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Empowering the Solar Shift: The Strategic Role of Retailers and Installers in Advancing Energy Storage Solution

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Abstract: The residential solar landscape in Australia has been significantly influenced by the decarbonization and sustainable development goals complemented by government-regulated incentives and subsidies. The penetration of small-scale solar in Western Australia (WA) is more than 35% as per the data obtained from the Australian government's Clean Energy Regulator website, listing a postcode-wise installation of small-scale solar. As the solar penetration increased, the phasing-out of incentives from the government and regulations by utilities against high levels of solar penetration into the grid is encouraging the adoption of solar energy storage (SES) devices among residential solar users. Stakeholders such as policy-makers, SES manufacturers, installers, and retailers, and end-users play a major role in enabling this transition. The study recognizes the SES installers and retailers as prominent stakeholder categories in the field of SES since they bridge the gap between a prospective consumer who becomes a prosumer on the adoption of the technology. The study analyzes the role of SES installers and retailers in the adoption of SES devices based on stakeholder theory. Semi-structured interviews were carried out to make a qualitative analysis of the role played by SES installers and retailers and their perspectives on SES adoption. The engagement of SES installers with the technology and direct involvement with the consumers makes them important. The analysis of stakeholder dynamics indicates a lack of integration between SES manufacturers, installers, and retailers, affecting the availability of the product and expertise of SES installers in the SES technology. The policy-makers, who are a high-power stakeholder category, should formulate standard regulations, unifying the installation and maintenance practices. The study underlines SES installers can promote the adoption of SES through integration with other stakeholder categories, gaining expertise, and transferring the knowledge to the consumer for proper maintenance of the product, encouraging re-adoption.

Keywords: solar energy storage, stakeholder theory, decarbonization, stakeholders, power and interest

1. Introduction

The case of Australia is ideal to study the adoption of solar energy storage (SES) devices, since it has a rich residential solar landscape supported by the decarbonization and sustainable development goals [1]. The high insolation rates make Australia suitable for the implementation of residential solar projects [2]. Currently, the penetration of residential solar has reached overwhelming levels. The excess solar energy fed-back to the grid has seen a voluminous increase, in particular, middle of the day, whereas the demands in electricity peaks in the evenings. The California Independent System Operator (CAISO) observed this mismatch between demand in electricity and generation of solar and traced the net load curve, which was shaped like a duck. As indicated in the California duck chart, power is overgenerated during times of lower demands, leading to grid instability and wastage of power [3]. This is not only the case of California. The issue exists worldwide, wherever the solar penetration became high in the presence of incentives and subsidies, which were a major driving factor for household consumers for mass adoption of solar energy. Now, due to issues caused by high solar penetration, these incentives and subsidies are gradually phasing-out [4]. The excess power from residential sources is adding to the grid instability [5]. The solution to this problem is the adoption of batteries or SES devices which can store excess energy from solar when the demand is low and recharge when generation is high [6]. This ultimately results in de-centralizing the energy distribution scenario [7]. However, a mass adoption of batteries for household energy storage is prevented by high prices, technology-related uncertainties, and lack of policies subsidizing SES [8]. The implementation of subsidies and incentives requires intervention from the government, formulating policies encouraging the adoption of SES. There are various stakeholders involved in enabling this transition of residential renewable energy scenario to a secure and independent one. The power is vested in federal and state government organization who makes the regulations and policies. Policies should be oriented to elevate the market value of the product and also provide support to the consumers through subsidies or rebates [9]. Then, there are market players such as manufacturers, suppliers, and retailers, who are interested in the transition toward SES; however, due to lack of power, they cannot enforce it. Electricity utilities have the power, but lack the interest in supporting the transition. Solar energy SES installers, end-users, and energy advisors are the low-power, low-interest stakeholders. This study focuses on the role of

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SES retailers and installers in fueling the adoption of SES systems. Retailers sell residential solar and SES to the end-user. SES installer is responsible for the installation of the system. Hence, SES retailers and installers are important intermediaries in the adoption of battery-assisted residential solar systems, owing to their direct engagement with the end-user. Compared to the high-power stakeholders such as state or federal government systems and electricity network operators, SES retailer and installers have lower power, based on the power-interest grid by Ackermann and Eden [10]. Hence, there are limited number of studies analyzing their influence in the adoption of energy storage systems for residential solar systems. However, due to the positive disposition of SES retailers and installers, an analysis of available options to increase their power and interest will be useful in disseminating the technology further [10]. Moreover, the direct involvement with the technology and end-users makes their opinions significant in proposing the regulations necessary to encourage the mass adoption of the technology. This study focuses on the perceptions of SES retailers and installers as important stakeholders in promoting the adoption of battery-assisted residential solar technology.

Stakeholder theory puts forth the idea that any business can be perceived as a correlated network of relationships among groups or categories who have a stake in various aspects which builds the business [11]. Stakeholders are classified into two: primary and secondary. Primary stakeholders have access to resources and have direct influence on the process of transition, whereas secondary stakeholders need to act as a group to effect changes. Power, legitimacy, and urgency have been defined as the three attributes of stakeholders. Primary stakeholders are important because they hold the power to make decisions, manage the distribution of resources, and provide rewards or levy fines. It is evident from the case studies in Australia that many users of residential solar adopted the technology due to government policies and incentives and would not have done so otherwise [2]. Hence, power vested in stakeholder categories such as state or federal government systems and electricity networks makes them relevant in the adoption of new technologies like SES. Legitimacy is an attribute which puts the stakeholder's actions under the moral framework of propriety or socially constructed values and systems [12]. Pragmatic legitimacy involves support for an organizational policy in exchange of expected returns. Moral legitimacy is driven by the notion to do the right thing regardless of the benefit offered by the situation. Cognitive legitimacy, at the same time, can be based on comprehension of a technology or transition or the adoption of a technology when alternatives become impossible. A legitimate stake, in the absence of power, can be enforced only if it is proven to be urgent. The urgency of a stake depends on its time dependence and criticality. Hence, while evaluating the significance of each stakeholder category, it is necessary to consider these three attributes. The present study involves open-ended discussion with participants from the stakeholder categories of SES retailers and installers. Their perspectives were analyzed based on power, legitimacy, and urgency.

2. Theoretical Framework

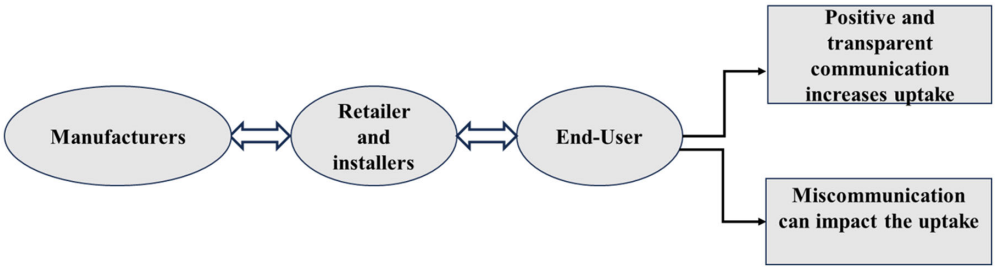
The stakeholder theory emerged after the pioneering works of Freeman, who defined stakeholder as a group or individual who exerts influence or is influenced by the achievement of a common goal or target [13]. Donaldson and Preston [14] developed stakeholder theory further, by considering its descriptive, instrumental, and normative aspects [15]. Stakeholder theory is descriptive and incorporates various stakeholders, it is instrumental in establishing connections, and it is normative [16]. Being normative implies legitimacy and intrinsic value. Stakeholder theory also invokes simultaneous management of multiple legitimate stakeholders.

The first step in stakeholder theory is the identification of the stakeholder [17]. There have been multiple definitions of who a stakeholder could be based on narrow and broad perspectives [18]. Stanford Research Institute put forth the narrow vision that a stakeholder without whom the system cannot exist [19]. This definition excludes actors who may have indirect but profound impacts on the system and its changes. Yet another classification involves categorizing stakeholders and voluntary or involuntary bearers of risks, which restricts the idea of stake to its vulnerable value. According to Mitchell et al. [20], any actor can become a stakeholder once he or she possesses any three attributes – power, legitimacy, or urgency. Identifying stakeholders based on such broad criteria is more beneficial in comprehensively addressing all the barriers and drivers in any system transition. Curtius et al. [21] analyzed the influence of an array of actors such as peers, authorities making policies, SES manufacturers, installers or salespeople, strategic investors, etc., on the adoption of residential solar, and proved their influence on the adoption. Such studies show the relevance of appropriately identifying the hidden stakeholders to address the system transition.

Power, legitimacy, and urgency are three important characteristics of a stakeholder in the stakeholder theory. Power is the ability to induce change. Legitimacy of a stakeholder impacts the degree of influence [22]. Trustworthiness is also a part of moral legitimacy. Cognitive legitimacy and moral legitimacy of the stake can also be endorsed by effective communication; however, communication should not necessarily be used as a tactic to hide a lack of expertise. The ideal communicator is trustworthy and an expert. The adoption of any technology is based on information or communication from different agencies. Such communications are particularly significant for an emerging technology like SES devices. Literature suggests that the expansion of a technology, say residential solar, is highly dependent on the existing, installed residential solar. Hence, reliability at the time of installation or purchase and sustenance of the reliability are important in encouraging mass adoption of the technology. The adoption of SES is inherently an urgent stake, given the depletion of fossil fuels and promotion of decarbonization. Moreover, in the context of Australia, with a high residential solar penetration, the adoption of SES is all the more urgent. Hence, SES retailers and installers of SES can be assumed to uphold an important stake and their perspectives are relevant in accelerating the adoption of SES. Considering these factors, the stakeholder theory is utilized in this study to understand the role of SES installers or retailers in supporting the adoption of SES devices. In the present study, special attention is given to SES retailers and installers as a relevant stakeholder category with low power, high legitimacy, high interest, and high urgency stake. They are a low-power category since they are not in a position to enforce the transition. However, their interests and legitimacy in the transition are high and are endorsed by urgency. They are also an important intermediary in communicating the technology to the end-user. Their understanding of the technology evolves with experience, communication with the manufacturer, and with the end-user. The study indicates that the perspectives of this stakeholder category are characterized by urgency, considering criticality, and time dependence.

Stakeholder communication is an integral part of the stakeholder theory. Mutual learning and communication between stakeholders is crucial in adoption and acceptance of any new

Figure 1
Relevance of communication between stakeholder levels



technology [23]. SES retailers and installers bridge the gap between a manufactured technology and the end-user. Communication between the SES manufacturer and retailer/installer is necessary so that the retailer can ensure continued availability of the product, and the installer is completely aware of the technology they handle. Similarly, it is the responsibility of the SES installer to make the end-user understand the performance parameters of the system, including its limitations. All the communications involved should be positive and transparent so that the early-adoption phase can lead to a mass adoption phase.

Figure 1 shows a flowchart of the communication between manufactured technology and end-user through the SES retailer or installer, which indirectly influences the acceptance or rejection of the technology. Hence, SES retailers or installers play a major role in ensuring the awareness of the end-user, while being knowledgeable themselves. The expertise of the SES installer is crucial in effective communication gaining trust of the end-user [24]. There are many reports discussing the role played by SES installers in solar energy systems adoption. The work by Rai et al. [25] outlines information barrier as a primary hurdle in the adoption of solar energy systems. Among the different sources of information considered by Rai et al., such as peers, solar owners, and SES installers, the information from the SES installers is given higher priority and value because they are considered as primary sources of expert information. High unpredictability and absence of coordination among stakeholders are also barriers to the acceptance of the technology [26]. As shown in Figure 1, the communication between the SES installer and manufacturer is crucial in enabling the installer to convey information about the product effectively to the end-user. Dewald and Truffer [27] describe commodification of an emergent technology product leading to its adoption as a process requiring intensive communication between the market actors and the consumers. Hence, all the reported works emphasize stakeholder dynamics as an integral factor influencing the perspectives and adoption strategies of end-user.

3. Methods

3.1. Methodology

The mapping of participants was carried out primarily through social networking sites and professional websites. The key factor in selecting the participant was expertise in the field. Participants with an expertise in the field (at least 3 years) were chosen for both categories– SES retailers denoted as Re1, Re2, etc., and installers denoted as In1, In2, etc.

Table 1 lists the participants selected in the SES retailer and installer stakeholder categories. The designation of the interviewees shows their expertise in the domain.

Table 1
Interviewee details of the semi-structured interview

Interviewee category	Code	Designation
SES Retailer	Re1	Accredited (CEC) National solar retailer
SES Retailer	Re2	Sales Manager (CEC-accredited)
SES Retailer	Re3	General Manager (retailing firm accredited by CEC)
SES Retailer	Re4	Sales Manager (State-level)
SES Retailer	Re5	Lead of Business Development (Global)
SES installer	In1	Service Engineer (SES installer accredited by CEC)
SES installer	In2	SES installer accredited by CEC
SES installer	In3	SES installer (accredited by CEC)
SES installer	In4	Operation Manager
SES installer	In5	Operation Manager

3.2. Data collection and analysis techniques

Semi-structured interviews of 40 to 45 min duration were conducted, leaving the scope of open-ended questions based on the response of the participant. Questions were patterned to identify the role played by the stakeholder category in popularizing the adoption of energy storage systems for residential solar, their motivation to encourage the technology, and the uncertainties involved in the mass adoption of energy storage systems. A snowball sampling was employed to identify more participants. The author requested the participants to provide a referral for an individual who possesses the requisite expertise in relation to the residential solar and SES sector to identify more individuals for data collection. The reliability and validity of the study were ensured by the following:

1) The data for the study were gathered by employing several sources of evidence. The various sources encompassed existing literature and the reports from the government agencies and apex bodies in the renewable sector.
2) A coherent framework was established by establishing connections between the research questions, semi-structured interview questions, gathered data, and resulting conclusions.
3) The primary interviewees were given the opportunity to assess and evaluate the author's summary of draft study reports, transcripts, and findings in order to obtain valuable feedback.
4) Triangulation approach was used to support the finding of the study using other multiple sources such as previous literature and data published in websites such as the Clean Energy Council of Australia.

5) The internal validity of the study was strengthened through the process of participants' concordance. The author shared the findings related to, and attributes involved in, the transition to SES via email with two participants from each stakeholder category who had participated in the study. The purpose of this communication was to seek confirmation, congruence, validation, and approval of the interpretations made by the author.
6) The author established document databases with comparable organizations for each investigated stakeholder category, ensuring reliability and transparency. The database of each company encompassed various components, including interview questions, audio recordings of interviews and transcripts of interview emails, organizational documents, interview notes, and external secondary data sources, such as reports by the CEC and CER and existing literature on SES.

The participants of the study belonged to the residential solar and storage market at various levels, and they were representative of the particular stakeholder groups. The interviews were conducted between January 2023 and November 2023. Quality of the interviews was controlled based on the quality of response from participants. All efforts were made by the researcher to make the participants understand the scope of research. The participants were made aware of the need and relevance of the research. To obtain informed consent, the participants were emailed with the participant consent form and participant information statement containing details of the interview two days before the interview. Signed participant consent forms obtained from all the participants prior to the interview and verbal consent were obtained during the interview.

4. Results and Discussions

The stakeholder perspectives were gathered to identify the common ideas, which were then classified into themes, as shown in Table 2. Analyzing from the perspectives of SES installers and retailers, there are primarily three major barriers to the adoption of SES devices like batteries – the product or technology-related uncertainties, lack of integration between solar manufacturers and SES installers/retailers, and economic uncertainties. Though the stakeholders equally commented on the common drivers supporting the adoption of SES devices, the urgency of the barriers demoting the adoption of technology needs to be considered carefully by other stakeholder categories with relatively more power, such as state and federal government-level policy-makers.

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4.1. Stakeholder perceived barriers to the adoption of SES

4.1.1. Product-related uncertainties

According to Rogers et al.'s [28] diffusion of innovations, despite a technology being advantageous, its diffusion is always affected by a huge gap between the perceived notions of its utility and the practical degree of utility. This is specifically true in case of a complicated technology such as batteries. It is inherently uncertain, i.e., it lacks predictability in various dimensions, which makes it all the more difficult to promote its adoption, for instance, the conversation with a retailer entailed his concern regarding the lack of knowledge about the battery and its functioning (Re1).

SES installers are the primary source of information for consumers, and the complementary inputs from them are very

Table 2
Stakeholder perspectives

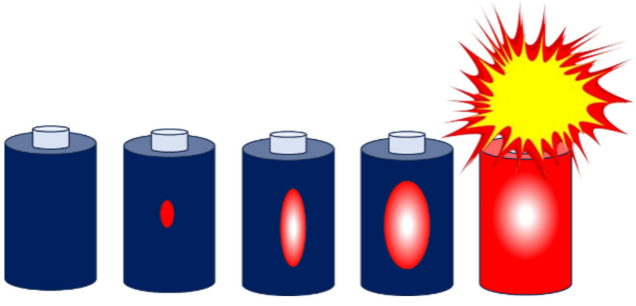
Participant	Perspectives	Themes
Re1, Re2, Re3, In1, In4	Uncertainty regarding the technology and battery safety Absence of skilled solar energy solar installers and retailers Trustworthiness of the product Communication issues Incompatibility between components	Product-related uncertainties
In2, In1, In4	Knowledge of sales consultant Supply chain issues and unavailability of battery, prolonging the wait period, discouraging consumers Manufacturers are still working on the technology Availability of brands and supply chain issues Manufacturer reliability and information Lack of technical support from manufacturers	Integration between multiple stakeholder categories
In2, In4, In3, In4, In5	High pricing, longer payback periods, low ROI, absence of incentives	Economic uncertainties
Re1,Re2, Re3, Re5, In1, In2, In3, In4	Decarbonization and clean energy Energy independence and self-sufficiency Adoption of more renewables Utilizing excess power Power backup Phasing-out of tariffs Community battery	Drivers to the adoption

important in determining the acceptance of the technology. However, these intermediaries themselves lack confidence of the technology they sell. There is a lack of information about the functionalities of the product, and the SES installers or retailers are not skilled in the technology. There are also concerns from the end-user regarding the safety of the product. A retailer conveyed that batteries are associated with issues such as explosions, making consumers more conscious, and they tend to more vigilant by adding home insurance to be on the safe side (Re2). Other participant also expressed that he was subject to a number of questions regarding the safety of the battery, such as whether it will catch fire, whether it will burn the house down, etc., which according to his perspective was also caused by the information the consumer is getting from the media. The news regarding battery-related explosions are often projected by the media, raising consumer concerns when it comes to adoption of batteries (Re3).

The SES installers or retailers are also unable to convince the consumer regarding safety of the product unless they are aware of what might or might not go wrong. The familiarity with the evolving energy storage scenario is necessary to convince the consumer of its pros and make them vigilant of the cons. However, the SES installers themselves are struggling while adapting to the new and changing availability of energy storage device. The participant said how he was familiar with the old type of lead acid battery, in which one had to check water, whereas now lithium ion-based batteries are more common. The SES installers do not get any prior training before installation, they learn and gain experience from the installation process itself (In2).

The residential solar market initially supported the use of lead acid batteries due to their low cost and low maintenance; however, they suffer from deep-discharge issues [29]. Lithium ion batteries with their ability to endure deep-discharge cycles are considered more techno-economically viable than lead acid batteries [30]. However, there are also safety issues associated with lithium ion batteries that cannot be ruled out [31]. The product-safety concerns from the end-user are relevant, given the fact that thermal runaway is a disadvantage of the lithium-based batteries [32]. Figure 2 illustrates the thermal runaway in a battery, which can take place from several minutes to hours or days. Hence, it is necessary that the SES installer is aware of ways to combat any possible accident scenarios. Implementation of monitoring systems such as battery management systems and standardization practices are necessary to protect the batteries used in residential solar application by controlling overcharge and deep discharge [33]. The stakeholder perspective is a clear indication of these product-related uncertainties and absence of standardized regulations on the installation and maintenance of SES devices.

Figure 2
Illustration of thermal runaway in a battery



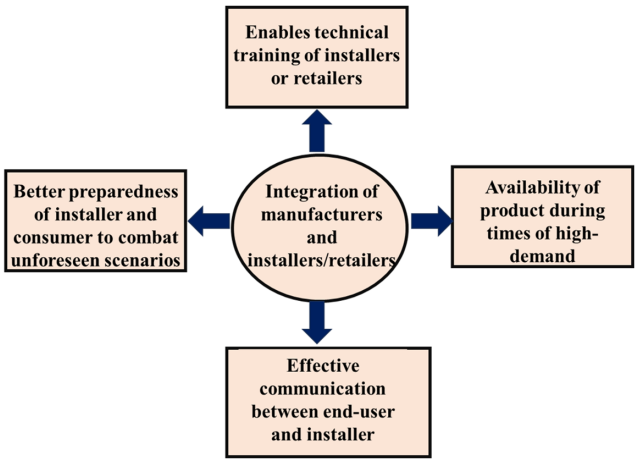
These issues also reduce the interest of the SES installers as a stakeholder category in promoting SES devices. The negative sentiments conveyed by the SES installer will directly influence the consumer. Hence, enforcing standard regulations and installation practices, taking into consideration the difficulties faced by the SES installers, is necessary to increase the stakeholder interest in promoting SES devices.

4.1.2. Lack of integration between multiple stakeholder categories

Availability of information and communication plays a very crucial role in persuading the end-user to adopt the technology. For information to be available, there should be an integration between multiple stakeholder categories. Communication between SES manufacturers and installers should be strong enough to instill in the SES installer a confidence of the product. However, often SES installers do not get technical training on the product. SES installers or retailers were not satisfied by the information they obtained from the manufacturers. The participant felt that the biggest challenge was dealing with different battery technologies with little or no prior training on the installation processes. As SES is an emerging technology, the SES installers lacked familiarity with the product, which they expressed as a major concern (In1). The manuals provided by the manufacturers are not sufficient when dealing with a complex technology, such as energy storage systems, particularly when they are integrated with residential solar systems. In-person training of the SES installers is necessary to increase their understanding of the product. However, enough support is not provided by manufacturers in this regard. Hence, there is a lack of communication between the SES manufacturers and installers, which will ultimately affect the information gained by end-users.

The rate of adoption of any innovation relies on perceived notions of its relative benefits, compatibility, sophistication, reliability, and observability. The communication between SES installer and the end-user should ensure that the end-user is aware of the relative advantages of the energy storage systems and their integration with solar systems. It has been seen that the mass adoption of residential solar occurred under the perception of relative financial advantages such as feed-in-tariffs and lower electricity costs. However, this led to consumer dissatisfaction when the incentives began to phase out. Simpson and Clifton [34] used the diffusion of innovation theory to analyze the role played by incentives in encouraging the adoption of residential solar in Australia. The survey conducted in the study found that 70% of households adopted residential solar due to the availability of financial incentives. An adoption solely based on incentives reduced the probability of re-adoption of the technology. Hence, the relative advantages conveyed to the consumer from primary sources should also include societal benefits such as transition to clean energy. The SES installer should be equipped with information of the sorts to make the consumer aware of the financial and societal benefits of adopting SES systems. Most people who adopt the technology due to the availability of an incentive or subsidy may not be fully aware of the technology and the benefits it offers to the environment in the long run. Hence, communicating and educating the consumer by the SES installer will increase the probability of re-adoption of the technology. In a nutshell, the SES installer should work within the framework of moral and cognitive legitimacy, rather than pragmatic legitimacy, i.e., the customer should be drawn to the idea of SES adoption as an option beneficial to the environment and as a primary alternative to the conventional fossil-fuel based systems, rather

Figure 3
Benefits of integration between manufacturers and retailers/ installers



than as an option to receive monetary benefits via financial incentives or subsidies.

Another indicator of lack of integration with manufacturers and retailers is the supply chain issues. A SES installer voiced this concern by saying that the unforeseen demands should be anticipated and the warehouses should maintain 20–30 percent additional stock so that the customer who wishes to adopt a battery can get it immediately (In2). The SES retailers and installers would like the manufacturer to be mindful of unforeseen demands in the market so that the consumer will not have to endure long wait periods once they make up their minds to install the energy storage systems. The cooperation of the stakeholder categories is important to avoid scenarios where an unavailability of the product discourages the consumer from adopting the technology. Figure 3 shows a schematic summary of the benefits of integration between manufacturers and retailers/installers.

4.1.3. Economic uncertainties

The SES installers and retailers recognize economic uncertainties as a major hurdle in the reluctance towards accepting SES devices. From the perspective of stakeholder theory, stakeholders exercising power can only make relevant changes in that front. SES installers and retailers lack the power to implement any kind of changes that will eliminate the financial constraints involved. However, their opinions on the economic uncertainties should be treated with urgency by those in power. The SES installers are often faced with customers who understand the benefits of the technology, however, wish to avail potential rebates or subsidies before adopting the technology (In2). High payback periods, low return of investments, and absence of incentives discourage people from adopting the technology. The participant conveyed that getting a payback within the warranty period is a critical factor in encouraging adoption of batteries. Then only the technology can justify its own capital import within the period of warranty. This is perceived as a stumbling block for the retailers to strongly recommend the technology to customers (Re4).

The high-price scenario makes it difficult for the SES retailers or installers to recommend the system to the consumers, especially when they are too concerned about the financial constraints. This also calls for an integration between SES installers or retailers and other high-power stakeholders to increase the economy of SES devices in the market. Developing countries have adopted the pay-as-you-go (PAG) model to encourage the adoption of residential solar [35]. Such kind of models can be implemented to encourage the adoption of energy storage devices through a periodic, incremental, and flexible payment system.

4.2. Stakeholder perceived barriers to the adoption of SES

Decarbonization goals and the urge to achieve energy security are perceived as greatest drivers in the adoption of SES by SES installers/retailers. United Nations sustainable development goals 13 and 7 (clean and affordable energy and climate action) call for integrated efforts from nations to achieve the net-zero carbon target. Specifically, Australia has embarked upon an ambitious target of attaining net-zero emissions by 2050 or earlier [36]. The SES installers and retailers consider this tendency to switch to the "clean energy option" as a major motivator in the adoption of storage devices for residential solar.

The SES installers can play a significant role in giving more awareness to the people. Door-to-door marketing is considered as the most influential marketing strategy for the adoption of residential solar and storage [25]. Such marketing campaigns should also involve multiple stakeholder categories such as sales personnel and SES installers who can give perspective on the technology and its role in reducing greenhouse gas emissions and decarbonization. Sales techniques involving a direct interaction with the consumer will also encourage proliferation of SES in a community via peer-to-peer interaction. One of the retailers shared his experience, wherein the news of the installation got out in the neighborhood and family via word-of-mouth and it kept spreading through friends and family. Door-to-door marketing and word-of-mouth can influence an entire community. The market players adopting this technique can make the consumer aware of the "big picture" including the decarbonization and climate action, while also conveying the other advantages such as financial incentives. However, the legitimacy of the market player is also important while considering such marketing strategies.

Consumers can also be made aware of the benefits of attaining independence from the grid. SES installers and retailers have also recognized the change in attitude of their consumers, wherein they wish to achieve energy security and energy independence.

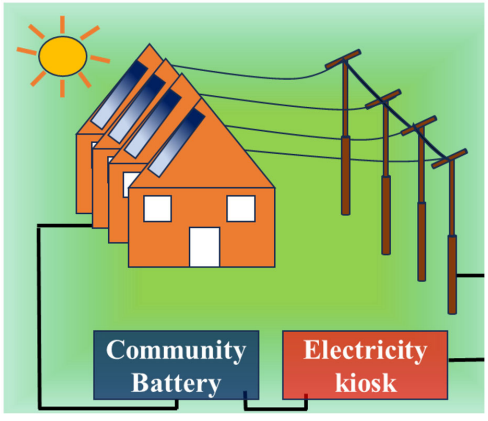
The retailers mentioned how everyone wanted to get a complete independence from the grid, and the concept of creating your own energy offers more flexibility on how the power is used. Moreover, people also tend to give relevance to the greater good that can happen in the world by the adoption of more renewables and storage systems. (Re3). The retailer said how everyone wanted to have their own energy systems and how they wanted to be energy independent. In general, consumers realize the benefits of having a grid-independent energy system at home. The retailer expressed how the consumers wish to generate solar energy and they wish to use it in the daytime and store excess in the battery for use in the nighttime. Attaining energy independence is perceived as a major motivator to the adoption of solar and storage systems (Re1). Batteries are increasingly being viewed as an energy backup option, which will redeem the consumers from reliance on the grid. Combining various energy storage systems, such as batteries and hydrogen vector energy, has been considered in literature to obtain 100% renewable energy-powered residential scenario [37]. High pricing of the batteries is yet again a hurdle for the consumers who wish to adopt the technology. In the

context of Australia, the existing premium feed-in-tariffs schemes such as the solar bonus scheme and subsidies on residential solar can be re-directed to batteries to motivate mass adoption of SES [38]. This requires action from high-power stakeholders. Community batteries are another viable option which will reduce the burden on individual consumers while ensuring availability of energy and avoiding wastage of excess power. The participant expressed how everyone in a community can share the battery power, which eliminates disparities because everybody has access to the power. He also said that when someone in the community did not have enough power to run certain things in their house, they could borrow energy from the neighbor who may have enough storage (In2).

A shift from ownership status to a community-owned status will reduce the investment costs and risks held by individual consumers. Unlike batteries installed inside house, the community-owned battery is installed outdoors, as shown in Figure 4. Berg et al. [39] have indicated increase in economic benefits when individual-owned batteries are replaced by community-owned batteries. Interactions within a community and their correlation with market dynamics can influence the promotion of novel technologies like SES. Simpson [40] conducted 50 semi-structured interviews to analyze factors beyond financial incentives influencing the adoption of renewable energy among two Australian communities. The study reported that integrated community activities promoted adoption of residential solar in the neighborhood whereas activities lacking cooperation and integration within the community resulted in sub-standard installations.

Concerns regarding the high prices, safety, and lack of government regulations are roadblocks in the proliferation of SES devices. High-power stakeholders should intervene and make policies in consultation with market players, SES installers, and retailers to understand the needs of the end-user and promote the adoption of SES. Since SES retailers and installers communicate directly with the end-users, they play a vital role in addressing consumer concerns while making them aware of the pros and possible cons of SES. They also play an important role in educating consumers about the decarbonization goals. However, being a low-power stakeholder category, SES retailers and installers need support from other stakeholder categories such as manufacturers and high-power categories such as federal governments and policy-makers to implement their perspectives. They also need a strong support from the manufacturer to gain necessary expertise in handling the SES technology, assisting the consumer with the maintenance of the device, and sorting any issues that may arise during the functioning of the device. Currently, even certified SES installers complain of the lack of training and orientation provided to them on the products they install. This is where standardized regulations can help SES installers in maintaining the quality of installation regardless of the manufacturer. The manufacturer should be liable to formulate standard practices on the functioning of the product and provide hands-on training to the SES installer. The manufacturer should also make sure of the availability of the product, in case of an unforeseen surge in demand. When retailers are faced with a deficit of the product, the customer who is willing to adopt the technology will have to wait for long periods of time, ultimately discouraging the customer to buy the product. The integration between various stakeholder categories is, hence, essential to ensure a smooth transition to a reliable and independent residential renewable energy scenario, combining solar and energy storage devices.

Figure 4
A schematic illustration of the community battery



5. Conclusion

The study recognizes the SES installer/retailer as a prominent stakeholder category in the field of SES, since they bridge the gap between a prospective consumer who becomes a prosumer on adoption of the technology. Stakeholders are categorized based on power and interest. SES retailers are a high-interest, low-power category, and installers are a low-interest, low-power category in this regard. Their engagement with the technology and direct involvement with the consumers make them important. The power and interest aspects of the SES retailers and installers can be enhanced via co-evolution of various stakeholder categories. The analysis of stakeholder dynamics indicates that a lack of integration between the stakeholder categories is a major issue faced by the SES installers and retailers. Retailers are unable to ensure availability of stocks, without which a prospective consumer may be discouraged to adopt the technology. Hence, integration between manufacturers and retailers is necessary to ensure an uninterrupted supply of the product. The communication between SES installers and consumers should be efficient and effective. The SES installers should be experts in the product, so that they can enlighten the consumer with specific and technical information regarding the product. Hence, the integration between manufacturers and SES installers is necessary, so that the SES installer can co-evolve with the manufacturer from a low-interest category to a high-interest category by gaining more insight into technical aspects of the product. The policy-makers should also consider the difficulties faced by SES installers and retailers to formulate standard regulations unifying the installation and maintenance practices and also fund consumer awareness programs involving these stakeholders. The SES installers should also take the responsibility of making the consumer aware of the possible issues that might arise in the product in the long run and should not create a mirage regarding the functionality of the product. A mismatch between the perceived and actual functioning of the adopted technology will disappoint the consumer, preventing further adoption of the technology within the community. Hence, the SES installer-consumer communication should be transparent and legitimate, so that a peer-to-peer communication will encourage the adoption of the device. The study underlines how SES retailers and installers can energize the future through a proper integration with other stakeholder categories, increasing the availability of the product,

gaining expertise, and transferring the knowledge to the consumer for a proper maintenance of the product, encouraging re-adoption.

The current study is qualitative in nature which gives the perspective of various stakeholders of the transition. An expanded quantitative survey, conducted among diverse sample populations, could offer more insights to the study. In order to better understand the value offered by solar and storage systems, financial assessments may be conducted as part of future work on the SES in the residential sector. This would help determine how much, in the way of subsidies or incentives, power users might reasonably look for to encourage avoiding network augmentation. Theories of consumer behavior may be relevant in aiding the implementation of tariff reform; more research on this topic is warranted. To maximize savings potential, this may entail improving customers' comprehension of, and readiness to, adjust to new technological systems and price structures. Using ideas from other industries that take cues, habits, and non-financial incentives into account, one may look into factors that influence behavior change in addition to monetary benefits.

Recommendations

The study used stakeholder theory to study low-power stakeholder categories such as retailers and SES installers who engage directly with the technology and end-users. The major barriers to the proliferation of SES are product-related uncertainties, economic uncertainties, and lack of co-evolution of stakeholder categories. The drivers were found to be decarbonization goals and urge to attain energy security and independence, and energy sharing. The stakeholder perspectives indicate that the stake upheld by SES retailers and installers are legitimate and urgent. However, they lack the power to enforce the stake. Hence, policy-makers should consider these stakeholder categories, taking their experience into account while formulating policies. A co-evolution of SES manufacturers and installers will increase the expertise of the installers. Coordination between manufacturers and retailers will make the product available at all time. Integration between policy-makers, SES manufacturers, installers, and retailers will enable a smooth bridging of the technology and the end-user, encouraging adoption and ensuring re-adoption.

Ethical Statement

This study does not contain any studies with human or animal subjects performed by the author.

Conflicts of Interest

The author declares that he has no conflicts of interest to this work.

Data Availability Statement

Data are available on request from the corresponding author upon reasonable request.

Author Contribution Statement

Nikhil Jayaraj: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration.

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