic conditions or greater domestic fossil fuel reserves.

The identified gaps in the current literature present an enticing opportunity for researchers to explore uncharted territories. These gaps include the need for longitudinal studies assessing the long-term economic impacts of renewable energy adoption, comparative analyses of Greece’s policies with those of other European nations, and evaluations of the effectiveness of government incentives on energy transition. Additionally, further research is needed to address methodological variations and discrepancies in existing studies, such as variations in data collection techniques, modeling approaches, and assumptions regarding causal relationships between energy consumption and economic growth. These gaps encompass specific methodological deficiencies as well as broader thematic areas, paving the way for a new wave of research that can further enrich our comprehension of Greece's energy-economy dynamics.

Finally, the broader economic implications of Greece's transition to renewable energy, as gleaned from the literature, are manifold. Studies such as Apergis and Payne (2010) and Menegaki (2011) highlight the role of renewable energy in fostering economic growth and employment opportunities. Furthermore, research by Antonakakis et al. (2017) underscores the potential for energy security improvements and resilience against external market shocks. These implications include potential job creation, positive spillover effects on related sectors, increased energy security, and a sustainable route to economic resilience. These implications include potential job creation, positive spillover effects on related sectors, increased energy security, and a sustainable route to economic resilience.

In summary, the last 30 years in Greece provide a compelling story that highlights the interconnectedness of renewable energy policies and economic growth. This analysis not only documents this evolution, but also paves the way for future investigations that can shed more light on the various facets of this vital relationship.

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