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# A Survey of Renewable Energy, Climate Change, and Policy Awareness in Israel: The Long Path for Citizen Participation in the National Renewable Energy Transition

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**Abstract:** The social acceptance of energy policies and renewable energy technologies is crucial in the era of the renewable energy transition. Yet, little is known about Israel's transition in this regard. One thousand five hundred Israeli citizens were engaged through a survey to examine their perceptions of climate change and awareness regarding renewable energy technologies and national energy policy. Individual-level factors such as gender, age, and education were included in the survey to assess their possible influence on replies. The main findings were the following: (i) climate change impact is not felt as an immediate threat by the majority, and there is (ii) a lack of accurate knowledge about renewable energies; (iii) a lack of awareness regarding national energy and climate policy; and (iv) a lack of trust in citizens' role in energy decision making. These findings are evaluated as a barrier to public engagement within the renewable energy development process in Israel.

**Keywords:** renewable energy transition; public engagement; public acceptance; social sustainability; energy policy



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## 1. Introduction

The renewable energy transition involves a vast array of changes across energy systems. Technically, it targets a reduction in greenhouse gas emissions by phasing out fossil fuels, increasing the share of renewable energies (REs), and electrifying transportation. However, it is well acknowledged that merely focusing on technological solutions can limit a comprehensive understanding of the complex challenge of implementing energy system shift [1].

Energy systems are socio-technical systems where technical and non-technical elements and their nexus determine the systems' functionality. Technology is strictly linked to institutions, knowledge, norms, thinking, and social practices in socio-technical systems. In this respect, the renewable energy transition corresponds to social change processes which are directly and indirectly connected to energy [2]. Indeed, successful transformations depend on changing energy sources and re-establishing social, economic, and political arrangements.

Achieving wide-scale changes requires the substantial and active contribution of people in adopting renewable energy technologies and sources; moreover, it implicates their financial involvement and changes in their users' behavior [3]. The renewable energy transition implies the appropriate accounting of people's preferences and requests, overall acceptance of policies, local acceptance of renewable energies and energy efficiency, and balancing economic and social expectations. Although people generally acknowledge the urgency of cutting greenhouse emissions and accept options for increasing the renewable

energy share in electricity generation [4], experience has shown how implementing new energy infrastructure often faces rejection and resistance from the public, materializing as a social barrier to sustainable technology proliferation [5]. Social acceptance and participation of the public should not be taken for granted, and public resistance to policies exists and persists, often presenting climate and energy goals as unacceptable to the public, as shown by the case of the yellow vests [6]. For a policy to be effective, it needs to be economically, technologically feasible, and socially acceptable [7].

In this regard, public engagement has plenty of potential to enhance social acceptance of climate and energy policies and thus enable renewable energy transition [8].

Public participation practices consciously engage an extensive part of the public in political and economic decision making and behavioral changes. Different forms of direct public participation exist, encompassing (i) representative democracy as nominated groups represent the public interest, (ii) social movements as groups personifying societal imageries, ideals, values, and structuring public resistance, (iii) active citizens generating their own energy and managing its production and use, as we see in community energy initiatives [9]. In particular, social mobilizations have been determinant over the past decade; their collective actions have impacted public opinion, reinforcing climate change objectives and putting national governments under pressure to move away from fossil fuels [10].

Currently, we see an increasing urge to organize public participation and innovate decision making and governance within the energy system. Besides technological and economic aspects, the people themselves should be accounted for in enabling the renewable energy transition. Subsequently, the population must be surveyed to empirically evaluate how renewable energy development and policy are perceived and experienced, and citizens' preferences and values must be appraised.

There is a need among renewable energy transition scientists to systematically collect data on population perception and evaluation of renewable energy transition worldwide and monitor changes and trends over time [7].

This research wants to contribute to filling that void by focusing on the specific case of Israel. So far, only limited data have been made available on the public's perception of the Middle East region over renewable energy, renewable energy transition, and climate policy, and the case of Israel seems little studied [11].

There is a need to understand better which factors influence climate mitigation actions and the principal factors that enable or inhibit public participation and behavioral changes. However, not only individual motivations need to be considered, but also social and contextual factors.

## 2. Background

### *2.1. The Energy Landscape in Israel*

Due to its geopolitical positioning, Israel cannot connect its electricity system to the grids of neighboring countries. Therefore, Israel is defined as an "electricity island" [12–14].

Israel's total final energy consumption reached 15.02 million tons of oil equivalent (toe) in 2020 [15]. Natural gas has become more predominant in the Israeli primary energy mix, representing 38.7% of the total final energy consumption in 2020. In addition, Israel uses coal and other fossil fuels (approximately 56%). Renewable energy represents 5.2% of the energy mix. Following the introduction of natural gas and renewables into the Israeli energy mix, the share of oil and coal declined.

Between 2013 and 2020, Israel's final energy consumption increased by 8%. This resulted from a few trends: (1) the consumption of oil distillates and electricity products has increased gradually, in line with the increase in population (which increased by 14% during the same period) [16]; (2) the relatively high growth in natural gas consumption (approximately 62%) [15]. Due to the rising share of industrial plants connected to the natural gas system as an alternative for oil distillates, (3) most of the renewable energy

consumption is derived from solar–thermal heating water systems. In addition, refuse-derived fuel (RDF) consumption increased by 405%, which has impacted the general trend.

Electricity demand has grown during the last decade by about 3% per annum, reaching 67 TWh in 2020 [17]. According to the Bank of Israel [18], the electricity demand is expected to increase by 2.7% per annum. In 2021, the electricity demand increased by 1.9% compared to 2020, reaching 68.4 TWh. The household sector represents 31% of the demand, followed by the commercial industry with 25% and the industrial sector with 21%. As a result of the high share of fossil fuels in the fuel mix, the electricity sector remains the largest source of carbon dioxide equivalent (CO2e) emissions, accounting for 55% of total greenhouse gas emissions in 2015 [19]. In 2020, approximately 23% of the total electricity generated in Israel was from coal, down from 59% in 2010. A total of 67% came from natural gas, up from 39% in 2010, and an additional 5% was generated from renewables. However, from 2010 to 2018, emissions from power production declined due to the increase in natural-gas-based electricity generation and, to a lesser extent, renewables [20].

In 2020, the share of renewable energy consumption in Israel's final energy consumption amounted to 2.7% [15]. By the end of 2020, the Israeli energy sector's total capacity for renewable energy factored to around 2.5 gigawatts generated by solar energy, constituting more than 95% of the renewable energy capacity. According to the Israeli Electricity Authority [17], at the end of 2020, the share of renewable energy in the electricity generation fuel mix amounted to 8.5%. Hence, the 2.5 gigawatts produced by renewable energy fell short of the 10% target, and Israel did not achieve its 2020 objective.

### 2.2. Energy Policy in Israel

The Israeli Electric Corporation (IEC) implemented substantial structural changes in 2018. As part of the structural change, the electricity supply will be competitive, with production being privatized and a new government company, system administrator, will be established. In addition, as part of the privatization, six power plants formerly owned by IEC will be purchased by private producers in the coming years [20].

At the end of 2018, the Israeli Parliament's (the Knesset) Construction and Regulations Subcommittee approved the Planning and Building Regulations update (Building Design) regarding hot water supply in residential buildings. These regulations require the installation of efficient water heating systems in all new buildings, including high-rise residential buildings. This update replaces the old regulation, which required solar–thermal water heating for only the top seven floors [21].

The Israeli government approved Government Resolution No. 465 in 2020. This raised the target for 2030 from 17% to 30% and set an interim goal of 20% for 2025. However, this was met with objection from the Ministry of Environmental Protection, claiming that this target needed to be more ambitious. Therefore, the Ministry of Environmental Protection suggested a minimum target of 40% renewable electricity generation by 2030 should be set [22].

In the same year, the Green Building Standard (TI 5281) and the Planning and Building Regulation (Sustainable Buildings) were published, requiring all new construction in Israel to meet at least the first level of the Israeli Green Building Standard [23]. Furthermore, as per Government Decision 171 (2021), Israel will determine targets for zero-energy construction in new buildings by mid-2022 [24].

Israel submitted its updated Nationally Determined Contribution (NDC) in 2021, which included an unconditional economy-wide emission reduction target of 27% relative to 2015 levels by 2030 (58 metric tons of carbon dioxide equivalent—MTCO2e) and 85% to 2015 levels by 2050 (12 MTCO2e). The new targets were approved by government decision number 171 [24]. As part of this decision, emission reduction targets were also set for the power generation sector: a 30% reduction relative to 2015 by 2030 and an 85% reduction relative to 2015 by 2050.

Furthermore, later the same year, Israel published an updated National Action Plan on Climate Change (2022–2026) [25]. The implementation plan includes 100 economy-wide

and sectorial measures regarding mitigation, adaptation, finance, investment, and reporting. This plan consists of some main steps in the energy sector. The first is to phase out coal-fired power generation completely by 2026. The second is to increase renewable-based electricity generation, with a focus on dual use. The third focuses on the distribution of sustainable Energy Grants. The budget includes a total of EUR 127 million for 2022 to 2026, of which EUR 99 million shall be allocated to the industry and EUR 28 million to the business sector and local authorities. In addition, the government has drafted a budget of EUR 41 million from 2022 to 2024 for promoting renewable energy and climate change adaptation across local authorities. The final step is to promote the construction and implementation of green and net zero energy buildings.

A tariff regulation has established a size-based tariff system for solar PV systems up to 630 KW for different uses, such as building rooftops, water reservoirs, parking lots, cemeteries, etc., from 2021. The regulation sets a higher tariff for small-scale PV: 0.14 euro/kWh for 0–15 kW, 0.12 euro/kWh for 16–100 kW, and 0.05 euro/kWh for 101–630 kW. Above 630 KW, the Electricity authority publishes competitive tenders and quotas [26].

The Electricity Authority published a decision regulating the operation of distributed production facilities, particularly solar and storage facilities, in the autumn of 2022. According to the published regulation, producers who establish decentralized production and storage facilities can sell electricity to consumers through private suppliers or to the system administrator [27]. In this way, the suppliers will be able to offer consumers different packages based on the means of production from which they purchase the electricity, for example, packages that guarantee the purchase of renewable energies at one rate or another. Similarly, a consumer who integrates production facilities and/or storage facilities at their place of consumption will be able to contract with a supplier who will sell on the excess electricity produced at the place of consumption and, on the other hand, purchase the electricity for the consumer during hours when the energy produced at the location of consumption does not satisfy all the consumption requirements. This is expected to start in 2023.

## 3. Methodology and Data

One thousand five hundred people participated in an online survey that aimed to assess public awareness and perceptions regarding climate change, renewable energy technologies, and national energy policy in Israel. We prepared twenty-six questions, including closed-ended questions (Yes/No) and multiple choice options. The questions were designed in alignment with a previous work [28] and through the support of the REs literature on public awareness and perceptions [29–32].

All the questions were translated from English to Hebrew. Before conducting the survey, we established the method and the criteria for sampling. The sample includes only Israeli citizens currently living in Israel and 18 years older. The sample includes an equal number of women and men. A private company conducted the online survey by contacting (according to established criteria) participants listed in a database.

After the data collection, the results were summarized and analyzed.

## 4. Results

The online surveys involved one thousand five hundred respondents. The socio-demographic and economic factors show that based on gender, fifty percent of respondents were female, and fifty percent were male. The share of the respondents by geography was the following: 35% were from the Gush Dan region (the area with the highest population density in Israel); 25% were from the northern part, 19% were from the south of Israel, 11% were from Jerusalem, and 9.5% were from the Hasharon region.

According to the political identity of the respondents, 43% identified themselves as right-wing voters, 13% as leftist voters, and 34% as centrist voters. Around 8 percent did not affiliate themselves with any current political ideology. When asked to provide their highest level of education, almost one-third of respondents extended to a bachelor's degree

(32%), then a high school degree (21%), a professional no-academic certificate (19%), a master degree (14%), without the high school degree (13%), Ph.D. (1%). A total of 1% of respondents declined to answer this question.

Based on income, 42% of the respondents' income falls within the range of EUR 1400–2800 per month, while a significantly high number of respondents said their income is below EUR 1400 per month (23%). Roughly 10% of the respondents said they earn more than EUR 4200 per month.

After the gender and demographic factors, in the second part, the survey mapped the perception of the climate change effect on day-to-day lives. The data show that 44.70% of the respondents perceive climate change impacts their lives; 40.11% predicted it would affect them more in the long term, while 15.19% stated that climate change does not impact their lives (Figure 1). When these data were crossed with the level of education, it was found that most of the "NO" respondents (Figure 1) displayed a non-academic education. Irrelevant differences in education levels were found between the respondents who identify the impact of climate change as a current issue in their lives and those who see it more as a long-term issue. In these two groups, equivalent percentages arose by splitting respondents between academic and non-academic levels of education.

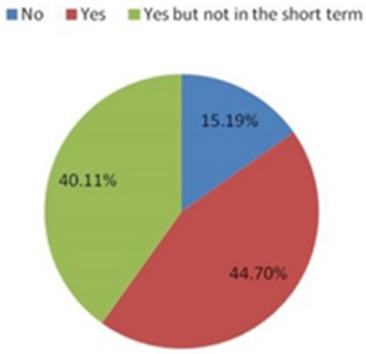


**Figure 1.** Replies to the question, "Does Climate Change Impact Your Life?".

Examining the gender factor of those who replied "YES" (Figure 1), it was found that women (48.53%) sensed their lives as impacted by climate change more than men (40.75%) (Figure 2).

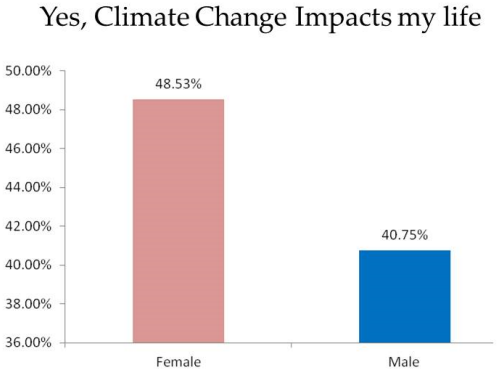


**Figure 2.** Gender (female/male) of the respondents who affirmed, "Yes, climate change impacts my life".

The third part of the survey examined the general knowledge of renewable energy technologies. At first, through a multiple-choice question, it was asked which type of renewable energy respondents knew. As Figure 3 shows, solar energy (88%) was the most known by people, followed by wind (66%), hydro energy (28%), wave energy (25%), heat pumps (14%), and geothermal (12%); meanwhile, biomass was the least known among the proposed options (3%).

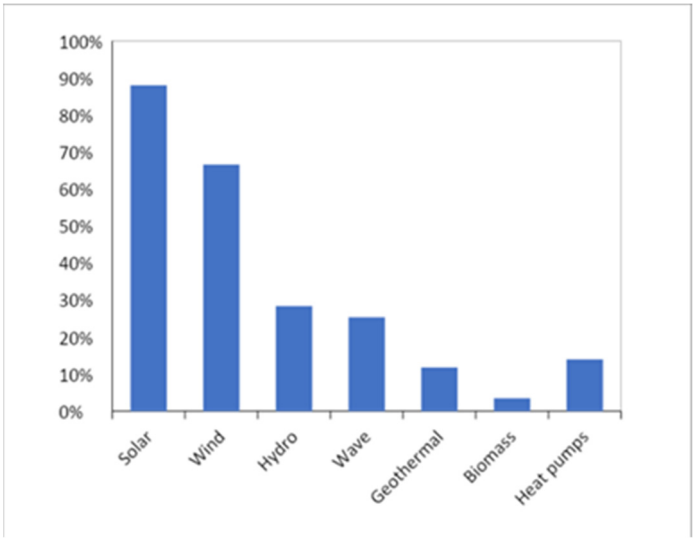


**Figure 3.** Replies to the question, "What type of renewable energy technologies do you know?".

Secondly, it was asked if survey participants had seen or directly experienced renewable energy technologies such as solar and wind systems. Among the respondents, 52.56% had seen solar or wind systems, while the remaining 47.44% had not seen or encountered any (Figure 4). If only respondents with an academic (bachelor or higher) degree are considered here, 55% of them had seen a solar or wind system, while 45% had not. It means that education level did not substantially affect these replies. Moreover, a clear relationship between economic status and these replies was not observable.

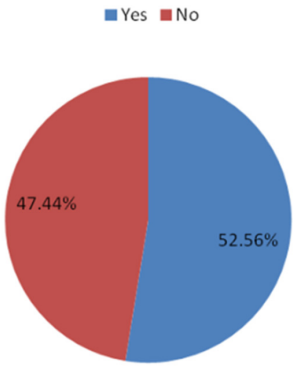


**Figure 4.** Replies to the question, "Did you see a renewable energy technology as a solar or wind installed system?".

Thirdly, the survey participants were asked to self-evaluate their knowledge about the advantages and disadvantages of solar energy. More than half declared themselves aware, and among those, 18.3% defined themself as "very much" informed. In contrast, more than 14% felt uninformed, while 35% of respondents could not elaborate on their awareness of solar energy. These percentages did not change significantly when only respondents with an academic (bachelor or higher) degree were considered.

The fourth part of the survey focused on public knowledge regarding national climate policy, energy policy, and REs regulations. When asked if they were familiar with the country's climate and energy policies, only 14% of the 1500 respondents said "YES". Then, when asked if they knew the regulation and national standards for renewable energy, 90% of the respondents said that they did not know the regulations or standards. Furthermore, when asked about the citizens' impact on the decision making on REs implementation, climate change policies, and climate goals, 65% of the respondents said they did not feel they could influence as citizens those decision-making processes.

In the fifth part of the survey, the questions were centered on the economic dimensions of RE sources from the respondents' perspective. The questions evaluated the public perception of REs affordability, REs economic benefits, and citizens 'willingness to pay for installations.

It was found that 64% of the respondents thought that RE technologies are not expensive, but 68% said they were unwilling to pay extra money to install those systems. Despite this, 88% of the respondents acknowledged the economic benefit of renewables, as they affirmed that REs could reduce energy costs in the future. When asked about household energy spending, 42% of the respondents pay between EUR 90 and 170 for their bi-monthly electricity bill, and about 38% spend more than EUR 170.

The sixth and latest part of the survey investigated the social acceptance of solar and wind installations, focusing on public perception of those systems regarding landscape impact, risks, and safety.

More than 37% of respondents thought neutrally regarding the impact of solar and wind installations on the landscape; a comparable percentage (36.5%) did not consider those systems damaging to the landscape, whereas the rest of the participants (25.9%) said such a negative impact on landscape occurs.

Regarding the perception of safety and risks, the majority of respondents considered producing electricity through the wind and solar systems harmless; however, it is not irrelevant that 10% of respondents felt wind turbines were unsafe, while another 15% were concerned that solar PV panels on their roofs could harm their health (Figure 5). At this point of the survey, respondents were also allowed to express their concerns openly. For the wind turbines, the expressed concerns comprised the environmental damage ("effect on the birds and insects" and "the turbine cannot be recycled") and the risks or negative impact on human health ("turbine may fail"; "turbines are noisy"; and "children may reach the turbines"). In the case of solar PV, the concern was that cancer could be caused by radiation from panels. The respondents who expressed this concern were found to hold high school degrees.

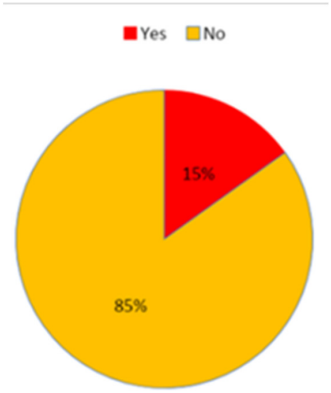


**Figure 5.** Reply to the question, "Do you think that generating electricity from solar panels on the roof of your house is a danger to your health?".

## 5. Discussion

Data from the survey have revealed that the majority recognize the climate change impact, but not all perceive that impact as already existing. As shown, 40.11% of participants predicted climate change would affect them more in the long term. Moreover, around 15% of respondents did not perceive the climate change impact on their lives (Figure 1).

It was examined if those perceptions of climate change impact related somehow to individual factors such as education and gender.

A possible positive effect of education was found when the level of education of respondents who feel the climate change impact (whatever a current or long-term issue) was compared to those who do not feel that. The majority of "NO" respondents to the climate

change impact question (Figure 1) had an overall lower education level (a preponderant non-academic level). In contrast, comparable education levels were found among those who feel the impact of climate change (both as a current and long-term issue). It may suggest that respondents' level of education affects their perception of climate change impact (as YES or NOT reply), but it does not affect their perception of the timescale of climate change impact. Several studies have already shown that education positively affects climate change concerns [33–35]. However, people with higher education are not necessarily more conscious of climate change's impact "in the here and now" [36]; according to our results, the respondents perceived the climate change impact on their lives as proximate or distant unrelated to their education levels. In our case, education does not correlate to the psychological distancing of the impact of climate change [37]. It may occur because the perception of a risk implication is generally based on beliefs, understanding, and levels of emotional engagement that make individuals perceive themselves as less or more at-risk than others [38]. Or, as already discussed by Sun et al. [33] the effects of education on risk perception are minor when people ponder climate change as a personal threat dimension because "normalcy bias" drives people to underestimate the impact of a disaster on themselves.

When the gender factor was analyzed, women appeared slightly more concerned about climate change's impact on their lives than their male counterparts (Figure 2). Previous studies [39,40] have already observed that women communicate a deeper concern about future risks related to climate change than men. We tend to attribute the gender factor to the higher levels of pro-environmental concerns generally displayed by women, following the McCright study [41]. However, gender dynamics associated with climate change perception may be interpreted differently, as the literature shows. Several studies, as in van der Linden [42], stated that females have overall higher risk perceptions than males, which is also reflected in climate change perception. In other studies, as in Davidson and Haan [43], the gender effect is predominantly attributed to politically ideological differences between women and men. The higher risk perception of women is often associated with a higher level of gender inequality in a specific society, as in Norgaard and York [44]. Anti-egalitarian and individualistic worldviews of men are also used to explain the gender difference in risk perception, as in [45]. Discrimination based on gender results in unequal socioeconomic status and marginalization; in the developing world, it increases vulnerability and exposure to climate change [46], which may determine a gender imbalance in the risk perceptions between men and women. However, in developed countries, too, a higher perception of climate change risk is interpreted as a function of privation and distress of women and minorities [47,48]. An opposite trend also emerged in the literature; for example, in the survey conducted by Poortinga et al. [49], across 23 European countries the gender effect on risk perception appeared in nations with higher levels of gender equality.

Regarding the present study, although the gender effect was observed in the perception of climate change impact, the results gave no indication of gender equality in Israel.

The European Social Survey in 2018 [50], spotted that concerns about climate change were relatively low in Israel compared with other countries such as Germany. Considering our survey results, 15.19% of respondents consider climate change to not affect them, so they showed a lower risk perception of personal threat from climate change. We are not certain whether to define them as "climate change skeptics" or not, although previous authors have already proved that higher risk perception is related to lessening climate change skepticism [51].

Even though some are still not convinced by the reality of climate change, the main challenge remains that those who do are not consistently and persistently engaged in climate mitigation actions [4].

Among our respondents, 40.11% see the climate change impact only in the long term (Figure 1); time (or temporal dimension) is a crucial aspect of climate change perception. Although its impact is already evident, climate change extends into the future, and this aspect favors creating a broader psychological distance of climate risks and increases the

human difficulties in responding to climate change issues. A disparity exists between a general concern and substantial commitment to climate change; perceiving climate change as a distant threat represents one of the most significant individual barriers constraining people from engaging entirely with climate change, public participation, and behavioral change [52]. On the other hand, the sense of urgency increases motivation to act [53]. Indeed, how "dangerous" and "urgent" climate change is taken eventually affect mitigation actions [54]. The Eurobarometer survey shows direct examples of this trend across multiple European cases [55]. In Germany, 79% of interviewed people think climate change is "a very serious problem at this moment", and 56% of respondents declared feeling personally responsible for tackling climate change (the EU average is 41%). It translates into personal engagement, as 79% self-declared to have taken action to fight climate change over the past few months. For the Netherlands, the Eurobarometer survey showed that 80% of respondents perceive climate change as a severe problem, and 57% sense tackling climate change as a personal responsibility; it has resulted in 61% of people taking action to combat climate change in the past months. On the other hand, in Latvia, only 59% of Eurobarometer participants think climate change currently represents a severe problem, and only 20% feel personally responsible for tackling climate change, which reflects that only 42% have taken action against climate change.

Due to recent discoveries of natural gas reserves along the Israeli coastline [56], natural gas has become the most popular source of electricity in Israel. However, cumulative solar power capacity in Israel corresponds to around 9% of the national electricity demand in 2019, with 1.72 GW generated from PV power and 0.24 GW from concentrated solar power [57]. According to the results, the highest level of generic knowledge was regarding solar energy, recognized by 88% of survey participants (Figure 3). With no other indications, a possible reason why respondents were most aware of solar energy could be that solar deployment has increased in recent years due to cost reduction. So, as solar technology costs have decreased, their popularity has increased [58]. Probably, it may also be the result of a public campaign (on roof solar panels) launched in Israel in 2019 and rolled out by the Energy Ministry and the Electricity Authority [59]. Other case studies showed that the massive advertisement has influenced the popularity of solar technology among people [60].

Our respondents were less familiar with wind and hydro, while biomass was the least recognized technology (Figure 3), maybe because the term "biomass" is less self-explanatory, as suggested by Baile et al. [61], which observed a similar trend.

Although hydropower is generally less developed in the Middle East region, this form of electricity generation appeared better known in other Middle East countries than in Israel, as an analogous survey study found [30]. The Israeli Public Utilities Authority is developing a pumped storage power plant in the Gilboa mountain (about 120 Km from the North of Tel Aviv) [62]; however, Israel's current electricity generation system has no hydropower resources [63]. The low availability of water surfaces, such as rivers and falling waters, explains Israel's lack of hydropower development. It might also justify, to some extent, why fewer people in Israel are aware of hydro energy, which is among the most important and developed renewable sources worldwide. The results showed that a quarter of respondents know about energy derived from wave sources. It may sound surprising as wave technology is still in its infancy and remains the less exploited source type compared to other renewable sources, such as solar, wind, biomass, geothermal, and hydropower, which are already being used commercially [64]. Without any other information, we speculate that a less developed technology, such as wave energy, sounds more familiar to our respondents because of the recent attention of Israeli media to wave energy converters (WEC) [65–67] in Jaffa Port [68]. Indeed, other studies noted how the mass media reports on green technologies could profoundly affect how they are acquired by the public [69]. Respondents' proximity to WEC installations at Jaffa Port may also have made wave energy so popular, as already observed with communities in Southwest UK [61].

Besides the popularity of wave energy, what most caught our attention was that 47% of survey participants declared they had never seen solar or wind systems (Figure 4). As described in the result section, these percentages did not change substantially if only respondents with higher education were considered.

Wind technology installations are limited in Israel and only located in the remote Golan Heights [70], which may be why few people have seen wind turbines in Israel. As explained in the analysis of Devine-Wright, renewable energy technology knowledge is higher in individuals living close to tangible installations but tends to be circumscribed only to that particular technology [71].

On the contrary, the same result for solar systems does not correlate with the fact that, to date, approximately 90% of residences in Israel are equipped with solar water heaters [28]. Such a result, which appears incongruent, may suggest that the survey replies depict public imaginaries of renewable energy over actual knowledge and thus demonstrate a general lack of awareness overall. The word "imaginaries" here refers to socio-technical imaginaries, a concept that has recently gained attention [72]. It is necessary to recognize that the renewable energy transition connotes the future, which is uncertain and linked to the imagination as a horizon for perspective actions. As people tend to make the future tangible and understandable, the socio-technical imaginaries concept was created to understand the role of imagining the technological future. From the sociological perspective, socio-technical imaginaries originate in the present and depend on social practices, thinking patterns, cultural values, and utopias. Socio-technical imaginaries contain crucial insights into hopes and concerns about a certain future. Comprehending socio-technical imaginaries also means figuring out the processes involved in the renewable energy transition. Such comprehension is critical for policy agendas as imaginaries affect the perception and acceptance of present-time policies [73]. In our view, the evidence that people do not recognize or perceive solar water heaters on roofs as renewable energy systems is a tangible representation of a socio-technical imaginary where renewable technologies are perceived as unknown and indistinct. Recognizing this distinction draws attention to how some people are detached from energy technologies in their daily lives. It certainly keeps people further distant from those innovations. We want to highlight that capturing such imaginaries and gaining awareness of various imaginaries among citizens represents potential input for policymakers to improve policies and address the lack of information among citizens. As socio-technical imaginaries reflect thinking patterns and cultural values, the context of a specific country might not be neglected to fully comprehend the data about people's perceptions of energy technologies [74].

The results showed that only 14% of respondents admitted a lack of knowledge about the positive and negative aspects of solar energy systems; however, the evidence that 31.27% of respondents provided a neutral response gave no clue how they assess their knowledge. There is a likelihood that they are, in fact, unfamiliar with the topic but unwilling to acknowledge it. It was shown that education level does not impact knowledge of the positive and negative aspects of solar energy systems.

Evaluating the pros and cons of energy alternatives requires accurate knowledge, as the more knowledge citizens have on renewable energy technologies, the more they perceive them as being environmentally friendly and safe [3]. Otherwise, the absence of knowledge drives citizens to perceive renewable energy installations as dangerous.

According to the results, most respondents felt producing electricity through the wind and solar systems was harmless, but there was a slight disparity between the public acceptance levels of those infrastructures. The results showed that 10% of respondents felt wind turbines were unsafe, while another 15% were concerned about solar PV panels. These findings may differ from other results that showed solar systems are the most positively appraised compared to wind [71]. Regarding the solar systems, we recorded concerns about the health risks of radiation from panels. Regarding the wind installations, respondents that described wind installations as unsafe expressed their concerns as "the turbine could fall", "wind turbines are noisy", and "children can reach them* (* regarding turbines)".

These sentiments can be recognized as not-in-my-backyard (NIMBY) attitudes manifested when citizens are concerned about having the infrastructure in their proximity as they believe it will negatively impact their health [75] In our results, the health concerns about wind systems did not relate to educational levels.

Regarding the aesthetic impact, 37.57% were neutral in defining the landscape impact of solar and wind installation. It may indicate a lack of capability in discerning environmental issues. In perspective, it may represent a lost occasion for public participation in monitoring the environmental impacts of renewable projects, thus losing an effective practice for environmental assessment [76].

Renewable energy technologies were evaluated as not expensive by 64% of the respondents; however, 68% are not disposed to pay to install renewable energy solutions. Despite this, 88% of the respondents acknowledged the economic benefit of renewables. This apparent divergence can be explained as the factors contributing to the positive attitude toward green electricity differ from factors that affect the willingness of citizens to pay for it [77]. It is well known that the decentralization of energy systems needs investment to support household installations and that citizens must have financial motives for not installing solar systems on their roofs. Indeed, financial barriers impede household participation in renewable energy projects, as shown for other countries in Europe [78–80]. In countries such as Italy and Germany, installing household PV panels relies on government subsidies [81]. As 90% of respondents declared, they did not know any regulations and standards of renewable energy; thus, apparently, they hardly know about the national legislation that supports investments in rooftop solar (for reference, see Sections 2 and 6). This factor may represent another barrier as it reduces citizens' motivation to be part of renewable energy deployment [82]. Moreover, more than half of the respondents feel excluded from decision making, so their public participation in the energy systems seems further discouraged [83].

## 6. Further Considerations and Policy Recommendations

Public support and/or opposition influence the success of energy policies, and the "social gap" should be filled in during the implementation of energy projects, in particular, with reference to the disparity between the public support for a green transition and local resistance to renewable energy projects [84]. According to the "Four central systems of society" by Ortwin Renn [85], social systems should consider mutual understanding, social values, and different lifestyles for a successful renewable energy transition. The participation and the public's input in the decision-making process regarding energy transition policies are crucial as (public) participation is the primary connection between social and political systems. In other words, participatory approaches and bottom-up governance are necessary for meaningful renewable energy policy to be effective and for a successful transition.

Regarding the case of Israel, academics have pointed out the necessity to "cultivate an environmentally active civil society" to ensure a successful renewable energy transition. Others have seen innovative participatory practices as an essential pathway for democratic revitalization and more ambitious climate action in Israel. According to Friedman and Rosen, the planning system is centralized and lacks participatory governance, particularly in energy policy [86].

Although the absence of participatory governance in a centralized government is often considered inescapable, cases such as the French energy transition policy offer an alternative narrative. For its Energy Transition Act, the French Government structured diverse initiatives to increase the participation of civil society and, overall, transmit and disseminate knowledge about energy transition among citizens. The initiatives included national conferences and debates organized between 2012 and 2015. That broad process of public participation in the design of law represented an unusual practice in the French energy policy that historically has been consistently dominated by technocrats and the "engineering elite" [87].

Such a meaningful societal engagement through conferences and debates represents one of the models of institution-led participation and engagement orchestrated by governments [88]. That might also represent a way for Israel to switch from a top-down attitude to a more bottom-up practice for promoting public participation in energy policy planning. Delivering accurate information and trust-building with the public must be added to energy policy objectives to have democratic governance of the renewable energy transition in Israel. In the same way, Friedman and Rosen have been proposing "citizen science" as a potential form of citizen engagement for implementing a techno-scientific energy policy [86].

The government must be aware of the importance of pursuing institution-led participation practices because citizens lack awareness about the national energy and climate policy, and a large part seems to have limited general knowledge of renewable energy technologies. These insights are aroused from our national survey and evaluated as barriers to public engagement in energy projects. Energy policy debates and information campaigns have the potential to improve citizens' awareness and knowledge successfully. Generally, public education and information campaigns on energy topics are not perceived as the most pressing matter and are scarcely implemented by Israeli Institutions. One of the few examples of initiatives is the roof solar panels campaign held by the Energy Ministry and the Electricity Authority (discussed above in Section 5, with reference to [59]). We see the importance of these initiatives becoming a priority for policymakers. In other words, we recognize the benefits of establishing first dialogues that will further promote the active involvement of citizens. Social perceptions about energy sources deeply affect energy choices [89], so the relevant role of citizens in the renewable energy transition should never be ignored. In the Netherlands, successful energy projects were linked to trust-building with citizens; it was succeeded by delivering accurate information to the public and public engagement [90]. Likewise, in the German case, a positive attitude to renewable energy was strongly associated with environmental concern and community trust [91].

Legislation has been a buster for residential PV installation in Israel, demonstrating that power policy implementation enacts positive change in the energy system and enhances renewable energy diffusion. In 2009, the newly introduced Feed-in-Tariff for residential and industrial solar photovoltaic installations pushed solar investment [92], but the feed-in tariff was closed in 2013 and replaced by a net-metering system. As the data provided by the Israeli Electricity Authority indicate, only 15,333 installations of 15 kw solar panels have been undertaken since 2009. Of these, 7507 have been installed in just the last two years, following a policy change to incorporate solar panels in new constructions (Figure 6).

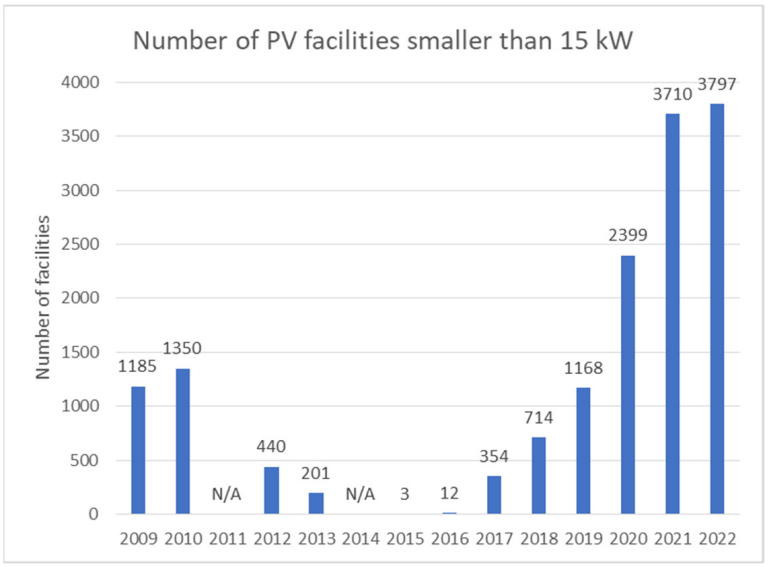


**Figure 6.** Number of PV facilities (for electricity production) smaller than 15 kW in Israel.

In 2016, Israel introduced new legislation to encourage solar investment for households by cutting the rooftop solar tax [93]. However, Israeli citizens should be better informed and supported in the bureaucratic processes to reduce those legal-administrative barriers currently affecting PV deployment. Indeed, as the survey disclosed, the vast majority of participants declared a lack of knowledge of regulations and standards of renewable energy installations.

*Future Research*

The present research will benefit from future development centered on assessing the REs public awareness and acceptance in the different regions of Israel, which will help have a more detailed description of the local levels and to evaluate the location-related factors.

## 7. Conclusions

The present study shows and discusses the results obtained from an online survey that involved 1500 citizens living in Israel. The conducted survey has evidenced that among the respondents: (i) climate change impact is not felt as an immediate threat by the majority; (ii) there is a lack of accurate knowledge about renewable energies; (iii) there is a lack of awareness of national energy and climate policy; and (iv) there is a lack of trust in citizens role in energy decision making.

This study suggests that those points represent barriers preventing Israeli citizens from public participation in the renewable energy transition and that it is paramount to address these issues.

We conclude that understanding such barriers is indispensable if we intend to efficiently engage the public in planning, developing, and implementing climate policies and REs installations. We have echoed that effective public participation in decision-making processes is something that is currently inadequate in Israel and should be encouraged if we are to facilitate climate goals and renewable energy transition successfully.

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