

# Public Readiness to Adopt Solar Energy—Responses of Some Finnish Citizens

Md. Abdul Hai, Saad Mekhilef, and Khondoker Mokaddem Hossain

**Abstract**—Although most of the Finns are positive toward solar energy, they have long been stumbled to adopt and hesitated to rely on it due to its traditional weak images and mostly unfavourable weather conditions. However, in solar energy, Finland is already credited to award-winning innovation, demonstration projects, business models, and so on. Additionally, decreased price and the availability of some incentives have got the public attraction. In such contexts, the prospects of solar energy in the country in terms of public readiness to invest and adopt, have induced this study to undertake. Results driven by this qualitative study through some semi-structured interviews have shown a trend of escalating social acceptance rate of solar energy among Finns. However, they were seemed to be still entangled with some misconceptions, lack of well-exposed information, good numbers of visible success stories, etc. This study has also included some recommendations and future research directions.

**Index Terms**—Routes of adoption, route choosers, solar energy, social acceptance.

## I. INTRODUCTION

How prepared consumers in a given geographical region (the nation, state, rural-urban communities etc.) are to adopt new technologies, can determine the level of change to come in their everyday life. With the passage of time new and clean energy solutions are approaching to address the carbon emission issue and exhaustibility of non-renewable energy sources. The success of those solutions largely depends not only on how much new technology has appeared, but also importantly on how consumers have approached or are approaching those in terms of their acceptance and readiness to adopt. In energy studies, for example, there is significant need to delve deeply with human-centred approaches (e.g., qualitative research) so that human dimensions of energy use in terms of their action and decision could be captured [1]. Ref. [2] observed in Scopus database that in the last decade (2003–2015) a considerable number of articles (350) with the keywords ‘social acceptance’ has appeared in energy and

environmental journal, “with an exponential increase occurring toward the end of this period” (p. 763). With their growing maturity, renewable energy technologies (RETs) are facing different kinds of challenges in different parts of the world that are deemed to be tackled with the “social license for the clean energy deployment” ([2], p. 763).

In terms of renewable energy adoption although Finland is already running ahead of its 38% share in national energy consumption, the target set for 2020, surprisingly in such share there is no contribution of solar energy (Figs. 1 and 2). Actually, solar energy has remained very marginal for a long time in the country [3]. Different studies and Gallup polls although declare that most of the Finnish citizens prefer solar energy among other sources, the rate of its adoption in the country is very insignificant [4]–[6], [26]. Its utilization rate is also very low [7]. These may pose the question: are people not ready enough to adopt solar energy?

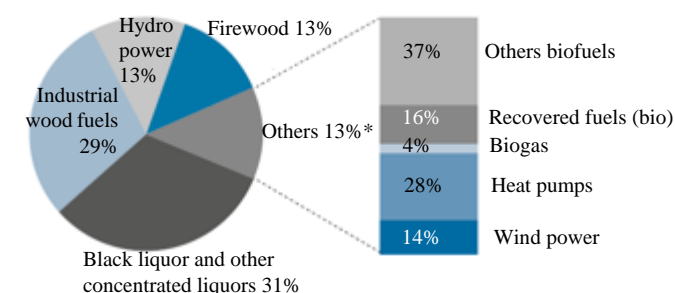
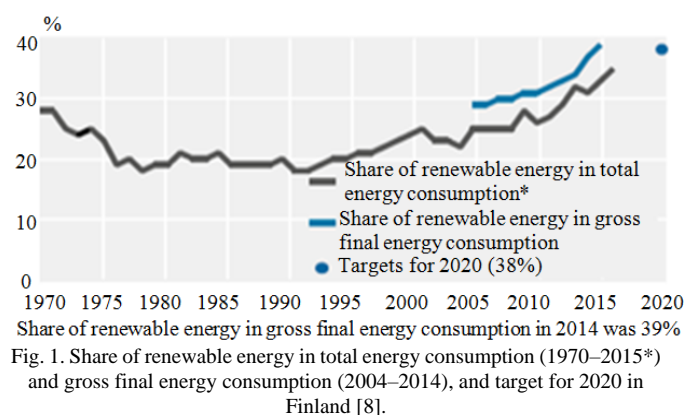


Fig. 2. Share of renewable energy in the total energy consumption in Finland in 2015 [8].

In such untapped market, Finland has recently made important contributions in solar energy. For instance, in terms of innovation the solar thermal solutions manufacturing company Savo-Solar Oy in Mikkeli, Finland, is already making waves throughout the world [9] and has received ‘Intersolar Award’ in 2011. There are also some

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examples of demonstration projects that have integrated solar energy in the buildings. For example, in Eko-Vikki in Helsinki by the side of sustainable housing activity, the largest solar energy integration at that time (2000-2004) was made in 10 multi-family buildings [10]. It received the prestigious 'Sir George Pepler International Award-2006' for being the best ecological project in the Baltic Sea and North Sea areas [10]. The community shared solar projects that have already been launched by the Helsinki energy company Helen have also received huge media and public attention. Furthermore, the business model drawn by the Finnish Environment Institute 'SYKE' in HINKU project of joint procurement of solar technologies by different municipalities was highly successful. The project eventually became the winner of the energy globe national award 2016. By the sides of those successful stories, it is known that solar panels work well in such cool and dustless weather condition that Finland has. Furthermore, the country does have almost the same solar irradiation that Germany has [3], [11]. Being pressured by the global boom of solar energy growth and stunning solar market structure in some neighbouring countries like Germany, recently different filed-configuring-events are undertaken by government-affiliated intermediaries in Finland for promoting solar energy technology. At present, there are allocations at 25% and 20% rates of costs for solar photovoltaic (PV) and solar thermal installations respectively as commercial investment support [12]. As of 2017, there is scope for getting 50% labour costs for domestic installation [13]. Additionally, solar products have become much cheaper. However, there are no specific support schemes (e.g., feed-in-tariff, net-metering etc.) for solar energy production and consumer-owned solar energy installation does not receive any investment support [6]. Furthermore, the payback period for domestic installation is very long, approximately 40 years [11].

Regardless of such condition, a growing interest has been observed among consumers and they have already started to invest in solar energy [3], [6]. According to Energiategollisuus ry [4], 91% Finnish respondents prefer solar energy which is indicative of positive social acceptance of solar energy. In such grounds, Finland's connected and cumulative PV capacity has increased from 11.2 to 14.7 MWp (in 2014) and cumulated capacity of solar thermal collectors installed has increased from 35 MWt (in 2014) to 37 MWt in 2015 [14], [15]. In such more or less promising contexts "what is the public readiness to invest in and adopt solar energy in contrast to its conventional weak images in the country that have stumbled public adoption so far?" - has been considered as the main research question of this article. An answer to it was searched through the following questions posed for the empirical section of this article.

- What routes of adoption are preferred by the public?
- Who would choose those routes to adopt solar energy?
- What would be the prospects of solar energy adoption in the near future?

The lens of social acceptance includes adoption, acceptance in principle, rejection and opposition issues [5], [16]-[20]. Through the lens of social acceptance, those stated questions have fuelled this research to undertake. The

subsequent part of this article is organized as follows. Section II presents the theoretical ground and review of recent literature. Section III deals with the detailed methodology employed in this study. Results and discussion of empirical research are described in the light of the reviewed literature in Section IV. Finally, based on the objectives, given literature, research results and discussion Section V provides a brief summary of those, research implication and future research directions mainly under the point 'conclusion'.

## II. LITERATURE REVIEW

Public readiness can be determined by different personal and contextual conditions and, consequently, is expressed as their social acceptance of a technology. Public readiness to invest in and adopt RETs can be expressed in their behaviour related to social acceptance in terms of adoption, acceptance in principle, rejection, and opposition [5], [16]-[20]. According to Ref [20] after adoption one may no longer continue adoption and fall into rejection category. Furthermore, one may share one's negative experience with other and that may play product sabotage activity. On the contrary, if one is satisfied with one's adoption, there is a possibility that one may tell others about one's good experiences. So, it will attract others to adopt. Would-be adopters and non-adopters may have different conditions to adopt solar energy. So, their opinions were very important to draw the nature of public readiness to invest in and adopt solar energy. Furthermore, those who reject solar energy, their reasons for rejection are also important to address the topic of this article. Likewise, reasons of the opposing persons are also important. Following social acceptance theory, if adoption (users' acceptance) and acceptance in principle (non-users' acceptance) are considered good for the market operation to ensure its bright prospect, a reverse market situation may come with rejection (non-adoption) and opposition (exerting technology sabotage activities).

In a recent study conducted in Finland, social acceptance of RETs for buildings was assessed in the Helsinki Metropolitan area. In that study, Ref. [5] by conducting a quantitative web-based survey on 246 respondents observed solar energy and heat pumps as the most preferred renewable energy sources for buildings in Helsinki and a strong willingness among their respondents to invest in RETs as a response to carbon emission reduction. Following a quantitative approach on the Finnish energy system for year 2050 in an EnergyPLAN simulation Ref. [31] found the relevance of solar energy storage. As a second phase of their study, by interviewing 31 experts and interested people they pointed out different technological, economic, institutional and political, and behavioural barriers and related solutions in their discussion. Their analysis includes both micro and macro issues of adoption as also stressed by [32]. A slight discussion of prosumers (who are both producers and consumers) of solar energy can be found in their discussion that is broadly studied by [32], [33].

The quantitative results of [11] confirmed that residential PV would remain uneconomical in Finland if it is left unsubsidised. Ref. [33]'s qualitative study consisting of 12 semi-structured interviews and 4 workshops presents that in

the joint procurement of solar energy technologies different patterns of involvement and ownership issues were found among their respondents, who were mostly the producers and consumers of solar energy. Poor ownership and engagement issues were reported by them and it was previously reflected in [28]-[30]. By analysing some documents and media reports, and interviewing 4 main champions Ref. [30] assessed the role of solar energy integrated demonstration projects in Finland. Some of the routes of adoption of solar energy could be found in their analysis in terms of community participation in energy production and consumption with the involvement of business and/or government organizations (e.g., municipalities). Ref. [3] mainly discussed different barriers to solar energy adoption in Finland with some solutions by conducting 19 semi-structured interviews and analysing climate and energy-related Finnish government strategy documents. Many of her findings were reflected in the study conducted by [31].

Both Refs [26], [32] emphasized on distributed energy (DE) generation and in their discussion solar energy was partly included as one such kind of energy in Finland. Based on results of 17 expert face-to-face and 9 online interviews Ref. [32] discussed the prospects, speed, barriers and four business models of DE generation in the country. According to them public acceptance of PV is up and many Finns are ready to offer their rooftops or lands to use that for energy production sites. Ref. [26] also followed a qualitative research structure and through 16 interviews and internet-based based research using a seven-point Likert-scale discussed solar energy as a part of DE technologies that are mostly used by individual customers in their summer-cottages. According to him, solar energy is mostly preferred in terms of individual installation and there is a good prospect for that niche technology in Finland. By applying domestication theory he found that the use of DE technologies at the local condition in residential houses had been building capabilities for an upcoming smart-grid environment.

### III. METHODS AND MATERIALS

Since public readiness to invest in and adopt solar energy is a complex matter, the social dimensions of energy technology and use are worthy of greater consideration [1]. To ascertain such social dimensions this study was designed based on qualitative research strategy. In this study, the face-to-face semi-structured interviews with ordinary (common Finnish citizens) and Finnish expert respondents were conducted during the field level investigation so that the most appropriate and highest rate of response could be collected from them (see Table I). At the time of the interview, a set of pre-scheduled semi-structured questionnaire was used to get research data by knowing respondents' own perspectives about solar energy acceptance, choices of different routes of adoption, route choosers and future prospect of solar energy in the country. Ample opportunity was kept open for probing so that maximum information could be absorbed. Such strategy was taken to secure an in-depth understanding of the research topic that

ultimately ensured data triangulation [21].

Initially, Eko-Viikki residential area in Helsinki city was chosen to conduct interviews with ordinary respondents consisting of adopters, would-be adopters, non-adopters, rejecters and opposing persons. Eko-Viikki is the only solar community that is still in working position in Finland. There are ten solar integrated blocks of flats and other normal houses in that residential area based on owner-occupied, tenants and right of occupancy categories of residents [16]. So, it was thought that at a time stated categories of respondents could be found there and their information would enrich the findings of the study. A purposeful sampling strategy was drawn to interview ordinary respondents. To absorb maximum input, following maximum variation technique 25 ordinary adult residents of Eko-Viikki (not below 20 years old) were interviewed in English who willingly participated in the research. They were also assured that their identity would be concealed. Rapport building with them initially at the time of interview aided a lot to get maximum information [22]. These interviews were continued until repeated information started to come again and again. Although some individual installations were observed in some of the housing premises, none of them were at reach during those interviews.

TABLE I.: KEY INFORMATION ABOUT THE INTERVIEW PROCESS

Respondents (Finns only)	No. of respondents	Place of interview	Sampling strategy
Ordinary	25 (12 males + 13 females)	Eko-Viikki	Purposeful sampling
Experts	17 (11 males + 6 females)	Other places	Snowball sampling

Snowball sampling strategy was used to interview expert respondents. At the time of interviews, they were asked to provide some references of key experts so that their interviews could be taken. Although a big list of experts was found, only most suitable and approachable experts were interviewed. Experts' suitability was assessed on the basis of their expertise in the field and organizational affiliation mainly. Thereby, 17 experts were interviewed who contributed a lot by providing their valuable information, opinions and thoughtful solutions to different issues. With such small sample size, which is common in all qualitative research [3], [30], [31], [33], it was tried to generate valued and depth responses from the respondents and later on, to provide a descriptive and analytical representation of those responses in the findings e.g., [23], [24]. Although following a 'maximum variation' strategy 25 ordinary respondents were interviewed for getting all sorts of consumers as theoretically explained in terms of their adoption status, opinions of the 17 experts received the highest importance to dig out generalized information. Both ordinary and expert respondents were asked to provide their opinion about the pattern of solar energy adoption among Finnish people including them, available routes of adoption; and their knowledge about it (e.g., consumers' preferences, ownership, and engagement). They were also asked to provide their opinion on who would adopt solar energy through existing routes of adoption. As such, they were also given the opportunity to opine on the challenges and prospect of solar

energy in the country.

All sets of interviews were transcribed and analysed based on content analysis strategy [25]. Thus, the systematic analysis produced different themes that were categorized and unitized later on. As this article was strictly and specifically directed to focus on public readiness to invest in and adopt solar energy, installation activities by different business organizations in their premises or other places for their consumption were not considered relevant. If anyhow the involvement of general consumers was seen in many forms of adoption, that was given priority of focus in this article. The findings were assisted and assessed through the studied literature. As such, dialogue between earlier literature and the analysis of the findings of this research eventually produced a structure of public readiness to invest in and adopt solar energy in the way of answering the research question and responding to the objectives stated in Section I. Although both expert and ordinary respondents contributed a lot to the research findings, their opinions seemed to conceptualize and expand different aspects of Finnish mentality toward solar energy preferences, adoption, and investment tendencies. So, the method employed in the analysis of such data assembled through interviews is exempted from making any concrete inferences about Finnish society in a broader perspective. The qualitative structure of the study has restricted the sample size and allowed to shed more light on human-centred issues.

#### IV. RESULTS AND DISCUSSION

##### A. The Lens of Social Acceptance

In line with the concepts of different patterns of social acceptance, some specific features of Finnish citizens were explained by the respondents (Fig. 3). Although the ordinary respondents also explained their own situation in terms of their pattern of social acceptance of solar energy, most of the expert respondents were mainly interested in and concentrated their attention on explaining the situation of others.

Among ordinary respondents, there were 3 adopters. They had purchased their flats in the solar energy integrated block of flats in Eko-Viikki. They were not directly involved in installing solar panels and/or collectors in those buildings. It was done previously by the housing company and its affiliated organizations. So, although they had become adopters of solar energy, it is more like passive adoption. It was also known from them that for maintenance, regulating and monitoring specific housing company and the City (the Helsinki Municipality) take necessary initiatives. So, they were also unsure about their ownership and engagement in solar energy technologies installed in those block of flats. All ordinary and expert respondents explained that the number of adopters of solar energy was very insignificant in Finland who represented their adoption mainly in summer cottages and detached houses, as stressed by [26]-[27]. The respondents also asserted that after adoption one could refer other for such adoption and some ordinary respondents stated that they had such kind of information. So, the activities of adopters at the post-adoption stage were considered

important for the diffusion of solar energy.

In terms of ‘acceptance in principle,’ all respondents argued that most of the Finnish citizens could be found representing this category, as stressed by earlier studies e.g., [4]. This category of people accepts solar energy mentally and ideologically but do not adopt it practically [17]-[18]. They may also postpone the adoption activities. According to the respondents, people falling in this category have their reason not to adopt solar energy, but they have positive attitudes toward solar energy. They may consider adopting the technology when at least their basic conditions are fulfilled. As observed, there were 21 ordinary respondents who represented this pattern of social acceptance. It is a pre-adoption stage because at this state of social acceptance people remain in a position to decide whether to adopt solar energy or not, when to do that and under what conditions.

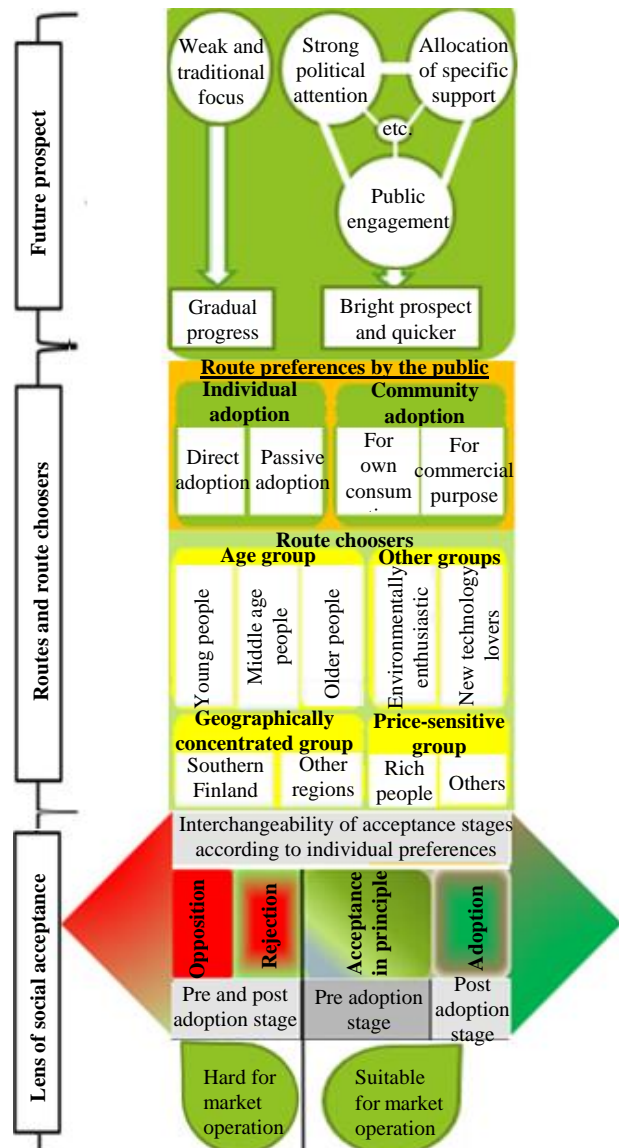


Fig. 3. Patterns of social acceptance, route preferences, and route choosers, and the future prospect of solar energy in Finland, according to the respondents.

The decision not to adopt or rejection can sparsely be found among Finnish citizens, as the respondents argued. According to them, there could be some people falling in this category, but they did not have the idea about what would be their exact figure. Just 1 ordinary respondent argued that he

would not adopt solar energy. Opposition to solar energy is very rare. Just one expert respondent showed her opposition to it indirectly. According to her, there is no logic to shed emphasis on solar energy in Finland since it is not feasible in its weather condition. According to her, Finland would focus on those energies like the bio-energy, where it has its strength and examples of proven success. She stressed that it would take a long time for solar energy to be in such strong base in Finnish energy cluster. Other respondents were positive toward this technology and no negative comments were derived from them at the time of interview. By assessing ordinary respondents' status, it was found that rejection and opposition were framed as pre-adoption stages, although some expert respondents argued that after adoption one could deny continuing the adoption and one being dissatisfied could play product sabotage role. That means it could be post-adoption stage also, as stressed by [20].

All the respondents asserted that there would be possibility among Finnish citizens to change their adoption or non-adoption decision based on their personal and contextual conditions. So, there is interchangeability among acceptance statuses according to individual preferences. It is important to state that this part of findings is presented here to see route preferences and to identify the route choosers in the decision to invest in and adopt solar energy, and, finally, to observe how the future prospect of investment in and adoption of solar energy were viewed by the respondents through the lens of social acceptance.

#### B. Route Preferences: Individual or Community (Collective) Adoption

There are different ways to adopt solar energy technology by the customers (Fig. 3). According to the respondents, it could be direct production or passive adoption. Furthermore, it could be a community, commercial, cooperative, or community shared solar plant. One key respondent, working at a top position in the Helsinki energy company Helen explained it, for example, as follows.

*"There are different ways. If you want solar energy based electricity connection, you can just make an agreement for that with us in your electricity connection. If you want to involve in our personal panel product, you can also purchase it, but the panels are limited and so selling could be finished anytime. If you want to build a solar plant on your roof, it is a different case. You have to do much more work for that."*

In line with the concepts of different patterns of social acceptance, some specific features of Finnish citizens were explained by the respondents (Fig. 3). Although the ordinary respondents also explained their own situation in terms of their pattern of social acceptance of solar energy, most of the expert respondents were mainly interested in and concentrated their attention on explaining the situation of others. As indicated in Table II, most of the Finnish people prefer individual adoption. Literature also acknowledges that most of the solar installation can be found by individual installation mainly in the summer cottages and in detached houses in Finland [26]-[27]. In the case of regular residential places availability of such interest was also reported by the respondents in different manners, as stressed by [5], [16].

TABLE II: EXISTING ROUTES OF ADOPTION BY FINNISH CONSUMERS

Variables	Options	Preferences
Individual adoption (direct)	Production for own consumption	Most preferred
	Production for consumption and selling	Not known
	Purchase from the energy company	Little interest
Passive and/or partial adoption	By purchasing flats in solar energy integrated buildings	Interest among buyers of new flats
	By consuming solar district heating system captured in the summer by energy companies like Helen	Not known
	Production for own consumption	Very little interest
Community adoption	Production for commercial purpose	Growing interest

Individual adoption can be classified in terms of (1) production for own consumption, (2) production for own consumption and selling, and (3) purchase from the energy company (see Table II). "Production for own consumption" would be beneficial for individual producers, as the expert respondents viewed. In the words of one expert respondent working as a key architect at the Helsinki 'City' (the Helsinki municipality), "That is something easier for a small house, summer house or single family house. It is much easier to plan and implement that kind of system. Just use it to your own energy." Some ordinary respondents viewed that it would be meaningless to have more than one sources of power connection, although solar energy is presented in the literature as "the most promising backup energy" ([34], p. 386). If one has solar power in the summer, one needs to have 'on the grid' connection also because the sun cannot be found in the night and mostly in the winter. However, the most of the respondents asserted that among different routes of adoption the interest should be given in individual adoption. There are consumer ownership and engagement in this route of adoption. They further explained that in the Finnish society people prefer to do things on their own than associating others in such activities what is termed as "do-it-yourself" spirit by [33]. One expert respondent working at a top position in EKOenergy Company argued, "The Finnish mentality is that making things by oneself: I built my house, I have installed solar panels in my house etc."

The second option "individual adoption in terms of production for own consumption and selling" is less preferred by people because they are a bit confused with how to sell extra electricity produced from their solar panels. The system of selling is very complicated, as stressed by the respondents. At the moment, selling to the grid in some respects is possible, as stressed by [27], but the price (the buy-back rates) becomes much lower than the market price of grid electricity, as stressed by [32]. The experts explained that there are intervening charges in terms of transmission, selling company etc. So, these make it less preferable for consumers to consume and sell power to the grid. One expert respondent specifically mentioned that 'the facilitator' business model offered by Oulun Sähköseuran Oy in Finland is dedicated to buy that energy but from the small-scale individual 'firm'. It is not appropriate for individually



produced solar PV which is tiny ion amount. Furthermore, according to the respondents, most of the common Finnish citizens even do not know about that since it started recently. There are consumer ownership and engagement in this route of adoption.

The third option “individual adoption by purchasing from the energy company” (i.e., purchasing solar electricity) has received little interest among Finnish citizens because such consumption still costs more than conventional power consumption. Consumers’ unwillingness to switch electricity supplier to use green electricity is another point in this regard, as stressed by [24], [35]. The respondents stressed that environmentally enthusiastic people favour such adoption. However, there is no ownership and engagement of consumers of such type of power production. Furthermore, respondents stressed that consumers have enough reason to be confused because they generally do not know whether the energy company providing the solar power all the time throughout the year or not.

According to Table II, passive and/or partial adoption can be classified in terms of (1) by purchasing flats in solar energy integrated buildings, and (2) by consuming solar district heating captured in the summer by energy companies like Helen. There are already different demonstration projects that include solar integration in the buildings, as stressed by [30]. While interviewing, three ordinary adopter respondents were found living in some of the solar energy integrated block flats. They were the owners of their flats and were living there on regular basis. However, they themselves did not feel as the owner of solar energy systems integrated with their block of flats and they also reported that they did not see anyhow their engagement in that, as also reported by [30]. However, it was informed that solar power was used there in the commonplaces of the building, for example, for washing room, store room and so on. Furthermore, it was keenly observed that they had actually very poor idea about solar energy use, ownership and engagement matters. Both the expert and ordinary respondents stressed that at the time of purchasing a new apartment, it could be a good option for Finns to choose solar energy integrated buildings who love it. One ordinary non-adopter respondent stated that she did not find any significant difference of price in purchasing flats in the Eko-Viikki in comparison to other places.

The other form of passive adoption is the consumption of solar district heating captured in the summer by energy companies like Helen. In other words, such adoption can be termed ‘passive partial implied adoption’. As explained by two experts of Helen and some other experts, consumers of that energy company do not generally know that solar heating is also integrated with the district heating system that is captured in the summer unless they make a thorough investigation out of their curiosity. Since it is centrally maintained, it becomes a passive and partial form of implied adoption of solar energy by the clients of the energy company Helen. One expert, thus, continued:

*“In Helsinki, we produce hot water coming to the flats. We have hot water from solar energy for our clients. People only do not know that because it works in different ways. We have district heating and district cooling systems. When the sun shines, people want little*

*bit cooler house. So, we can offer district cooling. Helen is taking heat from buildings and we do not waste it. We put that heat to the heating power plant and make it the same as district heating does.”*

Although Helen has such kind of system to integrate solar heating in its district heating system, the experts did not inform about other energy companies whether they have such system or not. In such implied passive adoption individual consumers do not have their ‘ownership’ feeling and they are not engaged in it thereby.

Community adoption as indicated in Table II can be seen presented in terms of (1) production for own consumption, and (2) production for commercial purpose. According to the respondents, community adoption of solar energy in terms of production for own consumption can sparsely be found in Finland, although it may include strong ownership and engagement feeling among community people. However, literature informs that community solar energy initiative could be observed among communities in Kaakonoja Area Residents Association, Kaakonoja, Valkeakoski, Finland and Yla-Kivel äblock of flats, Keuruu, Finland [28]. According to the ordinary respondents, such attempt would be difficult in different respects, especially reaching a consensus about the adoption. Some expert respondents stressed that such initiative would not receive any investment support from the government that could also be a matter of concern to the community people.

The other form of community adoption on the basis of ‘production for commercial purpose’ has recently become very popular in the country, as stressed by the expert respondents. Such commercial installation and adoption scope is created by the Helsinki energy company Helen. It is commercial in the sense that individual customer can rent a panel at 4.40 Euros per month and they can deduct the energy each panel produces from their monthly electricity bill as a customer of the company, as stressed by [31]. It is termed in the media as the ‘community shared solar’ project and Helen treats it as “personal panel product.” According to the experts of that energy company, some other energy companies have also started such kind of projects seeing its popularity. It is addressed by the term ‘utility-side solar PV’ business model, as stressed by [32]. Although such project seemed very popular, it cannot accommodate all environmentally enthusiastic people.

Most of the expert respondents argued that the ‘turn-key’ business model could be helpful for consumers in solar energy installation to get equipment, planning, grid connection and possibility to sell produced and excess electricity to the utility. Low buy-back rates have made it less preferred to the consumers, as stressed by [32].

### C. Route Choosers: Who Would Invest and Adopt?

All respondents agreed that although most of the Finnish citizens are positive toward solar energy, it cannot be expected that all of them would adopt solar energy. It is also reflected in the less demand of green electricity products in Finland than the supply, as mentioned in [35]. As such, questions like “why everybody would install solar panels?” came from the respondents. Reply to such questions was also given by them. For instance, one expert respondent argued:

*“I think, there are people who use electricity, but they do not care about the source. It is enough for them to get electricity when they press the switch, for cool or warm water and space heating as well. They do not care. I think, there is plenty of this kind of people.”*

All respondents argued in different manners about who would adopt solar energy through any of the stated routes of adoption (Fig. 3). Table III presents key facts about who would adopt solar energy on the basis of different opinions and logic offered by the respondents at the time of interview. In terms of age group, most of the respondents argued that young people could be thought of very much concern about solar and other renewable energies because they have a life ahead of them and they know that they have to do something for the environment. They have to live quite a long time on this earth and are able to live quite long. They are mostly aware and positive about solar energy. They are mostly afraid of what is happening on our planet. They know about the consequences of global warming but must not the one paying the bill. According to the respondents, there is a high possibility among this group of people to adopt solar energy. They argued that since young people lack money and/or own house/apartment, they would adopt after a long time when they would become established and at a decision to buy a house. More precisely, young people are concerned environmentally, but they do not have money to afford solar energy technology and to adopt it, and it is, therefore, “not evident necessarily in their consumer behaviour” ([36], p. 150).

TABLE III: THE ROUTE CHOOSERS

Variables	Options	Tendency to adopt	Tentative time of adoption
Age group	Young people	High	Later (would take considerable amount of time)
	Middle age people	Medium	Anytime on the basis of different conditions
	Older people	Low	Anytime
Price-sensitive group	Rich people	High	Not sure/anytime
	Others	Medium	Not sure/anytime
Geographically concentrated group	Inhabitants of Southern Finland	High	Not sure/anytime
	Inhabitants of other regions	Low	Not sure/anytime
Other groups	Environmentally enthusiastic group	High	Anytime
	New technology loving group	High	Anytime

Middle age people who can invest in solar energy and can adopt it. One expert respondent stated that she would prefer people around 50 years old as the potential group for a making investment in solar energy and to adopt it. One 32 years old expert respondent working at the Finnish Environment Institute SYKE stated, “Maybe my age group that is the most, or maybe a bit older and richer people are interested in the investment of solar installation.” The adoption and investment decision regarding solar energy by older people received different opinions. The respondents were critical in explaining this matter. Most of them directly

or indirectly argued that it would be unwise to say that older people are less concerned. However, while presenting comparative picture among different age groups about who would adopt and invest in solar energy through the stated routes they argued that due to their old age they might not thinking of other option for electricity or heating. Although they have money, they may think that their lifespan is short. So, there is no good for them in the investment and maybe they are not worried about what is going on. While shedding light on the matter one key expert working at EKOenergy Company argued, “It can be seen that many older people have invested in solar power who are interested in it, but generally the younger people know that it can be done, but older people are more sceptical”. Likewise, another expert respondent working as a manager in a multinational energy company argued,

*“Both aged and younger people are interested in investing in solar energy. In different cases, aged people are more ready to invest since they are financially solvent and capable of investing in solar energy. On the other hand, younger people may be positive about renewable energy, but they may not be economically solvent to invest in solar energy.”*

Adoption of solar energy and investment in it can be determined by the decision of price-sensitive consumers also (see Table III). Some ordinary respondents viewed that only the rich persons can adopt it since the cost of investment is high and return is very long term, as stressed by [3], [11], [27]. According to some ordinary respondents to maintain the status quo and a kind of fashion some people were installing solar panels in the Eko-Vikki, as stressed in terms of ‘solar-believers’ by [29]. All the respondents asserted that the people, who would adopt solar energy or fall in acceptance in principle category, mainly focus on the cost issues. So, price sensitivity among common Finnish people has been considered as a key factor in their decision to invest in and adopt solar energy, as stressed by [11].

In terms of the geographically concentrated group, some of the ordinary respondents stated that people living in Southern Finland would be more interested in investing in and adopting solar energy. In the words of one ordinary respondent, “I think people from the southern Finland are more concerned about solar energy because there is actually the better sun.” Southern Finland receives approximately as much solar irradiation as those of northern Germany and Denmark. Conversely, according to the opinions of some experts, even northern Finland, for example, the coastal city of Oulu represents more bright days with better solar yield than southern Finland, as stressed by [29].

Most of the respondents in different manners stated that environmentally enthusiastic people can anytime invest in and adopt solar energy. They have high tendency to do that. The respondents argued that although most of the Finnish people are conscious about nature, mostly the environmentally enthusiastic people are now adopting solar energy because common people are mostly concerned about price issues, as stressed by [24]. One expert respondent worked as a key person in FinSolar project argued,

*“There are, of course, green companies, green loving citizens and so on, who make investments so that they do not really look for any kind of return on investment. So, that uptake would really start to grow as it has been growing in many other countries.”*

There is another group of people who prefer new technology and are interested in investing in and adopting it. According to some expert and ordinary respondents in the case of solar energy adoption such kind of technology devoted people could be found in Finland and they were considered by them as trendsetters in solar energy, as stressed by [20]. As such one leading expert working as Professor at the Aalto University, informed and argued, “In residential areas, there are very few installations of solar technology most of among technologically interested people who are the pioneers in this area.”

#### *D. Future Prospect: How is Solar Energy Future Envisioned by the Respondents?*

Most of the respondents envisioned the future prospect of solar energy adoption in critical manners and also offered their prediction for the destiny and fortune of solar energy to appear. As observed, most of the respondents were optimistic toward the diffusion of solar energy in Finland, as stressed by [6], [31]. However, they explained few negative comments and challenging scenarios. Most of the ordinary respondents showed their confusion about the investment profitability and suitability of solar energy in the dark winter. None of them had any negative idea about the Finnish research strength to address technical solutions. Actually, Finland is savvy in terms of solar energy technology and continually addressing new solutions (see Section 1). Likewise, to address new solutions Ref [31] suggest learning lessons for storage solutions from Germany and Ref [30] considers that demonstration projects could open that door to learn different lessons.

The respondents argued that the development of solar energy market in most of the countries is largely dependent on the supported structure offered by the government, which is very tiny in Finland. If it is subsidised at small-scale and residential installation levels, it could be economical, as stressed by [11]. This is a quite interesting dilemma that ordinary people prefer solar energy. They would say: it is cool, we like that. According to the respondents, significant improvement in solar energy would come with the positive initiative by the politicians. In this regard Refs [3], [31] suggest to the establishment of and powerful roles of solar advocacy coalitions. According to one expert from the Aalto University, “If the politicians would listen to the people, there would be a better market for solar in Finland”. Furthermore, as one expert of FinSolar project argued:

*“So, then, the future of solar energy uptake depends largely on the politicians if we take economic feasibility as critical criteria. So, then, the politicians would need to see something worthwhile to promote, then there would be a bigger market boom.”*

The big challenge that is impeding the market growth is the financial matter. Consumers have not yet found it as profitable except for personal production and consumption,

as stressed by [11]. However, the investment return remains long, as stressed by [11]. The respondents suspect that with decreasing price of solar panels, the electricity price may decrease also and, thereby, solar energy market growth might not be swift, as stressed by [31]. Solar panels prices and battery prices are coming down, as stressed by [31]. At the same time, the grid-connected electricity price is also low. In such contexts, one expert respondent said, “So although a lot of people can be found are willing to adopt solar energy, but they are not yet ready to invest unless they know and become sure about the profitability of their investment.” These (i.e., solar PV price should be lower or equal to the conventional grid-based electricity, profitability of investment, etc.) address the willingness to pay (WTP) tendency for solar energy among Finnish people, as stressed by the respondents.

Some respondents also stressed on some other points. According to them, people lack confidence and security to invest in solar energy, because of the long-term investment return which is sometimes quite suspicious to them. People lack knowledge and information. They need to be educated. So, more information and examples of some successful installation stories should be disseminated, as stressed by [31]. Conversely, some experts argued that awareness is already there, but people just need a signal from political parties. Ref. [32] stressed that lack of it is responsible for the slow progress of DE technologies both in power and heat production.

Notwithstanding those challenging issues, an increasing surge of the uptake of solar energy had ushered the respondents to envision a bright prospect of solar energy in the near future if traditional and non-supportive approach could be changed. According to them, the normal consumers are the ones who are the most interested in this kind of investment. According to the respondents, the discussion about climate change is very up now. People are becoming more concerned about clean energy. Additionally, the average customer prices of rooftop solar plants are continually decreasing. There is a boom now that citizens are very much interested in solar energy, although the reverse findings were observed by [32] in case of small-scale installation. According to the respondents, there are a lot of investments happening in solar energy even though they are not the super-profitable investments. One expert respondent working at the Ministry of Employment and the Economy in Finland stated, “The present and projected tendencies of solar energy systems to be installed, owned, and/or used locally in Finland are growing rapidly”. The key expert of FinSolar project envisioned that by 2030 the situation may start to change and may look different. Different kinds of literature also declare that solar energy is at its initial growth stage now in Finland, but soon the diffusion would occur [3]. According to the key experts working at Helen, the community shared projects of the company have already received outstanding popularity and now the company has become the forerunner in the utilization of solar energy in the country. One key expert working at the Finnish Funding for Innovation TEKES thus aspired,

*“If Germany can do it, we can also do it. That attitude has changed during the last 2 years [from the*



*non-feasibility to the feasibility of solar energy]. More positive attitude has grown. People are becoming convinced nowadays with the fact that solar energy is feasible and normal for general people as well."*

In short, according to the respondents, if weak and traditional focus (e.g., scepticism about the feasibility and profitability of solar energy in the country, non-supportive approach) on solar energy is still continued, the diffusion and progress of solar energy adoption in the country would remain slow. Slow progress could also be observed in the growth of numbers of manufacturers, and spread of new business concepts, as stressed by [32]. On the contrary, the respondents viewed that bright prospect and quicker progress in solar energy than the present adoption rate could be achieved if strong political attention, allocation of specific support for solar energy and public engagement in different forms of installation mainly are ensured. The allocation of specific support for solar energy at individual and small-scale level is considered crucial [5], [32] that could gradually be curtailed and diminished when the market growth becomes visible and to prevent the quick market growth, as stressed by [37]. However, the experts argued that unless conventional electricity price goes higher than solar power, it could not reach at maximum popularity, as stressed by [31]. The respondents explained that public engagement can be ensured in terms of informing them, involving them and empowering them in the decision process of adoption and maintenance of solar energy systems mainly, as stressed by [28], [33]. Furthermore, the respondents considered that creating and exposing more successful demonstration projects, imposing stricter compensation rule toward environment degrading harmful energies, and creating new business structures and marketing strategies would intensify the diffusion of the solar energy market in Finland.

## V. CONCLUSION

This article has contributed to the "public readiness to invest in and adopt solar energy" in the context of Finland. This article was set out to assess such readiness in terms of route preferences of adoption, identification of route choosers and future prospect of adoption of solar energy through the lens of social acceptance. The findings disclose the fact that acceptance in principle and adoption are suitable for market operation. Since most of the Finnish citizens fall in these categories mainly, as the respondents argued, it can be predicted that a bright prospect is awaiting – politicians need to be more concentrated toward this energy, specific support schemes needed to be allocated for solar energy and public engagement has to be ensured. According to the respondents, public readiness is there, but actions stated in Section IV (D) are required to initiate that. There would be a bright prospect of solar energy at the change of traditional focus of solar energy both by the common citizens, authorities, and politicians. The indications of such change are already approaching. People are showing more interest toward this clean source of inexhaustible energy. However, there are still some misconceptions, lack of well-exposed information, sufficient number of success stories (of solar

energy projects) and intermediation (i.e., signalling positively toward solar energy by politicians mainly) that have remained a significant number of positive minded Finns undecided to adopt solar energy.

Future research can be directed to address how politicians can be attracted toward this energy and how the barriers can be tackled that has been preventing concerned authorities to shed light on this energy. There are already different support schemes available globally, for example, net-metering, feed-in-tariff etc. Future research can also be directed to how those support schemes can be addressed in Finnish contexts. There is also need to look at public willingness to adopt solar energy, segmenting customers based on such willingness and giving specific focus for each segment. Such segmentation could also provide direction on how to increase the rate of adoption without any change of the present support structure for solar energy in the country.

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