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Economical, Innovative, or Ecological? What Are the Green Energy Users?

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Abstract: Green energy sources play a vital role in mitigating environmental impacts and reducing dependence on energy imports. Growing concerns over climate change, coupled with public policies promoting the expansion of green energy, have notably shaped consumer attitudes and behaviours. This study aims to address the knowledge gap by examining the impact of a sustainable lifestyle, consumer innovativeness, and economic attitudes on the intention to adopt green energy sources. The research was conducted on 580 Polish consumers using an online survey. The results of structural equation modelling revealed that pro-environmental self-identity (PESI) and consumer innovativeness (CI) have a positive impact on consumer behaviour toward green energy sources. Pro-environmental self-identity (PESI) is the strongest determinant of consumer behaviour toward green energy sources. Our research on Polish consumer behaviour could serve as a frame of reference for other countries, particularly in Central and Eastern Europe. From a theoretical standpoint, this research enhances the understanding of pro-environmental self-identity (PESI) and its link to consumer innovativeness while also offering insights into consumer behaviour related to green energy sources, based on the experiences from the Polish market. The conclusions derived from this study may provide valuable guidance for managers and policymakers in formulating strategies to promote the adoption of green energy sources across Europe effectively.

Keywords: green energy; consumers' behaviour; pro-environmental self-identity (PESI); consumer innovativeness; economic attitude

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1. Introduction

The EU economy is shifting towards green development, and social concern regarding the environmental challenges that await Europe in the next few years has been amplified. And so, a question emerges: "How does the fact that The EU economy is going towards green development affect a consumption-based modern citizen and what factors affect its intention to adopt green product, services and solutions?" To understand the complexity of this matter, it is urgent to embrace to the determinants of a conscious lifestyle.

Climate change is a global concern. On a macro scale, EU governments have already taken ambitious measures to achieve climate neutrality by 2050 under the Paris Agreement [1]. The recently adopted "Fit for 55" legislation has, thus, posed a daunting challenge for European countries, not only to cease the disruption of the ecosystem, thereby pursuing the zero-emission objectives [2], but also to seek fully renewable energy sources without sacrificing the efficiency of the ones people are accustomed to using. Moreover, the Emissions Trading System (ETS) framework, which has moved into the fourth phase (2021–2030), is causing sleepless nights for countries like Poland [3], whose economy for man years has been built around agriculture, coal mining, and transportation [3]. Such a callous set of regulations can lead to risky ventures, e.g., planned mine closures [4], so as to prevent penalties aimed at polluters, which may increase Poland's vulnerability to reliance on imported energy sources [5]. At the micro level, local authorities are exploring the

possibilities to convert to renewables, such as subsidies for solar and wind energy, pursuant to the principles of the European Green Deal, in the hope of speeding up the successful implementation of these initiatives. Indeed, a hybrid photovoltaic–wind system has been found to display complementary behaviour [6], where the variability and intermittency of a single source of energy are compensated by the smooth transition to another source, ensuring a consistent primary power supply and, thus, supporting their integration into the energy grid. Research in Britain [7] and Sweden [8] has shown that the least seasonal variability in total power is achieved when incorporating solar. In addition, Chong et al. [9] reported that a wind–solar hybrid energy system with a hydro rainwater collection feature could deliver energy savings totalling an estimated 195.2 MWh/year. Norway, known for its scarcity of sunshine, has utilised hybrid offshore wind–wave energy converters that could generate a levelized cost of energy of EUR 107/MWh with 15% of shared costs [10]. Be it energy independence, savings on energy bills, or being "eco" (hereby meaning "the consciousness of being a responsible consumer of Earth's natural resources"), these are certainly the influences that lead individuals to explore and adopt these cutting-edge green technologies.

Although the theme of renewable energy sources in the European Union and in Poland has been around long enough to understand how these technologies operate, specifically, when it comes to the engineering perspective, the frame of consumer behaviour offers fresh insight into the research. Consistent with the epistemological underpinnings of consumer behaviour research, this study addresses the "why?" question—why do Polish people use green technologies? Until recently, prior work is limited to a subset of research motifs, including "the influence of pro-environmental self-identity on purchase intention" [11], "consumer acceptance of renewable energy" [12,13], "popular methods to generate green energy in Polish households, based on the surface area and the volume of the building" [14,15], "the willingness to pay for green electricity" and "the impact of socio-demographic variables on Poles' green purchase behaviour" [16–19].

Gajdzik et al. suggested that prosumers tend to exhibit advanced ecological behaviours and actively implement pro-ecological practices in their homes, indicating a general inclination toward sustainability. However, Kowalska-Pyzalska pointed out a significant barrier: a lack of knowledge about green energy and limited experience with green electricity tariffs. This gap in understanding poses challenges, especially considering that the Polish energy sector, as noted by Kubiczek and Przedworska, still heavily relies on coal, even as its future becomes increasingly tied to the development of renewable energy sources (RESs). Leading companies in Poland's energy sector recognize this shift and have begun investing significantly in RESs, reflecting an evolving landscape. Complementing this, the study by Grębosz-Krawczyk et al. emphasized the importance of intangible social and emotional values, which significantly influence consumer behaviour towards green energy. Zdonek et al. further contributed to this discussion by finding that the economic usefulness of prosumer photovoltaic (PV) technology is perceived as particularly valuable from a cost perspective. Klepacka et al. elaborated on this by noting that motivations such as the desire to reduce energy costs for heating and lower energy bills, along with factors like unemployment or part-time work, heighten the importance of evaluating total installation costs, subsidies, and energy expenses prior to adopting solar panels. Additionally, Maciaszczyk et al. revealed a correlation between the age and level of education of respondents and their willingness to engage with renewable energy issues, highlighting how these demographic factors influence the adoption of solutions that utilize natural energy sources in households. Together, these insights underscore the complex interplay of knowledge, economic considerations, and social values in shaping attitudes towards renewable energy adoption.

Previous international research has primarily focused on factors associated with environmental concern, such as awareness of environmental issues, social influence, environmental attitudes, knowledge, and responsibility, coupled with government initiatives aimed at shaping consumers' intentions to adopt green energy sources [20–32]. The preced-

ing research results confirmed that the functionality of green energy sources encompasses not only the physical characteristics of products but also the internal and external reference prices that customers consider when making purchase decisions [21]. Social acceptability is an important determinant of government decisions concerning green energy. Research has also confirmed that investments in green energy enhance individuals' self-image in communities actively engaged in eco-initiatives [20]. Ek and Matti [23] noted that social norms encourage consumers to participate in pro-environmental activities and influence their willingness to invest in measures that mitigate the negative impacts of large-scale onshore wind projects, whereas Pandey and Kesari [25] noted that an individual's ecological attitude plays a crucial role in influencing the decision to purchase solar energy products in developing countries.

This field of research is still growing in the academic literature, leading to significant advancements in both the theoretical and practical dimensions. However, factors such as sustainable lifestyle, consumer innovativeness, and economic attitudes have not been examined together in studies that addressed their influence on the intention to adopt green energy sources. This gap highlights the novelty of the issue and the need for further exploration. Understanding the impact of these factors in the Polish context could contribute to the theory of consumer decision making concerned with green energy adoption, offering valuable insights for policymakers, local governments, and businesses. In addition, the new findings on Polish consumers may serve as useful references for other countries.

The aim of this study is to examine how these three variables, sustainable lifestyle, consumer innovation, and economic attitudes, influence Polish consumers' willingness to adopt green energy sources.

This paper is organized into five sections. The first section is the Introduction. Section 2 covers the theoretical framework, including a brief overview of the Polish green energy sector, a literature review on pro-environmental identity, consumer innovation, and economic attitudes, and how these relate to consumer behaviour around green energy. Section 3 describes the research method used in this study. Section 4 presents the empirical findings, followed by a discussion in Section 5. Finally, Section 6 concludes this study with theoretical and managerial contributions, along with the study's limitations.

2. Theoretical Framework

2.1. Outline of Polish Green Energy Market

According to the National Energy and Climate Plan for 2021–2030, in 2030, Poland is set to achieve a 21–23% share of renewable energy sources in gross final energy consumption. This goal is to be achieved by increasing the use of advanced biofuels, developing offshore wind energy, and increasing the dynamics of the development of RES microinstallations [33].

On 8 August 2024, Miłosz Motyka, the Deputy Minister of Climate and Environment for the Republic of Poland, announced that Poland has a tremendous potential to become a hub of energy supplies for Europe by harnessing the power of offshore wind [34]. The energy potential of the Polish coastal area of the Baltic Sea is being estimated at 33 gigawatts (GW), making it one of the largest in Europe. It is believed that through such a massive undertaking, the energy generated from wind turbines will be superior to nuclear power—quite a bold statement, which disagrees with the results of a recent study by Emblemsvåg [35], who found that thermal energy beats the wind-based power alternative for Norway, constituting an economically profitable investment due to the long lifespan of nuclear power plants.

Notwithstanding the government's stance on this project, Polish people have vigorously embraced small-sized residential photovoltaic (PV) panels, which have become the most common form of renewable energy in the country, placing Poland third amongst the biggest solar markets in Europe [36]. Hence, a common way of obtaining renewable energy for Polish households involves a hybrid system of photovoltaic panels and heat pumps [37], a method that bears some resemblance to the early days of Germany's energy transformation. Thus, 2023 saw a 41% surge in installations of solar panels across households, making

the Polish PV market reach a total capacity of 17 GW at the end of that year [38]. Customers are looking for new technologies that can secure greater efficiency and yield.

2.2. Pro-Environmental Self-Identity (PESI)

Pro-environmental self-identity (PESI), formerly coined by Van Der Werff et al. [39] as "environmental self-identity", can be defined as an internal depiction that a subject conjures up about oneself as someone engaged in pro-environmental practices. Essential here is the explicit addressment of the "self" dimension—an idiosyncratic set of features that carry emotional significance to the individual's way of conduct, which, in the case of the present study, is the cognisance of being the "I" that is truly environmentally responsible [40]. Also, such a tendency to act in an eco-friendly manner is symbolically expressive and influenced by social pressure, which is congruent with the self-expressive nature of consumption [41]. Indeed, by making eco-positive decisions, a person's self-identity is enhanced, and so his social role as a sustainable consumer is being validated within his immediate surroundings. And this, in turn, coheres with Social Cognition Theory, wherein mental representations, such as PESI, depend on the context of a situation in which an individual finds himself [42]. Following in this vein, this implies that people have an inherent trait to frame their behaviour based on the imaginative portrayal of themselves engaging in specific activities. When somebody is involved in pro-environmental doings, not only does his attitude differentiate him from others but it also conceives a depiction of himself with a socially mediated meaning [43] that carries significance to the members of the collective entities he belongs to. In this manner, according to Ryan and Deci's [44] theory of human motivation, PESI epitomises intrinsically motivated behaviour—one that does not need any external regulations nor rewards; hence, an individual displays a high degree of volition having decided to become a green consumer [44]. The current literature names two kinds of stimuli that instigate sustainable practices: enjoyment-based and obligation-based intrinsic motivation. The former denotes an inclination to be "eco", and the latter invokes a sense of moral responsibility for the planet's welfare [45].

Much of the recent literature has approached the construct of PESI as a factor explaining the causality of specific, directed behaviour, including, in this sense, the broadly understood "sustainable consumption behaviour", also known as "green purchasing behaviour". Specifically, Abbas and Bashir [46] found that PESI mediates the effect of internalization—the extent to which one's sense of morality fits his self-identity—on pro-environmental activities. This finding matches the results of an earlier study by Van Der Werff and colleagues [39], who identified that biospheric values and cognitive variables (i.e., preferences, intentions, behaviour) are significantly related to pro-environmental self-identity, thus indicating that PESI is a predictor of a sustainable lifestyle. Similar conclusions emerged in a study by Dermody et al. [40], where biospheric and altruistic values positively impacted PESI, emphasising its fluidity, dynamism, multi-dimension, and contextuality. Zhao et al. [47], on the other hand, showed that a relationship between cultural values and sustainable consumption does exist via the mediating effect of pro-environmental self-identity, which signifies a culturally rooted context behind green consumption. Some studies [48–50] suggest, however, that in TBP and OBA framework models, the concept alone fails to be a significant antecedent of concrete, sustainability-oriented behaviour. And, while this may be true, the theory has been linked to a range of pro-environmental behaviours, such as eco-consumption [51], collaborative consumption [52], luxury fashion product consumption [53], and second-hand product exchange [54]. Of particular importance here is the usage of green energy sources, an area of research that has not been extensively explored. Whitmarsh et al. [50] revealed that energy conservation was one of the types of sustainable practices for which PESI was the primary determinant of behaviour. In a similar vein, Dermody et al. [40] later demonstrated a positive relationship between PESI and curtailment behaviour, with a notably stronger effect in Poland, alluding to the embracement of a new, responsible consumption lifestyle. Similarly, research by Thorbjørnsen et al., Whitmarsh and O'Neill [48] established a correlation between green consumption behaviors and PESI. And, lastly, serving as a direct exemplification from Poland, a study by

Grębosz-Krawczyk et al. [11] found that pro-environmental self-identity positively impacts the likelihood of using photovoltaic panels. These research findings indicate that the relationship between PESI and GEPI is fully mediated by social values and partially by emotional values. However, the mediating role of functional values was not supported. These results highlight the significance of intangible social and emotional values in shaping consumer behavior toward green energy.

2.3. Consumer Innovativeness

Because the lifespan of the current methods of generating renewable energy, projected to last 25 years at best, loses out to the potential of a nuclear alternative, and, in the wake of the negative landscape externalities, which forced Germany to halt their energy transition at some point between 2017 and 2019 [55], there is an imperative need to *innovate* new solutions. Indeed, innovativeness—or, in other words, openness to new products and how it varies across markets—is the cognitive crux in the diffusion process. Despite the lack of a universally accepted definition, the preceding sentence denotes the initial conceptualization by Midgley and Dowling [56], underscoring the meaning of innovativeness as "a function of dimensions of the human personality". In this perspective, having its roots embedded in trait theory, consumer innovativeness is a result of different traits, which is closer to some basic expressions of human behaviour. Staying on the theme of inherent cognitive processes, Grewal and colleagues [57] emphasise the role of social identity in a person's receptiveness to new products. Specifically, when the operationalised imaginative perception agrees with the subject's social identity, he is more inclined to embrace innovation, given the attitudes' role in nurturing a socially acceptable image [58]. Therefore, the take-off of a new product is contingent upon social processes, of which narratives convey a communicated experience with the innovation inside a system. Moreover, the definitions consistent with Hirschman's [59] view of seeking out new stimuli characterise consumer innovativeness as bringing "products" (hereby, an equivocal term) unbeknownst to a certain system, hence a domain-specific behaviour [57]. In essence, the domain-specific factor of customer innovativeness revolves around the relationship between new product adoption and a behavioural construct, thereby fitting the frames of the present study.

Had it not been for the consumer innovativeness, each purchasing behaviour would be a set of routinized responses to the same product categories [60]. That is why the construct of CI has been researched extensively in marketing and other fields. As regards the latter, the literature addresses two approaches to measuring innovativeness: the ownership of a new product or cross-sectional technique [56]. Tellis et al. [61], in turn, categorised the investigation of consumer innovativeness into three research themes: "measurement of innovativeness", "relationship between CI and new product adoption", and "antecedents of innovativeness". Nonetheless, the literature has not yet provided an explicit answer to whether or not this multidimensional construct affects the likelihood of adopting new green energy sources. Our review found that "consumer innovativeness" has been the central topic of research concerning green purchasing intention, namely the adoption of eco-innovative products, such as electric vehicles (EVs) [62], shared e-bikes and e-scooters [63], vacuum cleaners and innovative smartphones [64]. The evidence is equivocal in terms of the impact of the construct on curtailment and conservation behaviour. For instance, Paparoidamis and Tran [64] demonstrated that CI affects adoption intentions via formulating consumer perceptions of product eco-friendliness, whereas Park and Lee [65] revealed a marginal role in green product purchasing decisions. More research is needed to understand the effect of innovativeness on the receptiveness for green energy sources.

2.4. Economic Attitude

Green transformation is related to enormous economic challenges, encompassing not only the expenditures, investments, and funding operated by the governments on a macro scale but also individual costs incurred for the conversion to renewable forms of energy on a micro scale. The way individuals perceive such technologies reflects their economic

attitudes. As such, "economic attitudes" were defined by Walstad [66] as "noncognitive behaviour in the economics domain". Interpreting the construct through the lens of social psychology is congruent with the underlying theories on attitudes, thus emphasising the evaluative judgments about the subject matter [67]. Attitudes as a psychological construct are delineated as ideas charged with emotions [68], serving as inclinations that guide a behavioural response with some degree of favour or disfavour [69]. It is precisely the evaluative dimension that not only reflects the ambiguous nature of the concept but also highlights the individual's past experience, as captured in Fazio's [70] depiction as "an association in memory". Attitudes are, therefore, psychological tendencies that are crucial in understanding human thought and behaviour, and these, in turn, can be "cognitive" (perceptual reactions to the subject matter), "affective" (feelings towards the object) and "behavioural" (expression of intention) [66]. By providing information on what a subject thinks, feels and how he reacts to the stimulus object under evaluation, attitudes could serve as a promising predictor of consumer behaviour [71].

Based on the evidence from Soper and Walstad [72] and Zabalena et al. [73], the construct of economic attitudes per se, due to the conceptual difficulties in measuring and operationalizing in a measurement instrument, has been regarded as unworthy of the same scholarly focus as "cognition" and, hence, has received relatively scarce attention. In essence, it was Soper and Walstad [72] who acknowledged that these methodological constraints have hindered the development of a robust instrument; as a result, many of the present techniques for measuring economic attitudes seem to be ad hoc locally devised. One such example that fits the context of our study includes the results of Croatian research by Erceg et al. [74], wherein moral dispositions were found to be predictors of economic attitudes. In other words, individuals prone to altruistic behaviour are more inclined to embrace a positive attitude towards government intervention in the economy [74], e.g., the enactment of Green New Deal policies. Moreover, the findings from the literature review conducted by Zabalena et al. [73] unveiled that modern studies have centred around the idea of "money attitudes" or the evaluative stances towards money-related themes, like "saving", "debt", and "investment", indicative of entrepreneurial behaviour. In this context, it is worth mentioning the WTP (willingness to pay)—a hypothetical construct that has been residing in the field of renewable green energy sources. As can be inferred from recent studies, like Soon and Ahmad's [75] meta-analysis on WTP, the construct may relate more to the conative nature of attitudes than to "economic attitudes". A linear regression analysis made by Hojnik et al. [76] failed to show a statistically significant effect of "consumers' environmental concerns", "environmental concern", "consumers' commitment" and "perceived risk" on an individual's willingness to pay for green energy. Not surprisingly, the respondents' income was found to influence WTP. Consumers having an income of more than EUR 2000 a month showed the highest willingness to pay the costs of the energy transformation, while those earning less than EUR 500 had the lowest levels [76], which invokes the findings of Phillips et al. [77], who remarked that expenditures may hamper the embracement of green policies, even when these values are pertinent to self-identity.

Kesari et al. [24] found that financial incentives linked to policy initiatives significantly motivate consumers to install solar energy systems, particularly given the relatively high costs of photovoltaic panels. Additionally, the influence of laws, regulations, and policies on consumer decisions regarding the adoption of photovoltaic technology is noteworthy.

Nevertheless, in central-eastern European countries (e.g., Poland, Lithuania), the social pressure of the psychological environment has been identified to positively influence the WTP, since environmental concerns alone do not prompt such an action [78]. Hence, family relationships, group memberships, in sum, every human interaction within a social sphere may positively influence an individual to utilise green energy sources.

Therefore, we propose the following hypotheses:

H1. *Pro-environmental self-identity (PESI) has a positive impact on consumers' behaviour toward green energy sources.*

H2. *Consumer innovativeness has a positive impact on consumers' behaviour toward green energy sources.*

H3. *Economic attitude has a positive impact on consumers' behaviour toward green energy sources.*

Taking together all described factors with the consumers' behaviour toward green energy sources, we built a conceptual model, which is presented in Figure 1.

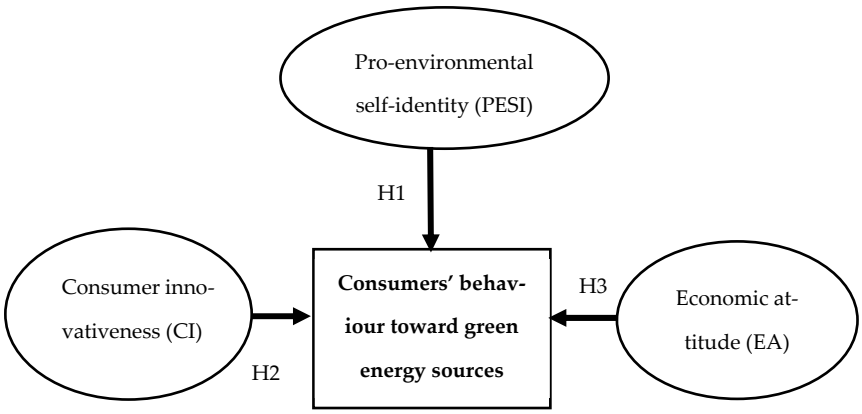


Figure 1. Conceptual model.

3. Materials and Methods

3.1. Sample and Data Collection

The survey was conducted in June 2024 on a sample of Polish consumers using a self-administered questionnaire. A random selection was applied [79]. The respondents were chosen based on a database offered by a data collection and market research company. The company owns the access to 4,000,000 consumers in 19 European countries.

In the first stage, we randomly selected 20 potential respondents to conduct a pre-test. Respondents evaluated the survey for content and relevance, providing feedback calling for minor adjustments in order to enhance the questionnaire's readability and clarity. In the second stage, a sample of 1000 consumers was taken from a database of over 40 thousand consumers over 18 years old. This resulted in a final sample size of 580 consumers, representing a response rate of 58%, which is acceptable for this type of survey [80]. To minimize biases, the respondents were randomly approached at various times and on different days [81]. While the sample used in this study is not representative of the Polish population, it is still quite large compared to similar studies in the field covering the Polish population (37.7 million), enhancing the reliability of the findings and strengthening the validity of the observed trends. We excluded people under the age of 18 due to legal, ethical and practical reasons. Children and young people under the age of 18 are a particularly vulnerable group when it comes to the processing of their personal data. Therefore, our research focused on adults who voluntarily consented to participate in this study and better understand the consequences of their choices.

The main characteristics of respondents are presented in Table 1.

This study included 304 women and 276 men. The largest age groups were "35–44", "25–34" and "55+". The majority lived in cities with a population between 150,000 and 500,000, as well as in cities with more than 500,000 residents. To sum up, most of the respondents were females from 35 to 44 years old with secondary education as well as consumers living in a city of over 500,000 residents.

Table 1. Sample characteristics.

Demographic Characteristics	N	%
Gender:		
female	304	52.4
male	276	47.6
Age:		
18–24	33	5.7
25–34	115	19.8
35–44	136	23.4
45–54	92	15.9
55–64	102	17.6
65+	102	17.6
Education:		
primary	31	5.3
secondary	342	59.0
higher	207	35.7
Place of residence:		
rural area	12	2.1
city up to 50,000 residents	13	2.2
city from 50,000 up to 150,000 residents	111	19.1
city from 150,000 up to 500,000 residents	244	42.1
city over 500,000 residents	200	34.5

3.2. Measures

The questionnaire consisted of 17 questions, including three construct variables under measure (Appendix A). Firstly, a question was asked related to consumer behaviour toward green energy sources. Respondents could choose one from three possible answers, such as: (1) "Yes, I use it"; (2) "Yes, I plan to use them in the next 4 years"; (3) "No". We explained to respondents what types of green energy sources exist on the local market.

Next, we selected 4 items measuring the pro-environmental self-identity (PESI), 4 items measuring the consumer innovativeness (CI), and 4 items measuring the consumer economic attitude (EA). We used a five-point Likert scale, where 1 = strongly disagree and 5 = strongly agree. The Likert scale was chosen because of its advantages of enabling questioning while minimizing systematic errors [82]. An initial list of measurement items was developed on the basis of literature review surrounding the themes of pro-environmental self-identity, consumer innovativeness, and consumer economic attitude. Consequently, items pertinent to the topic and market specifics were created. During the questionnaire development, various studies on green consumer attitudes and behaviour were taken into account in this study. The items created by Huang and Cheng [83], Gręposz-Krawczyk et al. [11], Barbarossa and Pelsmacker Soutar [84], Dermody et al. [40], Whitmarsh and O'Neill, [50], Chan [85], Mohd and Mohd [86], as well as Sangroya and Nayak [21] were selected. Having considered the specificity of green energy market, the selected items were then modified.

At the end, the demographic characteristics of respondents, such as gender, age, education level, and place of residence, were collected. These characteristics were measured using a multiple-choice response scale.

To conduct various statistical tests, we employed two statistical packages: Statistica 13 and IBM SPSS Amos 26. These tools allowed us to input data in the numerical form and conduct statistical analyses, streamlining and speeding up the process of generating research results. Furthermore, Amos proved particularly helpful for visualizing the structural equation models. The mathematical formulas used in the structural models were based on the assumptions presented by Brown [87], Harrington [88] and Gatignon [89].

4. Research Results

4.1. Scale Validation and Reliability Analysis

To assess the validity of measurements, we conducted a confirmatory factor analysis using maximum likelihood estimation. CFA was applied to test whether the measures are consistent with our understanding of the construct's nature and whether the data fit a hypothesized measurement model [90,91]. We assessed scale-convergent validity using the calculation of the standardized loadings. All standardized loadings are greater than 0.5. Table 2 presents the results of convergent validity expressed through factor loadings.

Table 2. Factor loadings.

	CB	CI	EA	PESI
CB	1.000			
CI1		0.931		
CI2		0.871		
CI3		0.805		
CI4		0.921		
EA1			0.788	
EA2			0.725	
EA3			0.745	
EA4			0.765	
PESI1				0.553
PESI2				0.700
PESI3				0.735
PESI4				0.625

Summing up, the CFA supported our measurement model and showed that economic attitude, consumer innovativeness, pro-environmental self-identity, and consumers' behaviours towards green energy sources are four distinct constructs.

Convergent validity was assessed using the Average Variance Extracted (AVE). AVE is higher than 0.5 for each construct, except PESI (0.432), but according to Hair et al. [92], it is acceptable for new constructs or constructs tested in new conditions. Reliability analysis was conducted by calculating Cronbach's α (standardized and unstandardized), as well as Composite Reliability (CR). The results show good consistency for Cronbach's α and Composite Reliability exceeding the threshold value of 0.7. Table 3 presents the results of convergent validity expressed through AVE as well as reliability assessed by Cronbach's α and Composite Reliability.

Table 3. Convergent validity and reliability of variables.

	Cronbach's α (Standardized)	Cronbach's α (Unstandardized)	Composite Reliability (CR)	Average Variance Extracted (AVE)
CB	1.000	1.000	1.000	1.000
CI	0.933	0.933	0.934	0.780
EA	0.842	0.841	0.842	0.572
PESI	0.748	0.747	0.750	0.432

All statistics (factor loadings, AVE, Cronbach's alpha, Composite Reliability) are at an acceptable level. Therefore, good internal consistency among the items was confirmed.

The square roots of AVE for a particular variable verified the discriminant validity of the scale [93] (Table 4).

Table 4. The Fornell–Larcker criterion.

	CB	CI	EA	PESI
CB	**1.000**			
CI	0.104 *	**0.883**		
EA	−0.055	0.177 **	**0.756**	
PESI	0.189 **	0.040	−0.037	**0.657**

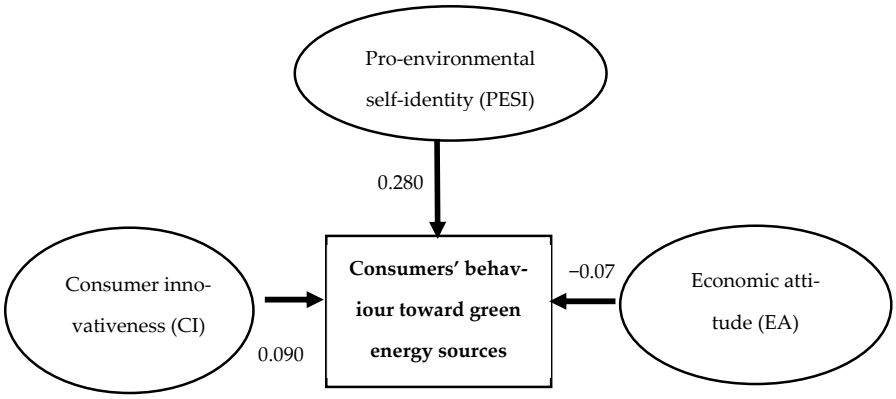
Note: the diagonal values (in bold) present the square roots of AVE. * Correlation is significant at the level of 0.05 (2-tailed). ** Correlation is significant at the level of 0.01 (2-tailed).

4.2. The Structural Equation Model and Hypothesis Testing

We employed structural equation modeling (SEM) with maximum likelihood (ML) estimation and used the covariance matrix as the data input to test our conceptual model and hypotheses. The ML estimation method is commonly recommended and appropriate for theory testing and development [91]. SEM was instrumental in identifying the causal relationships among the variables. The standardized residuals were below 0.05, indicating a strong model fit. Similarly, the statistics of the model (i.e., $\chi 2/df = 2.318$; RMSEA = 0.048; GFI = 0.966; CFI = 0.978; TLI = 0.971) prove its good fit [93]. The hypotheses were assessed by examining the standardized beta (β) values, t-values, and their respective significance levels. The outcomes of the structural equation modeling are detailed in Table 5 and illustrated in Figure 2.

Table 5. Results of structural equation modelling.

	β	SE	t Values	*p* Values	Path Coefficients (Standardized)
CI -> CB	0.090	0.035	2.556	0.011	0.108
EA -> CB	−0.079	0.052	1.509	0.132	−0.068
PESI -> CB	0.280	0.074	3.790	0.000	0.183



Evaluation of the SEM model		
χ2/df	2.318	max. 5.00
RMSEA	0.048	max. 0.10
GFI	0.966	<0.90;1.00>
CFI	0.978	<0.90;1.00>
TLI	0.971	<0.90;1.00>

Figure 2. SEM model.

In the typical CFA, observed variables are defined as linear functions of the latent variables. An observed variable x is formalized as [87]:

$$x = \lambda\xi + \delta x, \quad (1)$$

where

- λ refers to factor loadings;
- ξ refers to underlying factors;
- δx refers to measurement error of x.

Out of the three hypotheses formulated, two were supported by the data. Hypothesis H1 considering a positive impact of pro-environmental self-identity (PESI) on consumers' behaviour toward green energy sources was confirmed, and hypothesis H2 considering a positive impact of consumer innovativeness on consumers' behaviour toward green energy sources was also confirmed. From these two variables, the pro-environmental self-identity (PESI) had a greater impact.

Hypothesis H3 was not confirmed. The impact of economic attitude was not statistically significant ($p > 0.05$). Moreover, its impact was negative.

When considering the control variables—respondents' gender, level of education, and the place of residence—additional relationships emerged:

- Younger people statistically more often declare the use of green energy sources ($\beta = -0.094$; $t = 4.403$; $p < 0.05$);
- People with higher education statistically more often declare the use of green energy sources ($\beta = 0.121$; $t = 2.053$; $p < 0.05$);
- Gender and place of residence do not have a statistically significant impact on consumers' behaviour toward green energy sources.

5. Discussion

The focus of our study was to investigate whether sustainable lifestyle (PESI), consumer innovativeness, and economic attitudes instigate the behavioural response towards renewable energy sources, and we believe this has, by and large, been achieved, with two out of three hypotheses confirmed. The research has, thus far, utilised ANOVA, SEM, and a simple mediation model to assess the mediation effect of the constructs under measure. Standard statistical approaches may provide the findings the researcher wants to obtain; however, guaranteeing the validity of the input, such as the reliability of the collected responses to the questionnaire instrument, may not always be that indicative. We decided to use structural equation modelling, which represents a second-generation technique, to test our hypothesised model, using data from a nationally representative survey of the Polish population.

In addition to PESI, the results affirm other studies, finding that pro-environmental self-identity has a positive impact on the propensity to adopt green energy sources. In other words, the more environmentally friendly the depiction of one's imagined perception is, the stronger he is motivated to behave eco-ethically. Installing photovoltaic panels and heat pumps in Poland [37] indicates a type of curtailment and energy conservation behaviour, referring to the studies by Whitmarsh et al. [28] and Dermedy et al. [40]. The way in which solar panels may potentially secure national electricity supply, feeding excess electricity back into the grid, invokes collaborative consumption, for which PESI was also identified as an antecedent [52]. At this juncture, our results showed a confirmatory effect. Contrary to Lim et al. [53], we demonstrated that pro-environmental self-identity alone may explain consumer behaviour, especially in terms of renewable energy adoption.

As mentioned above, consumer innovativeness has not been studied extensively in the green energies domain. Instead, most studies have focused on purchasing behaviour related to the still-growing range of eco products. Our study adds to this stream of research by addressing the adoption of renewable energies. For example, Park and Lee [65] found no effect of consumer innovativeness on their decisions to purchase. Our results say something

different; the construct had a statistically significant path coefficient towards green energy sources, which suggests that Polish people are predisposed to new-product adoption in the sphere of sustainable energies. This finding suggests that initiatives promoting green technologies in Poland could benefit from highlighting the innovative aspects of these products. In addition, Paparoidamis and Tran [64] revealed that stronger innovativeness enhanced consumers' intention to adopt eco-innovation. Since the authors admitted that the ECI construct focuses on the overall tendency to adopt green products in particular, their results indirectly implied what our results could be. As predicted, the results confirmed the predictive validity of consumer innovations on the propensity to embrace new green energy technologies in Poland.

Because economic attitudes were already shown in previous studies to pose difficulties in designing a reliable measurement instrument, and due to the domain specificity of the construct itself, the SEM results concerning our third hypothesis are, therefore, not surprising. Hence, the money-related evaluations of green energy sources are not considered in this section. Although this finding is provocative, it raises additional research issues. Given the insignificant and negative path coefficient, additional research is needed to comprehend the concept. Future work needs to be directed at facilitating the operationalisation of economic attitudes to convey their tortuous structure. Another possible explanation might be that it is in the country's unhealthy fiscal situation that people evade energy conversion. Only in the last two years, the prices rose in Poland, making people vulnerable to the effects of inflation. Considering these challenges, further refinement of the measurement technique could provide a more meaningful insight into the consumption of renewable sources, ultimately aiding in the transition to sustainable energy systems.

Our study showed that younger people statistically more often declare the use of green energy sources. Growing up in a digital age, young consumers are typically more open to experimenting with new technologies. Young people are often also more educated about climate change and sustainability, which drives their interest in innovative green technologies. Their awareness fosters a willingness to adopt new products (such as smart home systems or renewable energy solutions like solar panels) that contribute to environmental sustainability. A similar situation was observed in the case of people with higher education who statistically more often declare the use of green energy sources. This is consistent with the results of other authors [11,94–97]. The awareness of consumers with higher education increases their willingness to adopt new energy sources that contribute to environmental sustainability. By choosing green energy sources, they align with their identity as environmentally conscious individuals, which can drive them to seek out and support innovative solutions.

6. Conclusions

Green energy sources play a crucial role in mitigating environmental impacts and reducing dependence on energy imports. Rising concerns about climate change, coupled with policies promoting green energy development, have significantly shaped consumer attitudes and behaviours. This study's aim was to address a knowledge gap by examining the impact of a sustainable lifestyle, consumer innovativeness, and economic attitudes on the intention to adopt green energy sources.

Conducted through an online survey of 580 Polish consumers, the research employed structural equation modelling, revealing that pro-environmental self-identity (PESI) and consumer innovativeness positively influence consumer behaviour toward green energy sources. Notably, PESI emerged as the most significant determinant in shaping consumers' positive behaviour in this context.

From a theoretical perspective, this research enhances the understanding of pro-environmental self-identity (PESI) and its relationship with consumer innovativeness while also providing insights into consumer behaviour toward green energy sources, drawing on evidence from the Polish market. These findings can be extended to other countries, particularly within the European Union, by providing a framework for examining

how ecological, innovative, and economic factors influence consumer attitudes toward renewable green energy sources. The research results also provide a better understanding of consumers' behaviours towards green energy sources and, consequently, the development possibilities in the green energy sector in Europe.

This study serves not only as a foundation for further scientific discussion but also offers practical implications for managers in the green energy industry and policymakers.

Policymakers and public institutions from Poland and other regions can use these conclusions to tailor strategies that resonate with the unique preferences and motivations of their inhabitants, promoting the adoption of green energy solutions more effectively. It allows policymakers to craft messages by highlighting environmental benefits. Public institutions should recognize that citizens prioritize environmental and technological values over functional benefits and, thus, should implement legal frameworks that support the growth of green local communities. Our research results can guide the creation of supportive policies by providing evidence on how different factors influence the public's perception of renewable energy sources. For instance, recognizing that a lack of information often leads to misconceptions, policymakers can organize educational campaigns and informative actions to raise awareness about the benefits of renewable energy. These initiatives can help foster pro-environmental self-identity among consumers, encouraging them to see themselves as active participants in the transition to sustainable energy. Additionally, promoting consumer innovativeness can be achieved by providing resources and support for adopting new technologies. Policymakers can also design frameworks that lower barriers to entry, streamline approval processes for renewable energy installations, or impose stricter emissions standards that increase the attractiveness of green energy alternatives.

In terms of managerial implications, this study offers valuable insights for marketers, in shaping their strategies, especially marketing communication efforts to promote the adoption of green energy sources and implement their solutions. Understanding consumers' green behaviors through the lens of environmental and innovative values carries significant implications. For companies in the green energy sector, these findings can inform the development of marketing strategies. Marketers should appeal to consumers' sense of social responsibility and their innovativeness curiosity.

These conclusions were drawn while acknowledging this study's limitations. The research focused solely on Polish consumers, with a relatively small sample size. Despite the representativeness limitations, this sample still offers valuable insights. We excluded consumers under the age of 18, mainly for legal, ethical, and practical reasons. When surveys exclude people under 18, it leads to gaps in market research that can limit understanding of consumer trends and emerging preferences. Including younger audiences who will make decisions about energy consumption in the future, with appropriate ethical safeguards, can provide richer, more comprehensive insights into the subject. The income and occupation of respondents were not analysed in this study due to the personal nature of these factors and the fact that respondents were very reluctant to answer these questions or even decide not to participate in the study. We suggest the introduction of additional factors, like geographic location and the accessibility of government incentives in future studies, to provide a more nuanced understanding of the variables that impact green energy adoption. Therefore, this study opens possibilities for further exploration into the influence of PESI and consumer innovativeness on green energy purchase intentions. Future research could benefit from international comparisons, examining attitudes of Polish consumers alongside those from other countries.

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Appendix A. Key Constructs and Items

Pro-environmental self-identity (PESI)

PESI1 Using green energy sources, I help to reduce environment pollution
PESI2 I am willing to commit myself to environmental protection
PESI3 I am convinced that my personal responsibility for the problems in the environment is important
PESI4 I am convince that my moral obligation to help the environment is important

Consumer innovativeness (CI)

CI1 If I heard that green energy sources were available in my area, I would be interested enough to trial them
CI2 Compared to my friends, I seek out a lot of information about green energy sources
CI3 Green energy sources arouse my curiosity due to their modern nature
CI4 Green energy sources are/can be a source of new experiences in energy use

Economical attitude (EA)

EA1 The green energy sources are reasonably priced
EA2 Using green energy sources offers value for money
EA3 Using green energy sources offers future savings
EA4 The incentive programs provided by the government to promote green energy sources are attractive to me

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