

# Women roles for saving energy and net-zero emissions for solar energy

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**Abstract.** Climate change and energy issues for saving, consumption, and renewability suffer from illiteracy and ignorance. In the patriarchal society like Indonesia, women performed vital roles in the households. Women can play strategic roles as agents of change i.e. transformation of energy sectors and decision makings. Indonesian Directorate General of Mineral and Coal launched regulation 26/2021 stated that household sector is the main consumer targets for solar energy plant using grid connected. The facts showed middle-high income's households unlikely install solar panel. Electricity motorcycles and cars do not mean so much when the batteries must be charged with non-renewable sources. Meanwhile, the heat in Pekanbaru is abundance and has potential for solar energy. The research will elaborate perception of 20 educated person and 10 career women on how their energy consumption and the possibility of solar panel usage in their houses using in-depth interviews. The research showed women in Pekanbaru spent at least a half million even two million rupiah per month, especially for air conditioning and hot water. The lack of knowledge of solar energy and solar plant installation led to women roles indecisive.

## 1 Introduction

Climate change results from fossil energy affects most people in the world. Indonesia has started to meet the target for net-zero emission by launching regulations and measures for green and clean energy. Net zero emission is urgent so countries in the worlds race to achieve their commitment for net-zero emission. The fulfillment is categorized into 3 categories from the best one to the least: In Law (27 countries), In Policy Documents (50 countries), and Proposed/In Discussion (60 countries). Unfortunately, Indonesia scored at the bottom of least one i.e. Proposed/In Discussion in the next year of 2060 [1]. Reports and news in Indonesia stated cutting carbon to net-zero plan to be done by empowering state-owned electricity company (PLN) to be a clean energy company.

Indonesia comprises over 17,504 islands and as well as across equators bestows with renewable sources from solar, wind, hydropower, ocean, and bio energies. Solar energy represents the highest potential of all existing energy sources in Indonesia. Located at the equator, the average solar energy generation potential is 4.8-5.1 kWh/m<sup>2</sup>/day, or equivalent to 112,000 GWh/day in Indonesia [2]. Solar energy has contributed to around half of global

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generation capacity additions because it is cheap. Indonesia's solar energy sector is small compared to its Southeast Asian peers. The installment of total 154 Megawatts (MW) is far below Australia (25,000 MW) and Vietnam (16,500 MW) and even below Singapore (377 MW). The development of technology and scientific solutions for clean energy progresses significantly but the society involvement for the target is lag. Integration of social aspects from women empowerment and inclusion was less likely conducted in Indonesia.

Several alternatives of solar panel include rooftop solar, agrophotovoltaics (APV), former mining sites, and Floating solar PV (FPV). Rooftop solar could be the option since it does not occupy extra space and large amounts of solar can be accommodated on residential, commercial, and industrial rooftops, building facades, and other urban areas. The cost depends on the panel type, roof type and size of the solar system. Overall, the price of installing grid-tiered solar systems can range from 40 million IDR for small houses, 90 million IDR for medium sized townhouses to 150 million IDR or more for larger bungalows.

Stable distribution of solar radiation thorough the year leads Indonesia's average global horizontal irradiation (GHI) 4.8 kWh/m<sup>2</sup> per day [3]. According to the Global Solar Atlas PV study (2020), it is higher than the daily average GHI in Germany (2.9 kWh/m<sup>2</sup>), Japan (3.6 kWh/m<sup>2</sup>), China (4.1 kWh/ m<sup>2</sup>), and Singapore (4.5 kWh/ m<sup>2</sup>) [4]. Pekanbaru, Riau's solar energy potential comes from irradiation intensity is even higher than 4 kWh/m<sup>2</sup>, i.e. 5.85 kWh/m<sup>2</sup> in February and even 6.06 kWh/m<sup>2</sup> in March for Riau [5]. Indonesia's achievement for 152.44 MWp in 2020 was far of target for 207.8 GWp. Costly investment, half-hearted government policies, and social economic disadvantages could be the main reasons. Women from middle higher class more likely make decision for household financial management. Culture, education, experience, and gender will affect perception that result in decisions and behaviors. Elaboration of women's perspectives of utilizing solar energy for their houses and businesses to achieve Indonesian government solar energy utilization for 207.87 GWh in 2025 and net-zero emission 2060 should be done [6]. The study explored women's perceptions based on her culture, education, experience for solar energy utilization and solar panel installation in achieving net-zero emission. Women's information and knowledge about government regulations and measures for process and the cost of rooftop installment, subsidy for electric vehicles (car and motorcycle) purchase as well as the benefit was provided.

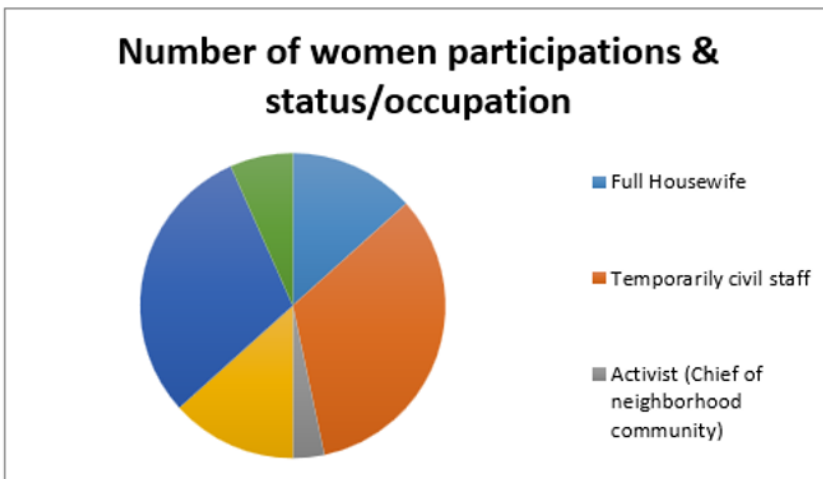
## **2 Material and methods**

Societies determine the goal, targets, and mission of global and government programs, especially on environmental awareness. Net-zero emission is still in proposed/discussion in Indonesia. The government has launched many regulations and policies for achieving the target by Gender Empowerment and Social Inclusion (GESI). Women's significant roles for decision and behavior resulted from the perception. Education, culture, and experience of the women are collected. Information and knowledge of the economic and social benefits for installing rooftop solar panel was acquired by conversation through WhatsApp and informal meeting individually and together. Living close to a female chief neighborhood community who is running for Pekanbaru councilor enabled researcher to converse with other female neighbors accidentally. By doing this, opinion, and perception of awareness for solar energy was raised and their responses were genuine and clear. Bills for monthly electricity and the proportion of the household budgets were collected. Questions raised were "Which residents of this neighborhood installed solar panel at their house? Are you aware of environment such as solar energy installation, electric motorcycle and car? "Does your house have rooftop solar panel? Is there any planning to convert and/or supplement (hybrid) your electricity energy from the electricity state-owned enterprise (PLN)? Why? "Have ever heard or seen solar panel energy (by showing pictures)? What do you think or know? Responses from the

conversation were recorded in a word document from mental memory, messages from WhatsApp were collected and conversations from housewives (taking 2 other enumerators to accompany) were taken into notes. All the data were compiled based on the issues to be described and analyzed about women’s understanding, perspectives, and behavior for solar energy. A female private bank executive charged with loan was interviewed of the credit processes and documents to install rooftop solar energy (number of clients, amount of loan and interest, installment loan, selling electricity overproduction from households, and subsidy from government). A detailed study could predict whether government policies will encourage households to install more solar on rooftop. Under a newly issued regulation by the Minister of Energy and Mineral Resources, the electricity state-owned enterprise (PLN) will pay for 100% of the electricity produced by customers’ solar panels (previously 65%). Meeting informally with an Indonesian state-owned electricity company (PLN)’s staff enabled the researcher to prove whether government promises to encourage people converting into renewable energy especially rooftop solar panel is progressing. Collecting data from different stakeholders and interest i.e. women, bank officers, a female local legislative candidate could verify the finding to increase validity [7].

### 3 Results

Women social status based on their occupation showed several different levels and activities (Fig. 1). Most participants more likely heard about renewable energy, especially solar panel but not exactly what it was. Education level, culture (social and economic class), and experience led to the perceptions of the green and clean energy. Experiences for going abroad and studying overseas played important roles for good information and knowledge of renewable energy i.e. solar installation, since Pekanbaru produces abundance of solar irradiance.



**Fig. 1.** Women status/occupation.

Among educational background, economic status, and experiences being abroad for studying or accompanying their husbands showed that the last one played the most significant (Table 1). Renewable energy has been harnessed from wind, water, and solar irradiation. Many develop countries utilize them for mass transportations (trains, buses, and cars), heaters, and any other electricity appliances. Having been in the United States, Germany, Australia, and United Kingdom enabled those 6 women saws or even utilized the solar energy.

**Table 1.** Education background, monthly income, being abroad.

| Education background |    | Economic status/monthly income in million Rupiah |    | Experiences going or/and studying overseas |    |
|----------------------|----|--|----|--|----|
| High school/ Diploma | 4  | < 5 million                                      | 2  | Never                                      | 20 |
| Bachelor             | 8  | >5<10 million                                    | 10 | Going                                      | 6  |
| Master               | 10 | >10<15 million                                   | 12 | Studying                                   | 4  |
| PhD                  | 8  | >15 million                                      | 6  |  |    |

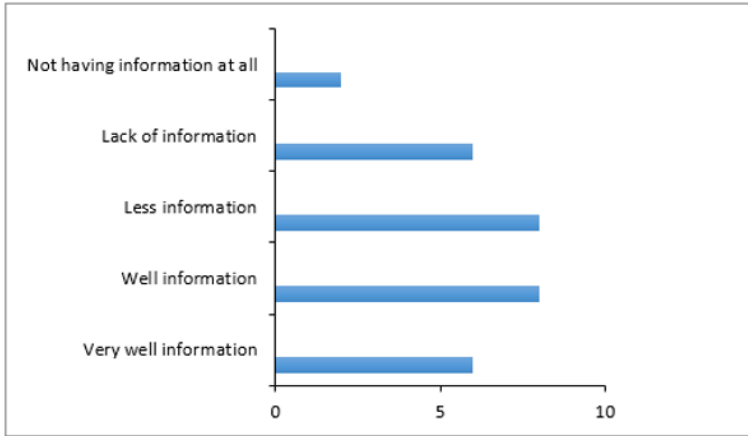
Proportion of electricity bills (not including gas for stoves/cooking) are more than 10 percent more expensive since houses in Pekanbaru do not need heater that consumes three times energy as much as air conditioning (Table 2). High temperature and humidity could be relieved with higher ceiling and plating big trees. Pekanbaru municipality mandatory tree planting for every household (at least one tree for every household) has been discouraged. Currently Pekanbaru authority is campaigning and appealing local society for having one fruit tree in every household to produce fruits, oxygen, and fresh air. Property development companies tend not to comply with mandatory to plant one tree that produce fruits, oxygen, and fresh air for everyone new house. Rarely did housewives complain bugged for electricity bill and natural gas.

**Table 2.** Electricity bills monthly.

| Thousand rupiah | Proportion of revenue | Number of women/households |
|-----------------|-----------------------|----------------------------|
| 200 - 400       | 10%                   | 2                          |
| 400 - 600       | 15%                   | 8                          |
| 600 - 800       | 18%                   | 12                         |
| 800 – 1,000     | 12%                   | 4                          |
| 1,000 – 1,500   | 21%                   | 2                          |
| >1,500          | 20%                   | 2                          |

### 3.1 Information about solar energy and installation

Women have more chance and opportunity to interact and communicate formally and informally through regular social gathering (*arisan*), monthly neighborhood meeting, parties, family gathering, and any other sociability. Generally, women converse about family conditions and achievements for schools, career, traveling, and viral news. Rarely were they talking about environmental issues such as energy saving and renewable energy development. When the researcher asked the building at the big public university in Riau Province to install solar panels the response took so long and unfulfilled. The participants more likely showed low information and knowledge about solar energy (Fig. 2).



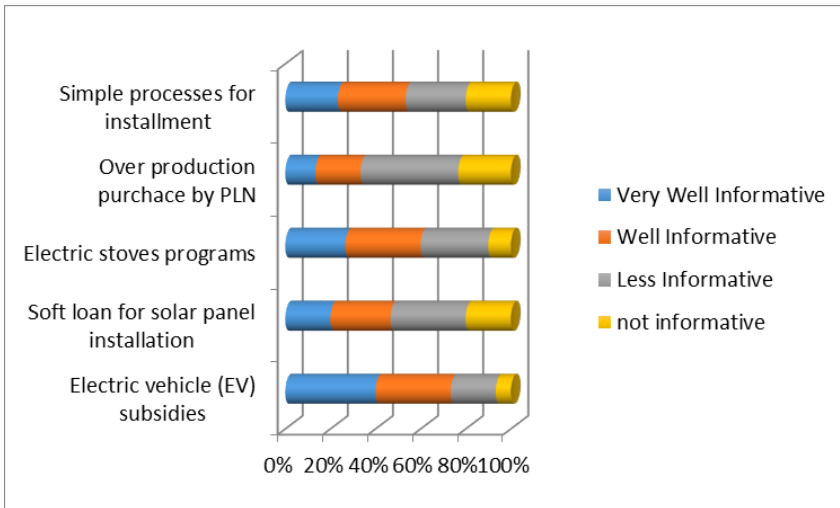
**Fig. 2.** Level of information and knowledge about solar energy.

Questions for installing rooftop solar energy to participant who have well information and very well information (14 participants) revealed their reluctance to do so for reasons of long process and procedures, cost, home esthetics (flat and very simple roof), and not prestige. Very well-informed women and well informed women tend to not be interested in utilizing rooftop solar energy to support national and international net-zero emission’s ambition due to the consideration (Table 3).

**Table 3.** Response of solar energy disadvantages from 14 participants.

|                          | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|--------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|
| Long process & procedure | V | V | V | V | V | V | V | V | V | V  | V  | V  | V  | V  |
| Cost                     | V | V | V | V | V | V | V | V | V | V  | V  | V  | V  | V  |
| Home esthetics           | V | V | V | V | V | V | V | V | V | V  | V  | V  | V  | V  |
| Not prestige             |   |   | V | V | V | V | V | V | V | V  | V  | V  | V  | V  |

Indonesian government has launched program, scheme, and strategy to boost New Renewable Energy (*Energi Baru Terbarukan*). Transforming Indonesia into a leading manufacturer of batteries and electric vehicles, subsidizing EV cars and motorcycles purchasing, developing domestic Electric Vehicles (EVs) production facilities, setting domestic producers manufacturing 15.3 million electric stoves to switch households’ cooking activities from subsidized liquefied petroleum gas (LPG), and facilitating soft loan to install grid-tiered solar system as well as purchasing the overproduction by Indonesia state-owned electricity company (PLN) are implemented. In-depth interviews to the participant also asked whether they have information about those Indonesia government schemes, the price of installing that can range from 40 million IDR for small houses, 90 million IDR for medium sized townhouses to 150 million IDR or more for larger bungalows, and the entire processes and procedures to set it. Two Indonesian private bank officers and one Indonesia state-owned electricity company (PLN)’s staff who are studying for their masters in Australia were interviewed about the process and procedures as well the policies and implementation. The results showed lack of information and interest among the women and issues of opportunistic mining entrepreneurs vested interest (Fig. 3).



**Fig. 3.** Level of information about Indonesian government schemes.

Economic and social advantages for profit, saving, as well prestige led to perception that manifested in acts and behavior. Prestige can be a power to impress or influence, coming from wealth and property. Wealth is an accumulation of valuable economic resources that can be measured in terms of either real goods or money value. Possessions of big house with air conditionings, good cars, branded clothes, bag, and shoes, travelling experiences are the indicator of success, prestige, or even happiness. Unfortunately, none of the participants mentioned for being eco-friendly by having rooftop solar panel as an indicator of success and wealth.

## 4 Discussion

Participation determines success of government programs. Information, knowledge, experience, and culture more likely influence the decision for action, behavior, and participation. Information seeking is an essential factor in the buying process of a customer to achieve satisfaction [8]. Citizen rarely engaged through the net-zero emission program when social and economic advantages remain limited. Knowledge and perspective influence citizens' engagement of government sustainable program [9]. Patriarchal Indonesian cultures mandate women to take care of domestic chores including wise spending. Many significant decisions such as electricity bills and liquefied Petroleum Gas (LPG) for stoves' saving, house maintenance to name a few is on the hand of women. People act on their perception the meaning of the world or environment. Educational background, age, social status, and experiences influence perception as the foundation for decision and behavior. New information plus new experience predisposes new perception [10]. Social media, informal interaction and communication, social gathering with neighbors, friends, families, and colleges provides new information and new experiences. Global survey about eco-friendly consumers by PwC showed Asia-Pacific region are becoming more eco-friendly. Indonesia ranks 86 percent eco-friendly better than its counterpart Vietnam and Philippines for 74 percent [11].

Ranking Indonesia for the highest eco-friendly consumers was ambiguous and questionable. Indonesian president Joko Widodo target of having 20 percent of all cars by 2025 and minister Luhut's ambition to becoming Indonesia "one of the top three countries in the world producing EV batteries as well as electric cars" by 2027 could be hard to achieve

[12, 13]. Electric Vehicles (EVs) for cars and motorcycles as well as stoves need electric charging at home, so the users must provide facilities by installing rooftop solar panel. Data showed most participants are reluctant to convert their energy from state-owned electric company (PLN) to independent solar energy.

Knowledge influences decisions, behaviors, and participations. Objective knowledge is the current information of that knowledge; meanwhile, subjective knowledge is the consumer's perception of something. Rational decision-making results from defining the problem, identifying the decision criteria, allocating weight to the criteria, developing the alternatives, evaluating the alternatives, and selecting the best alternative [14]. Advantages from economic consideration of profit coming from bank soft loan for installment and selling over production to PLN, simple and fast processes for conversion as well social achievement to be prestigious person as eco-friendly actor could not be demonstrated as the data on table 3. All of the women responded unanimously lack of economic and social advantages. Only two very informative women about solar energy stated being prestigious as eco-friendly consumers for installing rooftop solar panel in their houses. Reasons for not installing solar panel were share by one of high educated, rich overseas experiences, and very well informative participant:

I haven't had any solar installment for my house as well as the planning for it. My rooftop must be modified and that could ruin the architecture, undermine activities during installment and costly. I will convert my electric energy to solar if the government provides sufficient funding for the renewable energy project ... Honestly, I don't like electricity energy sources from fossil like coal, it's going to be reasonable if government install central solar energy like Singapore but many aspects should be considered, and it will be very tough to implement it.

Simple solar energy panels have been purchased and utilized by several informative and very informative participants as they stated:

I have several solar appliances for my outdoor lights at front yard and backyard gardens, even indoor. They are cheap, purchasable, and economical. Temporary electricity black out (very hard raining, gale) is solvable with portable solar appliances. Unfortunately, portable solar appliances only fit for lighting, not for television, or even electric car charging.

Advantages of having solar energy appliances have not motivated middle higher income households to install rooftop on-grid solar panel or hybrid due to long and tedious procedures. Motivation has an essential role in regulating someone's behavior [15, 16]. Moreover, consumers tend to be careful before purchasing electronic items because it need significant costs and usually used for a long time [17]. Easy, quick, and pleasant processes or procedures differ with United States, Australia, Singapore, or any other developed countries. Vested interests of investors, politicians, and even PLN itself to maintain their profit and position for monopoly discourages rank and files being eco-friendly persons by installing solar energy, buy electric vehicles, or even donating and volunteering for government schemes and programs. Advertisement about new Ministerial Regulation No. 49/2018 as a policy that would enable owners of residential, commercial, and industrial rooftop PV systems to "sell" excess power to the grid does not meet the reality [18]. Informal conversation with a PLN staff who is studying master in a prestigious English-speaking country proved the issue:

I am not sure about government regulations to achieve target of net-zero emission ... so far, I know the promise is to buy households over production from installing on-grid or off-grid solar energy installation is no longer implemented. Indonesia state-owned electricity company (PLN) has already been over-production and it needs consumers not competitive producers. PLN is state-owned company who monopolize electricity demand. Coal investors and entrepreneurs (even has roles as politicians and/or cabinet member) get advantages from Indonesian abundant coal ores. They want to be rich from

coal industries that are non-renewable and eco-destructively for environment ... that is why I plan to do research on hydrogen energy.

Chatting with two women private bank staffs asking process and facilitation to get loan and the payment to install rooftop solar energy showed not prospective decision:

I rarely had customer asking loan to install rooftop solar energy and its subsidy ... one of my customers was a public university associate professor who borrowed money to build off-grid solar energy at the campus area to process organic compost ... but I forgot the amount of money and the procedure whether it got soft loan and subsidy or not. I have contacted PLN staffs and they said customer candidates have to visit Pekanbaru PLNs headquarter, fill the form, and any other process by themselves, every customer has to come and talk to PLN staff ... no integrated processes among customer, banks, and PLN for the rooftop solar panel exists.

The evidence was proven from news and personal experiences. Government target to cover the purchase 200,000 new electric motorcycles and the conversion of 50,000 two-wheelers to electric one with subsidy could not be fulfilled since 1, 207 peoples who had registered for the subsidy with another 200 people already verified have not yet acquired the assistance [19].

Issues of solar energy installment, electric vehicle's purchasing and subsidies, and any other environment awareness are not interesting and promising. Several informal conversations with a female district legislative candidate as a close neighbor revealed the evidence. When she asked researcher support, the researcher asking whether she has campaign of being eco-friendly citizens, her responses were:

I don't catch what you're saying about ... what do you mean ... oh if that is you mean, I don't think our party has it ... we just want to make the society being happy and wealthy ... trust us we can make your lives much much better ... see what our party has done last time? Paving our local roads, Mosque's facilities improvement.

Women quota for 30 percent legislators has not represented environment improvement through solar energy. Rarely do female candidates voice the urgency of the best future.

## **5 Conclusion**

Women's perception for adopting rooftop solar energy installment to their house are not prospective yet. Insufficient information and knowledge about the benefit of renewable energy from abundance solar irradiance in Pekanbaru led to low engagement for converting to on-grid solar energy installment. Household's purchasing, budgeting, and planning are more likely in the hand of women. Information and knowledge about renewable energy, rooftop installation, green and clean environment or earth, and even net-zero emission are not familiar. Those issues are such kind of scholar or researcher responsibilities not for women whose duties for taking care of husband, kids, and families, cooking, and domestic chores. Electricity black out and expensive bills for electricity rarely do women's mind and decision change to find better alternatives for independent electricity sources.

Social and economic advantages influence the decision to convert electricity source from Indonesia state-owned electricity company to house rooftop installation. Being an environmentally friendly person is not prestigious and appreciated even as frugal and out of date. Symbols of success and wealth are big and modern house with air-conditions regardless trees they have, good cars, branded clothes, bags, and shoes, and overseas travelling. Conversations and discussions among women in social gatherings or parties less appreciate the one who are environmentally friendly actions. House rooftop renovations for solar energy installment spoil the architecture to be flat and unattractive. Process of installment demands time and budgeted. Collaboration among bank for loan, Indonesia state-owned electricity company, and consumers has not well integrated. Indonesian government program for



reducing even eliminating fossil and coal energy to achieve net-zero emission by producing electric stoves, electric vehicles' subsidies should be pioneered from the basic society i.e. women conducive perspective for renewable energy.

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