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STRATEGIES TO ENHANCE THE APPLICABILITY OF GRID POWER SOLAR NET METERING CONCEPT IN SRI LANKA

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ABSTRACT

The whole world is utilizing its all-non-renewable energy sources to power their social, economic, and cultural needs. Hence, the significance of renewable energy is considered all around the world at this moment. Especially compared to other renewable energy sources, solar energy shows more reliable and available in the whole world. As a result, the cleanest solar energy makes a huge contribution to the global energy balance. To power the grid with solar energy all countries around the world expanding their technologies related to solar power generation. Accordingly, the net metering concept becomes a platform to inject and strengthen the grid with solar energy. However, some conventional methods such as NCRE power generation facility, DC-AC inverter, and islanding protection system are used to expand the grid-connected solar net metering in Sri Lanka. Therefore, it is required to improve the newly applicable solar net metering expansion strategies. Hence, this study aims to propose suitable strategies for the increment in the application of grid power solar net metering in Sri Lanka. A qualitative research approach was selected to conduct this study. Initially, a literature review was completed. Then, data is collected through semi-structured expert interviews with 4 experts, who have experience and engagement in the solar industry. The collected data were analyzed through manual content analysis. Findings revealed the key driving forces and the barriers to expanding the grid power solar net metering in Sri Lanka. With regards to the identified barriers, the newly applicable strategies have shown a significant amount of importance in Sri Lanka to expand the grid power net metering concept.

Keywords: *Hybrid Inverters; Renewable Energy; Solar Farms; Solar Net Metering; Sri Lanka.*

1. INTRODUCTION

Renewable energy is a rapidly growing energy source, contributing to half of the world's energy consumption growth, and will be the primary energy source by 2040 (BP PLC, 2019). According to Apergis and Payne (2011), the global use of renewable energy for electricity production will increase from an amount of 3% per year and the use of renewable energy by 2.6% per year in the period 2007 to 2035. Coal power generation

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would be a significant source of around 40% of the Global Electricity Generation from 1996 to 2016 (Ceylon Electricity Board [CEB], 2017). Khani, et al. (2018) highlighted that gas power production has risen from 15% to 23%, while the output of oil power has declined from 9% to 3% over the last two decades.

Among those power sources, solar power has achieved the highest degree of attention throughout the world in past years (Malinowski, et al., 2017). Research has shown that world energy requirements can be achieved comprehensively using solar energy because it is available in nature and is a widely available energy source at no cost (Kannan and Vakeesan, 2016).

Solar photovoltaic technologies use the direct transformation of sunlight into electricity (Shivalkar, et al., 2015). The world average solar photovoltaic power generation proportion of 69 % is composed of Sunbelt regions with a typical solar photovoltaic electricity, a portion of 90% (Hoffmann, 2015). Therefore, photovoltaic Cell is now commonly seen as a source of energy in most residential and business premises, safe and renewable energy from available solar energy resources (Pacis, et al., 2016). Introducing solar roofs for middle-income families and linking to the national grid through net metering, paying for excess power generated and fed to the grid, and unblocking people's savings for such a purpose is economically feasible (Dharmadasa, 2016). When the amount of residential solar installations has grown significantly, utilities and other investors have expressed the perception that the Net Metering Policy delivers an incentive to solar power paid to the overall population of tariff payers (Comello and Reichelstein, 2017).

Net metering is an efficient reward program for consumers who produce electricity through their limited alternative energy systems (Sedghisigarchi, 2009). It accounts for the rooftop solar energy supplied back to the grid and can gain credits for all the excess energy supplied back to the grid over a year and can trade them for a financial benefit from the utility (Yue, 2018). Net metering allows the user to store excess energy on the grid instead of storing it in large batteries (Bedhi, et al., 2016). Besides, that net metering creates a market for solar energy systems, which, in effect, creates more jobs for installers, electricians, and manufacturers working in the solar supply chain (Cetin and Egrican, 2011). A well-designed net metering policy provides a precise, low cost, and simple plan to deal with residential photovoltaic systems (Poullikkas, et al., 2013). Historically, inverters used to convert the DC power to AC power were the primary cause of PV(Photovoltaics) malfunctions because the lifetime of an inverter usually does not exceed ten years, and the cost of maintenance is also very high (Barnes, 2013). Throughout Sri Lanka, the period of a net metering contract is restricted to 10 years from the execution date; therefore, there is a confusion that the net metering contract may proceed once the preliminary contract period has been confirmed (Wickramasinghe, 2019). Lack of knowledge or interaction of distributed generation programs and lack of awareness of the quality and advantages of the system among potential clients is holding as other barriers to implementation of solar net metering (Khurana, et al., 2020).

Consumer perception of and adoption of RTPV (Roof Top Photovoltaic) remains the most crucial obstacle in the development of solar energy that has a societal stigma (Eid, et al., 2014). Consumers have not only increased accessibility and perception of consumer rights but have also instigated flexible national policies and applicable subsidies (Matisoff and Johnson, 2017). During a survey awareness of residential heads using the net-

metering solar system was studied and results revealed that 77% of the domestic heads surveyed were mindful of energy savings through solar panel installations and the residual 23% were not aware of the gird power solar net metering (Weerasooriya, et al., 2019). Furthermore, studies illustrate that regulatory concerns do not significantly contribute to consumer attractiveness toward net-metered solar PV technology (Luthra, et al., 2015). There are no moderating effects of consumer education level and their social values on the attractiveness of net-metered solar PV (Kumara and Mahakalanda, 2019).

In the Sri Lankan context, a sufficient and expected amount of solar energy is not added to the grid due to the many barriers and interventions in the system; therefore, it is vital to be aware the general public increase the knowledge regarding solar power electricity generation (Apergis and Payne, 2012). However, the relevant bodies open to the solar industry are not adequately informed about these incentives, and the awareness of the grid power solar net metering is doubtful. Besides, several studies and projects for enhancing and developing the grid power solar net metering have been carried out in Sri Lanka. This research has identified the lack of perception among the community that impacts grid power solar net metering, and it proposes the strategies that would increase the application of the grid power solar net metering system. Hence, this study aims to propose suitable strategies for the increment in the application of grid power solar net metering in Sri Lanka.

2. LITERATURE REVIEW

In 2018, the contribution to the global energy demand for electricity production by sources seems to be 38% for coal, 23% for natural gas, 10% for nuclear power, 19% for hydropower, 7% for other supplies (solar, wind, geothermal, biomass, etc.) and 3% for oil (IEA, 2019). In addition, global renewable energy exceeded an amount of 2,351 GW by the end of 2018, of which half was still hydroelectric power. According to IEA (2019), global renewable energy production increased 7% in 2018, with wind and solar PV technologies together making provisions for 65% of this increase. Solar PV generation grew 22 % (+131 TWh) in 2019 and was the second-largest relative generation development among all renewable energies, only behind wind and ahead of hydroelectricity (Bossong, 2019). Therefore, in most countries, the production of wind and solar PV energy has become more cost-effective than the introduction of new coal-fired power plants (World Energy Organisation [WEA], 2019).

In Sri Lanka, the current level of electricity demand is around 12,000 GWh, with a rise from 6.5% to 9% per year (Kolhe, et al., 2015). The Ceylon Electricity Board has stated that Sri Lanka required an estimated 4000GWh by the end of 2025 (Ministry of Power and Renewable Energy, 2017). This amount is expected to be generated by solar power, other renewables, and native energy supplies (Laufer and Schafer, 2011). Figure 1 illustrates the solar electricity generation in recent years in Sri Lanka.

According to statistics in recent years, solar power generation and its use have observed significant improvement and accelerated production (Wijesena and Amarasinghe, 2018). To further enhance the generation of solar PV electricity in Sri Lanka, the Government of Sri Lanka promoted an incremental solar development plan in 2016 to encourage solar power projects in Sri Lanka (CEB, 2018). Following that Sagasolar power plant (10MW), Laughs solar plant (20MW), and Welikanda Solar Project (10MW) are a few industrial-

scale solar energy stations that have been installed in the last 3 years (World Bank [WB], 2018).

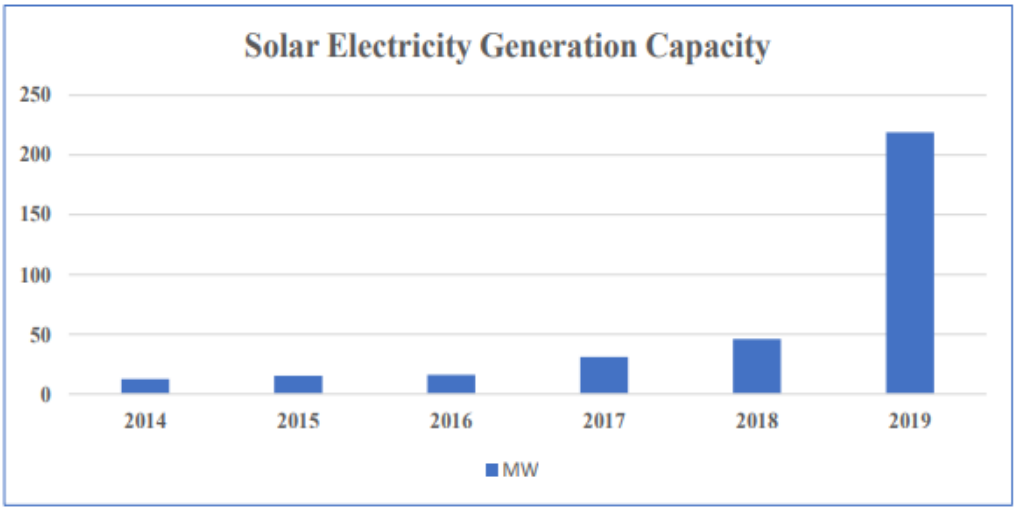

Figure 1: Sri Lanka's solar electricity generation

Source: Ceylon Electricity Board [CEB] (2018)

Grid Solar Power Systems and Net Metering are very popular in the world, particularly in the USA and Europe (Watts, et al., 2015). Many states and other countries in Europe, such as Austria, Belgium, France, Germany, and Denmark, have successfully turned their solar energy into electrical energy and power supply the surplus energy in the grid (Meena, et al., 2014). Many countries that are now generating power from solar panels have changed their off-grid solar systems to on-grid solar systems using net metering (Qamar and Khan, 2016). Small-scale grid-connected photovoltaic systems deliver renewable, carbon-free, and environmentally friendly power generation (Mitscher and Ruther, 2012). Grid-connected PV is commonly viewed as an energy system for developed countries, while independent, stand-alone PV is seen as more appropriate for applications in emerging countries where too many people often lack access to the national electricity grid (Goop, et al., 2017). However, considering the cost of the batteries it is advisable to use a grid connect system over a standalone solar power system in developing countries including Sri Lanka (Kolhe, et al., 2015). According to Hittinger and Siddiqui (2017), through this system, PV panels are installed on the roof or built into the building and the building's energy demand is met. The authors further stated that the grid is connected to the PV network and the surplus electric power is transmitted to the grid. The main advantage of a grid-connected rooftop solar system is when the power generated by the roofing system is used at the same location, the generation and distribution losses are minimized (Saxena, et al., 2017). The key components of the grid connected RTPV network are solar photovoltaic panels, module mounting mechanism, inverter, interconnecting cables and switches, and a net energy meter (Narula and Reddy, 2015).

3. RESEARCH METHODOLOGY

This study aims to propose suitable strategies for the increment in the application of grid power solar net metering in Sri Lanka. To achieve the aim, a brief literature review was carried out to identify the contribution of solar energy to the global electricity system, and

the contribution of solar energy to the Sri Lankan electricity system to get an idea about the grid solar power systems with grid power solar net metering through books, conference proceedings, internet, and journals in the first stage of research. Since it is required to collect in-depth information from professionals involved in the solar industry, a qualitative approach was carried out. Even though the aim is stated as the perception of consumers, experts were interviewed to get in-depth knowledge to identify suitable strategies for Sri Lanka to expand the grid-connected solar net metering, which helps to make it benefit the customers. Semi-structured interviews and open-ended questions were chosen in this study. Because it is increasingly realistic, and a lot of data can be obtained in a relatively cost-effective way over a shorter period. The interview guideline is prepared by incorporating the background information about the interviewee, fundamental details of solar billing schemes and grid solar power system application in Sri Lanka and the possible strategies to implement grid power system in Sri Lanka. Due to the unavailability of experts with adequate knowledge in Grid power solar systems and time constraints, the interviews are limited to four experts who have reasonable experience and broad knowledge of the solar panel industry, and experience in the solar panel whole life process in Sri Lanka. Table 1 provides those professionals' profiles selected to conduct the expert interviews. Further, the manual quality review method is used for expert interview analysis. The primary goal of the qualitative content review is to decrease the scale of the broad textual information to a reasonable size (Magenheim, et al., 2010).

Table 1: Profile of the interviewees

No	Profession	Experience	Interview code
1	Assistant Director	8 years	R_A
2	Engineer	7 years	R_B
3	Assistant director	5 years	R_C
4	Engineer	6 years	R_D

4. RESEARCH FINDINGS AND DISCUSSION

4.1 GRID POWER SOLAR NET METERING IN SRI LANKA

According to interviewee RB, Ceylon Electricity Board (CEB) and Lanka Electricity Company (Pvt) Limited (LECO) have given their customers the potential to generate energy and feed into the national grid in Sri Lanka. The current capacity of solar power that the grid is feeding by suppliers is 282MW. RA said *"Grid-connected solar is powered through net metering, net accounting, and net plus. Net metering is not like an investment in the Sri Lankan context. The consumers are intending to just pay off the electricity bill and the export credit will go to subsequent months' consumption. Due to that customer intention and other schemes are available for investment purpose from grid-connected solar power the net metering looks more important and inject more energy than other schemes"*. The respondent RB supports that by mentioning "Net metering powered the grid-connected much more than others". Interviewee RC argues that *"Sri Lankan domestic rooftop solar installations are higher because of that grid power solar net metering is shown a more significance than others".* According to the respondents' view, solar net metering is highly applied in Sri Lanka and the grid also gets received a considerable amount of power through it.

4.2 DRIVERS AND CHALLENGES FOR IMPLEMENTATION OF GRID-CONNECTED SOLAR NET METERING IN SRI LANKA

Driving forces shows more importance when achieving the established objectives to power the grid with solar energy up to 1000MW in 2025. A mentioned that" the *tariff paying for one unit is attractive".* Furthermore, C supports that "*The export energy is paying under an attractive and profitable tariff (1-7 years = 22.00, 8-20 years = 15.50 per unit) to the suppliers and it is the major driving force and the challenge to CEB and LECO".* Respondents R_B and R_D argue that "*This tariff is introduced by the CEB to promote the rooftop solar generation and it is successes up to now. But to continue this much of a rate is costly to CEB and now they are going to give a flat rate to export energy"*. The views of the respondents look a little complex, but they conclude that the tariff paying is crucial to act as a driver in grid-connected solar net metering.

According to R_C, "*The companies available in Sri Lanka are not dealing with a big profit margin due to competition in the market. Therefore, it acts as a driving force to implementation of the net metering concept".* Moreover, R_D said, "*The competitive solar companies in Sri Lanka is increased in the last decade so the net metering looks more reliable and expanded".* Therefore, the two interviewees, R_C and R_D mentioned that the solar companies' market structure also enables the solar net metering expansion in Sri Lanka. R_B said, "*The employment is over 8000 in solar net metering in Sri Lanka".* The employment opportunities in the solar industry are increased and it has grown dramatically in the last decade. Support that "*The local entrepreneurship has expanded through the grid-connected solar power projects".* According to interviewee R_D, '*Policy framework is more stable when comparing with other countries*. R_B insists that "*The regulatory bodies and policy framework are more reliable in Sri Lanka".* All interviewees support that local entrepreneurship, employment, and a stable policy framework in Sri Lanka act as a driver to expand the grid-connected solar net metering power generation.

According to R_A**,** "*The biggest challenge is on CEB that they have to pay 22.00 per until the supply end from the consumer and it is expensive than other energy sources".* As mentioned above a driver this tariff rate is introduced to promote grid-connected solar in Sri Lanka. But from another perspective, this tariff rate is a challenge to CEB and LECO. Because when compared with other sources the unit cost is higher on the utility. According to R_B, **"***Solar power is intermittent and there will be sudden drop and fluctuation on solar penetration, therefore, the system monitoring is difficult".* Similarly, R_A, the interviewee argues that "*Divergence and voltage difference. The solar energy provided by the photovoltaic system depends largely on the abundance of sunlight".* As an example, "*Areas like Battaramulla in Sri Lanka the voltage imbalance, frequency changes and instability are highly concern by CEB. In this area, the solar energy is prominently available but due to transmission and voltage fluctuations grid-connected solar is in danger sometimes". R_A* said, "*The solar power is only available in the daytime, and it has to be stored up to a capacity".* Respondent R_B support it *"Installed battery capacity is depending on the solar radiation and the location. At nighttime the electricity demand is higher, therefore, the export energy in the daytime has to be higher than the nighttime consumption".* So, the battery capacity is a limitation in grid-connected solar net metering. Furthermore, interviewee R_A emphasized that "*To improve the quality of the system technicians, they need to be aware with knowledge and training".* Training and development in the industry to expand the grid-connected solar net metering has

slowly progressed in nowadays. R_D highlighted that "*Present virus pandemic situation and climate pattern affects much on solar net metering application and development".* Furthermore, R_C said, "*The companies also in the industry have to be stable".* To improve the trustworthiness of the consumers the firms in the industry need to act as a driving force. Current global conditions and trends look challengeable to the expansion of the market.

4.3 CURRENT PRACTICES IN GRID-CONNECTED SOLAR NET METERING IN SRI LANKA

The literature identifies the various types of solar net metering practices and supportive strategies for solar net metering. Moreover, information concerning the existing practices which are unable to collect through literature review was collected through expert interviews. Soorya Bala Sangramaya and Rivi Bala Saviya (Supportive strategy) were identified through both literature and interviews, additionally, Rivi Aruna was identified through interviews.

4.3.1 Sooriya Bala Sangramaya

Under this whole scheme of Soorya Bala Sangramaya Rs.16.00 per unit of electricity, electricity is charged to power plants to get 01MW of electricity from each. Power is supplied from Rs.11.82 to 12.50 at the rate of buying 10MW from power plants. This can be decreased as large-scale solar parks are installed. Under this project, the government paid Rs.22.00 at the first stage and expected solar power generation systems on the rooftops of the customers and earns an income thereof. According to interviewee R_A, *"Soorya Bala Sangramaya is made up of four stages. A variety of initiatives to develop clean energies and power using solar energy have been initiated under this program. In the first point, every user of energy can produce electricity by deploying a photovoltaic solar system on residential rooftops.".* The current capacity and expected grid-powered solar energy capacity from Soorya Bala Sangramaya is illustrated in Table 2.

Table 2: Current capacity and expected grid powered solar energy capacity

Phase	Year	Capacity
I	2010	100MW
II	2017	150MW
III	2020	250MW
IV	2025	700MW

According to Table 2, the solar generation capacity was around 250MW in 2020, and the established goal is to power the grid up to 700MW in 2025. According to the interviewees, the most spread solar net metering practice in Sri Lanka is Soorya Bala Sangramaya. Moreover, R_A and R_D mentioned that "*Capacity of the projects have increased with the development. Relevance to the facilities of the project People can install a solar panel on their roof without obstructions and lengthy procedures".* Therefore, three interviewees mentioned, "*The Soorya Bala Sangramaya become more applicable in the country"*. R_C highlights that "*In Soorya Bala Sangramaya net metering scheme is the most used scheme to power the grid with solar power. Net accounting and net plus scheme are looking more forward as an investment so the domestic rooftop solar installations are more used as a grid-connected net metering system"*. Furthermore, R_B argues that "*The only difference*

is the solar schemes in Soorya Bala Sangramaya is based on the building type and the customer decision. Therefore, anyhow Soorya Bala Sangramaya is expanding whole over the country with that grid-connected net metering capacity is upgrading". R$_C$ said that "*Soorya Bala Sangramaya project is designed not only to solar net metering development. The aim is to aware and expands all three schemes and power the grid with solar energy".* Therefore, according to interviews, Soorya Bala Sangramaya becomes the frontline in the solar net metering in Sri Lanka.

According to R_A, "*Prosumers (stakeholders) generating electricity have risen. In Soorya Bala Sangramaya, the prosumer is a client linked to a distribution grid that holds an entity to produce electricity from a renewable source, at which energy produced is used for its use, does not own a certificate for the generation of electricity, and the surplus power is supplied in the distribution".* The opportunity of the Soorya Bala Sangramaya is it expands the stakeholders that produce electricity and power the grid with solar energy. Furthermore, R_A highlighted "*Employment and local market on solar appliances have strengthened".* R_C supports that *"Soorya Bala Sangramaya have expanded the local employment in Sri Lanka".* Therefore, all interviews support similarly with the introduction of Soorya Bala Sangramaya local entrepreneurship, and spare parts market demand has rapidly increased. The growth of the Soorya Bala Sangramaya has been slowed by some limitations in this project. R_A highlighted "*The utility party (CEB, LECO) may incur loss".* The tariff rate (22.00,15.50) paid by CEB, and LECO is high per unit. This is the major cause that CEB has to expend a considerable amount of cost to implement this project. R_B said, *"Solar energy is that it is difficult to calculate precisely the payback period of installing a solar system".* Support that "*Solar radiation is fluctuating and not available consistently. Therefore, the investment on solar is not easy to earn in quick period".* Furthermore, R_C said, "*Government interference is affecting their renewable energy policies. As an example, the newly appointed government looks to expand the wind power plants in Sri Lanka and this could affect capital investment in solar projects.*

4.3.2 Rivi Aruna

Rivi Aruna program has been launched by the Ministry of power, CEB, and SSEA in 2017 to provide solar rooftops to religious places. The total cost of this program was Rs.58 million. 135 solar systems were installed in religious places under the "Rivi Aruna" adding 270KW to the system. The summary of solar installations and capacities is presented in Table 3.

Table 3: Summary of solar installations and capacities

Religious Place	Number	Capacity (kW)
Temples	126	252
Mosque	4	8
Kovil	3	6
Churches	2	4
Total	135	270

According to Table 3, in 2017 to Transform religious properties into rooftop solar power systems by supplying affordable solar panels to chosen religious sites. The surplus power from these ventures is purchased by CEB either by a net metering or a net accounting

scheme. R_A highlighted that opportunity of this project is "*This system is become more attractive to people due to viability in many religious places".* The people get aware, and they are going to find out about this project, and it produces new opportunities to expand the grid-connected solar net metering and net accounting schemes. According to R_B, "*CEB launched this program to install solar panels in religious places and observe the beneficially of the energy feed into the grid". R*$_A$ said that *"The Rivi Aruna project becomes successful because the energy consumption of the religious place is low and the export credit energy is high towards the grid".* According to interviewees, they support that the Rivi Aruna program is beneficial and has made opportunities to expand the grid-connected solar systems. R_B argued, "*The main limitation in this system is that capital investment needs to be done by the authority".* R_A insisted that *"Rivi Aruna is a fully government-funded project. Therefore, it is difficult to carry the project whole over the country".*

4.4 SUITABLE STRATEGIES FOR SRI LANKA TO EXPAND THE GRID-CONNECTED SOLAR NET METERING

Current practices in Sri Lanka related to grid-connected solar net metering are identified in sections of the literature review. In addition, literature recognized different practices from professionals who are experts in the solar industry. According to expert opinion, can be further classified into various main sub-topics.

4.4.1 Flat Traffic Rate on Soorya Bala Sangramaya

According to R_A, "Install solar panel on roof with net metering with a fair tariff to consumer and the utility. As an example, encourage Soorya Bala Sangramaya in Sri Lanka with a flat rate that is beneficial to both utility and customer. R_B highlighted that the "Most attractive thing in the Soorya Bala Sangramaya is the tariff rate. The contract agreement of this project is 20 years and an average of Rs.17.75 per 1kW is paid by the CEB. Therefore, the rate needs to be cost-effective to both parties". R_C argues that "In this project Rs.22.00 is paying in first 7 years because the investor needs to get back his investment at a minimal time". All four interviewees seem, to amend the project proceeding with the cooperation of the Ministry of power, CEB, LECO, PUCSL, and SSEA is the easiest alternative to expand the Soorya Bala Sangramaya in Sri Lanka.

4.4.2 Introduction of Hybrid Inverters

Hybrid solar systems combine the best of the grid and off-grid solar systems. These systems can be defined as either off-grid solar with backup power or grid-tiled solar with excess battery capacity. Hybrid inverters, on the other hand, can store energy in batteries as well as provide energy to the grid. R_B highlighted "*Hybrid solar panels are more inexpensive than off-grid solar projects. Customers do not need a backup generator, and the capacity of the battery pack can be reduced. Off-peak power from the grid is cheaper than petrol".* R_A said, "*Sri Lanka has taken steps to approve hybrid inverters in the country through a draft specification published by the Standards Institution (SLSI) this month". R*$_C$ said, "The *regulations and feasibility study regarding the hybrid inverters in Sri Lanka are going to approve in this year".* Moreover, R_C said, "*Authorized for such inverters would mean that Sri Lanka would be able to deploy far more powerful solar systems than those currently in operation".*

4.4.3 Establishment of Solar Farms in Sri Lanka

Apart from residential and commercial schemes, they are dispersed and typically consist of ground-mounted solar panels in built-in wide areas. In certain cases, rather than supplying power to a local end-user such as a resident or a corporation, solar farms supply electricity to the electricity grid and are part of the energy balance of the utility. According to R_A, "*The Sri Lankan Government has launched up the production of solar energy to the private industry through a group entitled 'other' among the defined NRE tariffs proposed on cost-based tariff concepts.'* Furthermore, R_A, said, "*Neither of the privately solar projects was launched, as the tariffs on negotiation rendered all solar projects economically inaccessible"*. R_B highlighted that "*Through this project to approve the 100MW solar farm in Siyambalanduwa, the focus has been placed on the use of barren land not suitable for agriculture or other construction activities for the production of solar energy".*

As an example, "*Territory used to create solar farms offers a safer ecosystem for animals and plants. Land surrounding solar panels are usually wetland that can be preserved with trees and bushes*". Solar farms earn a strong return on investment, particularly when utility bill reductions, maintenance costs, and the encouragement of steady income are considered." R_C said to argue, "*Solar farms will require a lot of lands. Solar farms need a lot of sunny, unlocked space that could need some property to be cared for. This may cause some backtracking results that are not environmentally sustainable like deforestation and habitat loss".* Therefore, to expand the grid-connected solar net metering connections, the establishment of solar parks is a good strategy.

4.5 DISCUSSION OF FINDINGS

The findings include the introduction of grid power solar net metering in Sri Lanka, drivers and challenges for the implementation of grid-connected solar net metering, current practices in grid-connected solar net metering, and strategies to expand the grid-connected solar net metering. According to the literature findings grid integration barriers, lack of clearly allocated institutional responsibility, and financial barriers are identified as the significant challenges for the implementation of grid-connected solar net metering. However, the interviewees highlighted the high prices of solar PV technology, the solar subsidy program, policy makers' constraints, hegemony of power providers, financial incentives for rooftop solar installations, and other conceptual and technological limitations as challenges to the implementation of grid-connected solar net metering in Sri Lanka.

Literature findings emphasized that there are several drivers to expand the grid-connected solar net metering in Sri Lanka. Similarly, interviewees highlighted that net metering initiatives, the advantageous and beneficial tariffs for producers, competitive solar firms in Sri Lanka and local enterprises, jobs, and a sound policy system in Sri Lanka are indeed the drivers to implementing grid-connected solar net metering in Sri Lanka. Further, the respondents and the literature findings revealed that Soorya Bala Sangramaya, Rivi Bala Saviya (Supportive strategy), and Rivi Aruna are the current practices in grid-connected solar net metering in Sri Lanka. Moreover, suitable strategies are provided to expand the grid-connected solar net metering in Sri Lanka. The strategies include a flat tariff rate on Soorya Bala Sangramaya, the introduction of hybrid inverters, and the establishment of solar farms in Sri Lanka.

5. CONCLUSIONS AND RECOMMENDATIONS

Increasing demand for renewable energy is the key cause of the extension of traditional net metering growth policies, and the industry is looking to introduce new practices to extend grid-connected net metering. From traditional solar net metering to developing activities such as industrial policy, government legislation, and mechanisms, market understanding, information creation, promotion, and financial subsidies, the environment is heading towards fresh concepts such as VNM and feed-in tariffs. As a result, attention has risen in developing counties. Developing countries including Sri Lanka are increasingly defining and seeking to extend the grid-connected solar net metering in the coming concepts. The drivers for expanding the grid-connected solar net metering power generation in Sri Lanka were identified through expert interviews. Local entrepreneurship, employment, and a stable policy framework in Sri Lanka act as a driver to expand the grid-connected solar net metering power generation. However, several challenges such as the tariff rate, battery capacity, present Covid-19 pandemic situation, lack of training and development, and climate pattern were identified as the challenges for the implementation of grid-connected solar net metering in Sri Lanka. To overcome the identified challenges, suitable strategies are proposed to expand the grid-connected solar net metering in Sri Lanka. Accordingly, the Flat tariff rate on Soorya Bala Sangramaya, the introduction of hybrid inverters, and the establishment of solar farms in Sri Lanka are the strategies proposed to mitigate the prevailing challenges.

Further, grid power solar net metering policymakers and deploying solar panel entities, both suppliers and consumers, will benefit from the final research as follows. Using the findings of the research, the effect of current grid power solar net metering practices and the influence of emerging methods to enhance grid power solar net metering will be defined, preparing policies and guidelines for grid power solar net metering expansion to implement in the solar panel industry. Research findings can be used as a study material when leading awareness programs on-grid power solar net metering.

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