Net Metering Development in Sri Lanka

Prepared By: Public Utilities Commission of Sri Lanka

Content

Abbreviations

AC – Alternating Current

CEB – Ceylon Electricity Board

CSC – Customer Service Center

DC – Direct Current

kWh – Kilo Watt Hours

LECO – Lanka Electricity Company

NCRE – Non Conventional Renewable Energy

PV – Photovoltaic

PUCSL – Public Utilities Commission

SEA – Sustainable Energy Authority

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1. Introduction

In today's world most of the developing countries are already swamped with power crisis due to inadequacy of generation as well as energy storage facilities to meet the demand. Therefore there is a pressing need to implement mechanisms to manage the growing demand and improve the efficiency while reducing the energy losses, accelerating the development of low-carbon energy technologies such as renewable power generation, in order to address the global challenges of energy security, climate change and economic growth. In this context, the on-site power sources known as distributed renewable generation is becoming increasingly competitive with centralized power sources on a financial basis due to technological innovations, reduced capital costs, reduced maintenance requirements, access to inexpensive energy resources, and other benefits.

One promising means of distributed renewable generation of electricity closer to the end user is introducing net metering schemes which encourage customers to generate their own electricity through renewable sources of power such as solar, hydro or biomass in their own premises. Net metering programs can make self-generation more attractive for customers by eliminating the need to size systems to meet customers' exact power needs or install on-site storage and power conditioning devices. The deployment of distributed renewables through net metering also offers several environmental, economic and social benefits that are described in this report.

2. What is Net Metering

Net Metering is simply a policy that enables electricity customers to connect their own on-site generation system to the utility grid and receive credits on their electricity bills for their own renewable energy generation in excess of their electricity consumption that is exported to the electricity distribution network. The term net metering refers to the fact that the meter can measure the flow of electricity in two directions and it is also known as power banking since the consumers can "bank" the power they generate within the utility system by feeding the grid when excess power is produced and consume power from the grid at a later time when their production falls below consumption. This form of energy exchange is especially useful for intermittent renewable energy technologies such as solar and wind.

In most utilities' net metering systems, if the customer generates more electrical energy than he/she uses from the utility electrical system he/she will not be paid for that energy, but the customer receives only a kWh credit, which is applied to future bills. Whether the customer gets paid for that excess energy fed into the system depends on the net metering rules in the jurisdiction. While many different renewable energy sources may be eligible for net metering credits, solar rooftop installations are the most common and popular type of renewable energy source promoted with net metering. Many states have passed net metering laws and policies which allows utilities to offer net metering programs voluntarily or as a result of regulatory decisions.

3. Net metering technology

The main components of the net metering interconnection are

- NCRE Power Generation Facility
- DC-AC Inverter
- Islanding Protection System
- Import/Export Metering Facility

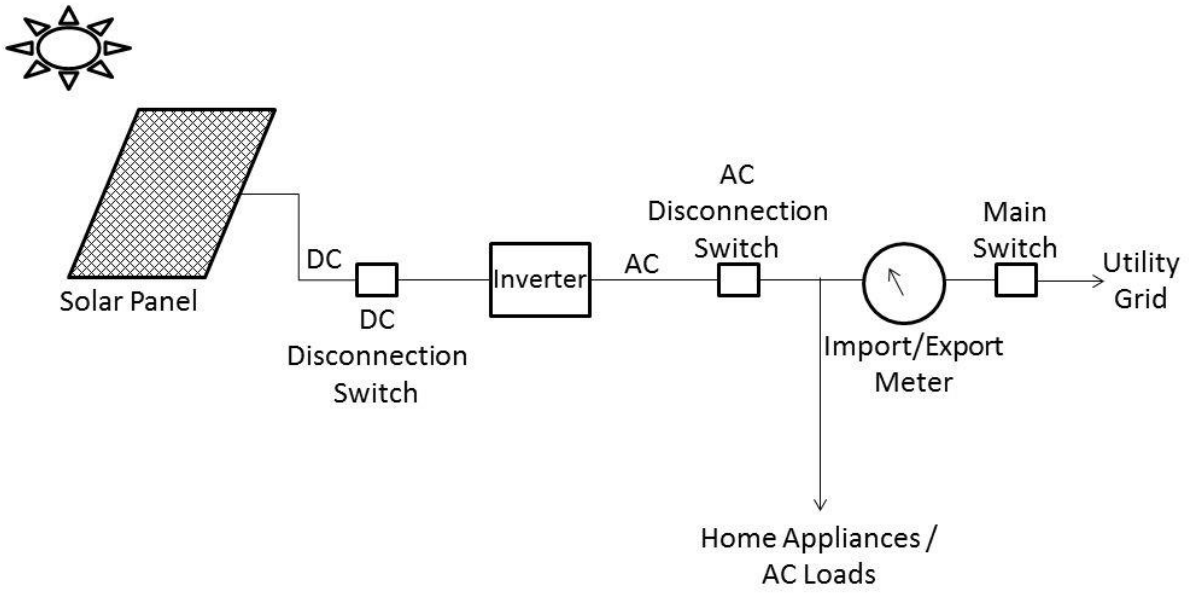

Figure 1. Solar PV Net Metering Arrangement

3.1 NCRE Power generation facility

Renewable energy can be defined as energy sources with long term supply characteristics with little chance of resource exhaustion over a human timeframe. Almost all electricity supply authorities worldwide allow only NCRE power generation facilities to be connected under net metering schemes to encourage small electrical customers to install environmentally friendly sources of electrical power supporting the development of distributed renewables. Some common examples of NCRE generation facilities used in net metering connections include rooftop solar panels, micro hydro turbines and small wind turbines. In Sri Lanka almost all the existing net metering customers are using solar panels (Photovoltaic modules) as their power generation mechanism.

Photovoltaic (PV) modules convert solar radiation into direct current (DC) electricity. Unlike in other power generation options, PV modules require very little maintenance since there are no moving parts. Also they are easily expandable, portable, durable and have a long warranty periods (10-25 years). PV modules produce electricity in proportion to the amount of sunlight falling on them and are usually installed on rooftops of buildings using mounting frames, usually facing southern direction in Sri Lanka, at an angle that is perpendicular to the sun at noon. PV modules are fragile but highly reliable. Because solar radiation is not available at night, net metering is ideally suited to PV systems, as excess power can be produced and banked during daytime hours and consumed at night.

Wind generators convert moving air into electricity catching it with blades, transferring that motion to a rotating shaft, and driving a generator that produces electricity. Wind generators don't produce their peak power at all hours of the day since wind is inevitably fluctuate resulting in a lower capacity factor for the output of the wind generator. Therefore wind generators are typically installed in locations with average wind speeds greater than 8 mph (13 km/h) and where wind impacts are visible through vegetation deformation. Wind turbines are usually mounted on towers above objects which can have detrimental impacts on wind speed and create turbulence.

3.2 DC – AC Inverter

When a net metering facility is equipped with a DC generator system, an electrical converter called an inverter is needed to convert the DC power produced by solar system into standard AC power produced by the utility. The AC output voltage and frequency of a power inverter device is often the same as the standard power line voltage. Solar inverters have special functions including maximum power point tracking and anti-islanding protection.

3.3 Islanding Protection System

If a net metering site continue to feed electricity back into the distribution grid even during a utility power outage it can risk the safety of the line maintenance workers. Therefore there should be a mechanism to prevent sending power back to the utility grid during a power outage. To address this issue there are variety of islanding protection and prevention options that can be implemented with net metering systems.

- **Islanding Protection with Trace Power Inverters**
  In this mechanism the grid interconnection inverter itself includes a technology to sense when the utility grid is down and disconnects the customer generator until the line is energized.

- **Micro-Sine Inverters**
  Circuitry of this system requires an external signal to produce power. Therefore this external signal will not be produced unless the grid power is not available.

- **Induction Generators**
  Net metering sites included with the micro hydro or wind turbines without self-excitation feature, require electrical excitation from the grid to operate. Without excitation current from the utility, the magnetic field cannot be created by the stator winding and therefore the machine cannot generate electricity.

- Installing a manual, lockable, system disconnect switch between the utility meter and the distributed renewable energy system

Since the modern solar inverters have an inbuilt anti-islanding function which cannot be manually overridden by the customer upon loss of utility service, a separate islanding protection system is not required for them.

Though a typical system would not have power in the event of a power outage, the system also can be designed to operate separately from the system during a power outage and provide power to certain loads in the home. However in Sri Lanka, power generation from the net metering system; even for the own consumption is not permitted during a power outage.

3.4 Import / Export Metering Facility

The traditional electricity meter can only record the electricity consumption of the customers over a period of time. Nevertheless, net metering is the practice of using a single electrical meter to measure the difference between the total consumption of utility electricity by a customer and their total generation of electricity from renewable energy resources. The traditional electricity meter is also capable of operating as a bi-directional meter by spinning forward to measures the amount of electricity a customer consumes and spinning backward to measures the amount of electricity a customer generates. Here the meter runs backwards when the customer's electricity production exceeds their consumption.

Since the above method is not capable of separately measuring the amount of import and export electricity, most of the utilities have mandated the customer generating facilities used for net metering to replace their old electricity meter with a modern bi-directional energy meter capable of registering both import and export of electricity.

4. How it works

Electric customers that generate their own electricity from a solar photovoltaic (PV) or other renewable energy source are eligible to participate in a billing arrangement called net metering. If the generation facility is a solar PV system, first the DC electrical energy produced must be converted to AC through an inverter before fed into the utility network. The power generated in excess of the owner's electricity consumption is fed into the grid through a bi-directional energy meter capable of registering both import and export of electricity. The arrangement of a net metering system utilizes the same service line for excess power injection into the grid which is already being used by the consumer for draw of power from utility network. However, an electrical inspection is normally carried out prior to energizing a generation interconnection to verify whether the generation arrangement meets utility, product safety and grid interconnection specifications and standards.

Net-Metering allows households to generate electricity and set off the power produced against the power used from the national grid and consumer pays only for the "net" number of units (difference between import and export energy) used each month. In the event the consumer produces power in excess of his usage in a particular month, the customer's energy charge becomes zero and the remaining number of units will be credited and carried forward to the following month. Normally most of electricity companies allow carrying forward the excess electricity generated for up to one year period. Some electric companies (Not in Sri Lanka) may pay back to the consumer for the extra power if more energy has been injected into the system than the consumer has used.

5. Aggregate Net Metering

Aggregate net metering is a net metering arrangement that allows for a single generating system to be used to offset electricity use on multiple meters, without necessarily requiring a physical connection between the system and those meters. While aggregate net metering has the potential to benefit many different types of customers, it can be particularly beneficial for customers with multiple meters or electric accounts.

In addition to potentially removing at least some of the obstacles associated with site limitations, it may also allow the customer to benefit from avoiding the limitations in system sizing, and allow the use of underutilized roof space or land in system siting.

There are four types of aggregate net metering practiced worldwide as described below. However, it is to be noted that aggregate net metering is currently not allowed in Sri Lanka.

5.1 Basic Meter Aggregation: Single Customer, Single Site

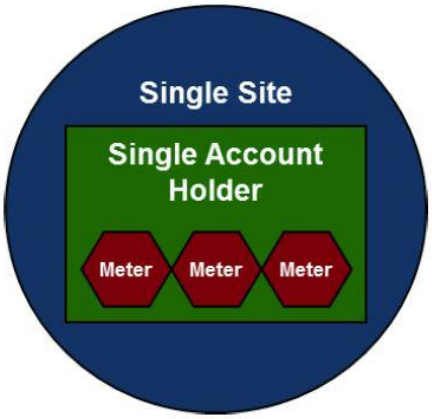

Figure 2. Arrangement of Basic Meter Aggregation

At this level, a single customer is allowed to offset multiple billing meters located on the same property with credits from a single generation system. This type of arrangement may be especially suitable for factories, universities or customers that have several buildings in a close proximity to one another, and with separate meters for each building.

5.2 Tenant Aggregation: Multiple Customers, Single Site

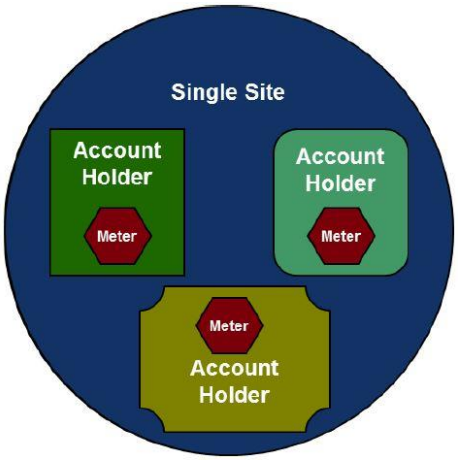

Figure 3. Arrangement of Tenant Aggregation

In this type, different customers are allowed to aggregate meters, but only if the customer meters are located on the same or contiguous property. This is most suitable for multi-family residential buildings and other multi-tenant buildings such as shopping malls or office building complex, where individual meters are owned by different customers instead of a landlord.

5.3 Multi-Site Aggregation: Single Customer, Multiple Sites

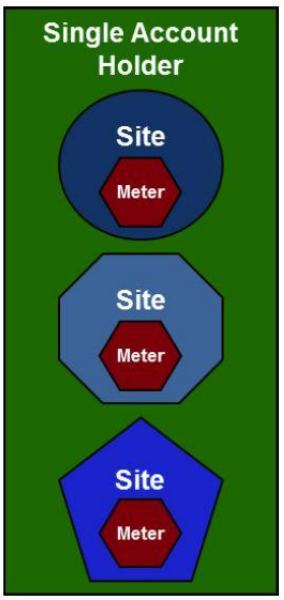

Figure 4. Arrangement of Multi-Site Aggregation

A limited number of electricity companies in the world allow a single customer to aggregate meters located in geographically disconnected areas. This arrangement is especially useful in a case where a customer owns land that would be a good site for power generation using renewable energy, but that site has a minimal load, while other higher load sites are less suitable for power generation. In this context the customer could use the electricity generated by an optimally sited generation system to offset loads at another site owned by the same customer.

5.4 Virtual Net Metering: Multiple Customers, Multiple Sites

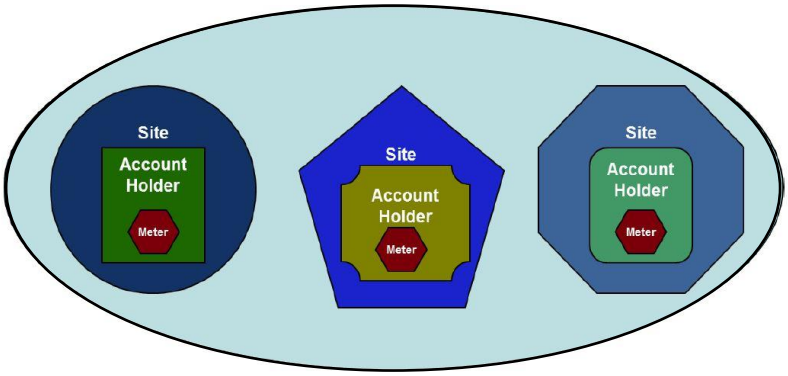

Figure 5. Arrangement of Virtual Metering

This is the most flexible meter aggregation arrangement out of all, since it allows several customers to participate in meter aggregation even if they are located on non-contiguous properties. Typically, these arrangements are subscriber-based, with a controlling organization that owns the net-metered system which allows the net metering customers to simply allocate net metering credits to any other customer.

6. Development of Net Metering in Sri Lanka

Few years ago, use of renewable energy to produce electricity in Sri Lanka was limited to large investors usually costing millions of rupees. But following the approval of the "Net Metering" concept by the government in 2008, the opportunity to participate in producing electricity using renewable energy in whatever small way they can afford, was open to all electricity customers in Sri Lanka. After sometimes in July 2010, the Ministry of Power and Energy, along with the Lanka Electricity Company (LECO) and the Ceylon Electricity Board (CEB) introduced net metering, where consumers could generate their own power from renewable sources and credit excess production back to the power utility.

Nikini Automation Systems (Pvt) Ltd stepped as the country's first ever solar photovoltaic installation to enter into a Net Metering Agreement with local power utilities in August 2010, with solar modules spreading over an area of more than 2000 square feet to generate and feed power for the daily operations of Nikini Head Office Building.

Sri Lanka is among the first few developing countries to introduce net metering, and that too free of charge, except for the initial one-time charge for a new bi-directional meter and protection equipment to avoid sending power back on the line during a power outage. Total flexibility is allowed to the customer to choose the type renewable energy facility based on the availability and his affordability, and the customer is free to switch on and off whenever he likes. LECO and CEB would always standby to provide the electricity supply, in case of renewable energy facility goes out of order or if the customer simply gives up using it.

The first expected to be benefited from this net metering facility was the tea factories that having small hydropower facilities, which were not connected to the grid then. Another targeted group of beneficiaries is the off grid households who now have a solar electricity supply for which they have already invested. Therefore by the time when they get the grid supply, they can continue to use the solar electricity system under the net metering facility.

In Sri Lanka this arrangement is applicable for existing or newly built generating facilities using renewable sources and the capacity of the generating facility need to be less than 1000kVA. The approved types of renewable sources are micro hydro, wind, solar PV, biomass, agricultural and municipal waste. Here the consumer is not paid for export of energy, but is given credit (in kWh) for consumption of same amount of energy later. These energy credits could be carried forward from one billing period to another, for so long as the consumer has a legal contract for the supply of electricity by CEB, and during the Term of this Agreement. And it should be noted that no rebate or credit is given for Maximum Demand. Therefore the bulk consumers with net metering facility are billed for Maximum Demand as in usual billing procedure.

Both CEB and LECO customers could apply for a net metering permit and sign a 10 year agreement under the purview of the Sustainable Energy Authority (SEA). However the net metering customer should ascertain and comply with applicable rules, regulations imposed by the Ministry of Power and Energy / CEB / LECO / Public Utilities Commission of Sri Lanka (PUCSL)/ Sri Lanka Sustainable Energy Authority (SEA) and any law or standard that applies to the design, construction, installation, operation or any other aspect of the Producers Generating Facility and interconnection facilities.

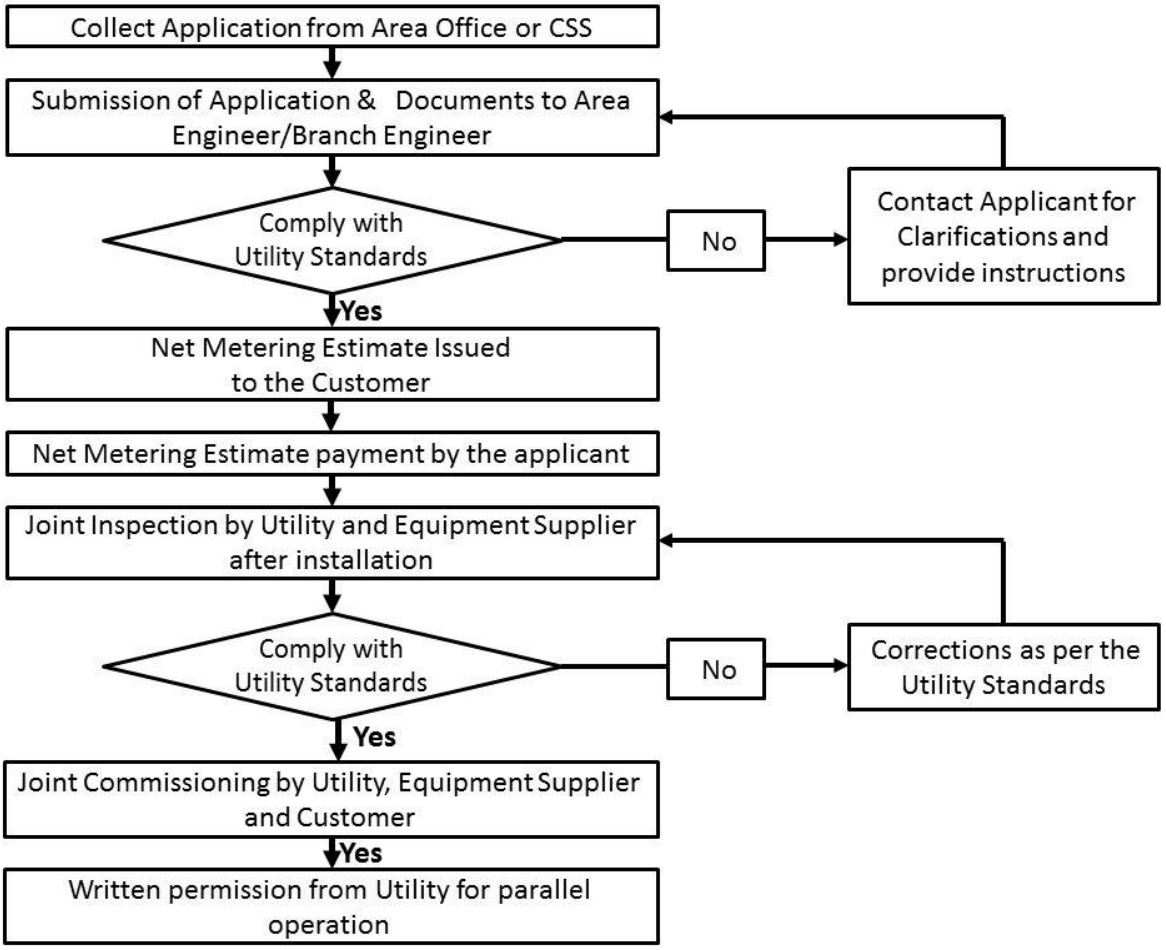

Figure 6. Application Procedure for a Net Metering Connection in Sri Lanka

7. Benefits of Net Metering

7.1 For Utility

- By encouraging electricity generation near the point of consumption, net metering reduces the strain on distribution systems, improves the stability of the grid frequency, improves the distribution voltage profile and prevents losses in long distance electricity transmission and distribution. Also, having more energy generators closer to where energy is used is making the grid more efficient, reliable and could bring down the cost of grid maintenance and saves the investments on transmission and distribution infrastructure in a long run.

- Net metering policies normally create a smoother demand curve for electricity and allow utilities to better manage their peak electricity loads. In many countries net metering programs have been launched expecting to take some of the pressure off the grid, especially during periods of peak consumption. It also mitigates the need for investing on new power facilities and the excess electricity generated will help the utility in bridging the gap between demand and supply

of electricity. But in Sri Lanka the system peak demand is recorded at night around 6.30pm – 9.30pm. Therefore the existing solar net metering facilities cannot contribute to manage the peak electricity loads and to avoid deploying expensive power plants during peak hours. Hence, Sri Lankan electricity utilities cannot reap the benefits from net metering facilities during periods of peak consumption.

- Studies have shown that net metering participants are more aware of their energy consumption, thus likely to conserve energy by investing in energy efficient appliances such as efficient lighting, efficient heating and cooling equipment in order to reduce the demand.

- Net metering schemes using clean energy are also expected to offset the construction and operation of expensive and polluting conventional power plants. Fossil fuel power plants emit greenhouse gases enormously while renewable energy sources emit less carbon in power generation. This total carbon emission saving achieved through promoting net metering can be calculated and converted into carbon credits and the utility can generate additional revenues by selling these carbon credits.

- Net metering of renewables can help utilities to gain expertise with distributed electricity generation technologies that they are not familiar with.

7.2 For Consumers

- Net Metering facility is viable for heavy electricity users who have to pay exorbitant rates for the last blocks of units (kWh) they consume. Although the initial investment is much higher to install a new renewable generation facility, the payback period would be very low for heavy electricity users.

- Net Metering generation facility can be turned off and on based on the needs of the customer. Therefore, on-site electric power production does not necessarily match on-site electric power consumption.

- Intermittent generators, such as solar and wind based generators, only produce electricity when their energy source is available. Conversely, when their energy source is not available, intermittent generators do not produce power and in a typical renewable generation system a bank of batteries is needed to store the energy for those times. But, the customers having net metering facility can use the grid to buy power during times when their own systems are not producing enough energy to meet their needs as well as it allows them to receive full value for the electricity they produce without installing expensive battery storage systems.

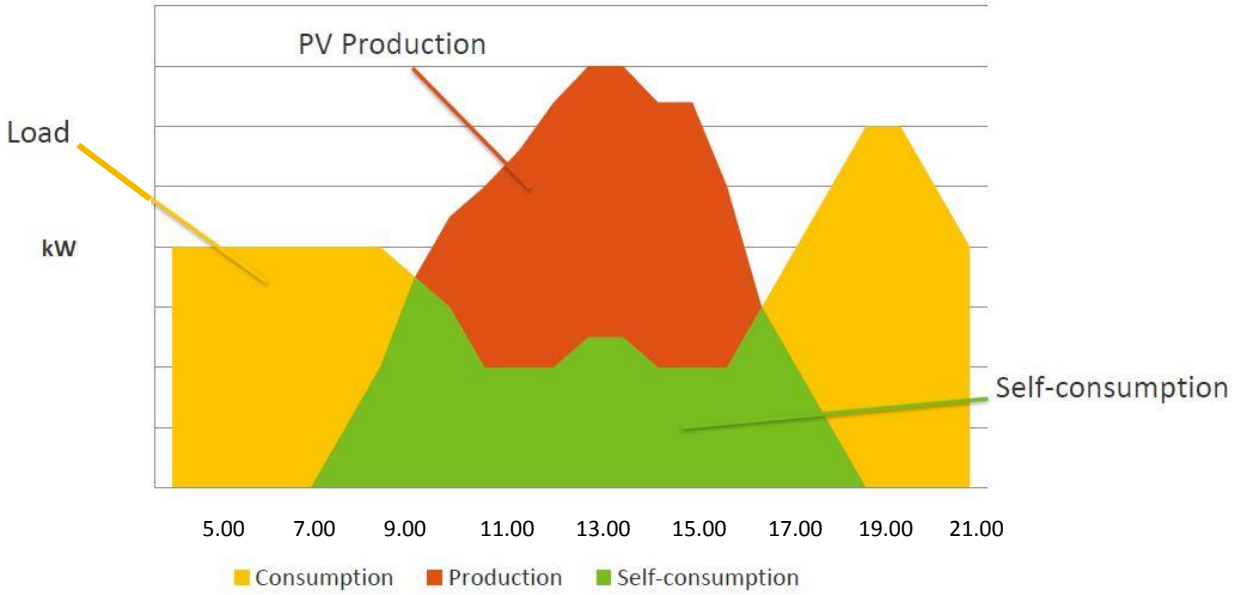

Figure 7. Typical load profile vs Solar PV generation profile of a domestic net metering customer

- Once people install a renewable energy system, they are generally more aware of how much energy they are using and consequently, they use less energy.

7.3 Social Benefits

- Using renewable power sources for electricity generation reduces the need for expensive and polluting fossil power generation. Their utilization can result in a net reduction in emissions of air pollutants that affect local or regional air quality.

- Net metering provides substantial economic benefits in terms of jobs, income and investment. Net metering increases demand for solar energy systems, which in turn creates jobs for the designers, installers, electricians and manufacturers who work in the solar supply chain. The employment opportunities are emerged ranging from skilled laborers to customer service and sales representatives.

- Net metering encourages consumers to play an active role in clean energy production, which helps to protects the environment and helps preserve natural energy resources.

8. Disadvantages

- In Sri Lanka the electricity tariff for the domestic consumers has been set with several blocks in order to cross subsidize the lower and affordable electricity price for the poor with the surplus revenue earned from the heavy users. This is a mechanism to recover the loss of selling electricity at a lower price by collecting additional revenue from heavy users those who utilize more electricity. But, with the introduction of net metering technology, those who tend most to enter into net metering agreements are the rich heavy users. By entering into net metering schemes they reduce their high electricity bills by offsetting the electricity that they would have purchased at a higher price and it causes to reduce the surplus revenue earned by the utility companies. Due to that the utility company could suffer a financial loss, and depending upon the severity of the loss may have to increase the price they charge for electricity from non net metering customers.

- Since Sri Lanka receives a good supply of solar radiation throughout the year since it is situated close to the equator, most of the net metering customers tend to use solar PV technology to generate their power. To implement a solar PV system all the expensive parts must be imported and country's money will be excessively flows into the foreign countries.

- Net metering technology is widely practiced in developed industrialized nations, where the peak demand is touched in day time driven by industry demand. In Sri Lanka the system peak demand is recorded at night around 6.30pm – 9.30pm. But the solar energy produced at daytime and redistributed among other day time users and helps to reduce the system demand during daytime. Therefore the existing solar net metering facilities do not help to reduce the country's installed generation capacity or to manage the peak electricity loads and to avoid utilizing expensive power plants during peak hours. Hence, Sri Lankan electricity utilities cannot reap the benefits from net metering facilities during periods of peak consumption.

  Following graph shows the load profile likely to be in Sri Lanka after improving the solar power generation contribution promptly.

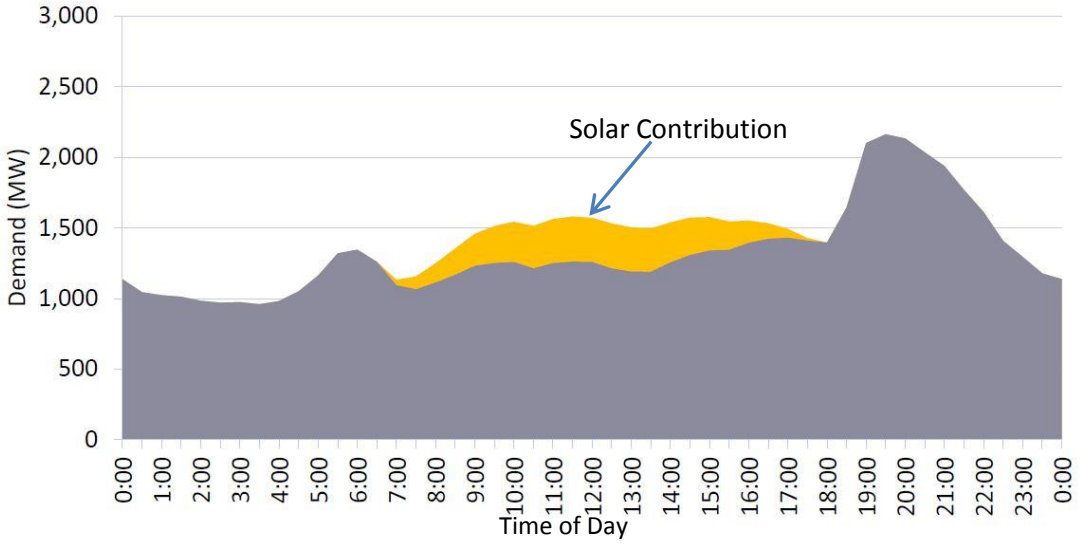

Figure 8. Anticipated Load Profile after improving substantial solar generation

- The full retail electricity rate includes not only the cost of the energy but also the company's cost of providing electric service, including the cost to transport and deliver the electricity to customers, cost of maintaining the grid and administration cost and other infrastructure cost that make the electric grid safe, reliable, and able to accommodate the distributed generation systems. Through the net metering credit, net-metered customers effectively are avoiding paying these costs for the grid. But if the net energy consumption of a net metering customer is zero or negative he /she pays nothing or pays a little fixed charge (Rs.30 in Sri Lanka) and avoids paying for all of the fixed costs of keeping the electricity grid viable. As a result, these grid costs are shifted to those customers without net metering systems through higher utility bills and it is argued that net metering schemes are protecting wealthy customers with competitive alternatives at the expense of others.

9. Key Challenges and Barriers

- When a net metering facility is equipped with a DC generator system, an inverter is required to convert the DC power produced into AC power. Inverters have historically been the leading cause of PV system failures. Normally, the lifetime of an inverter typically does not exceed ten years and the cost of maintenance is also very high.
- In Sri Lanka, the duration of the term of a net metering agreement is limited to ten years from the date of execution. Therefore, there is an uncertainty of continuing the net metering contract once the initial agreement period is concluded.
- Lack of understanding or experience regarding distributed generation systems.
- Lack of awareness of program availability and benefits among potential customers
- Unavailability of meter aggregation, which provides more customers access to renewable energy
- Lack of financing for systems with large upfront capital costs

10. Where are we now ?

Since the first net metering connection of Sri Lanka in 2010, the number of connections has reached to 1041 by now, showing a rapid growth in this new technology in Sri Lanka. This indicates the popularity of this technology among the electricity consumers in Sri Lanka. The total installed capacity of the existing net metering schemes in Sri Lanka has become nearly 6.1MW as at 30th April 2014 and implemented all over the island as follows;

Province	Number of Connections	Installed Capacity (kW)
Western	910	5080
Central	23	88
Northern	14	38
Southern	43	590
North Central	11	203
Sabaragamuwa	3	41
Uva	2	6
North Western	29	115
Eastern	6	13

Table 1. Existing Net Metering Schemes

Source: CEB & LECO

By analyzing the above figures it can be observed that 82% (5MW) of the total capacity of the net metering schemes has been connected in western province.

11. Conclusion

Developed world is already on the track for walking out from fossil fuel era and to involve mainly in the areas of energy efficiency and renewable energy technologies. Net Metering is one of the most powerful policy options for advancing renewable energy technologies which can certainly help in harnessing renewable energy resources in small scale. This is also a highly efficient methodology of storing the energy known as power banking. Nowadays lot of countries and states has developed net metering programs to enhance economic incentives to the owners of small renewable energy systems and encourage private investment in renewable energy technologies without requiring public funding.

Sri Lanka's national energy policy released in 2008 has declared that by 2015, the country would endeavor to achieve a 10% contribution to grid electricity from small non-conventional renewable energy sources and the net metering facility would certainly help to further improve this renewable energy contribution. Therefore to promote this concept among electricity customers, especially for whom this method could be more beneficial such as electricity intensive small industries, they must be edified properly about the benefits they can earn in return. And also there are rural households who are currently having solar electricity facilities which they have already invested, since the grid supply has not reached them yet. Therefore once they get the grid supply, they can enjoy the benefits of net metering facility by continuing to use the solar electricity system under the net metering facility.

But there are some concerns; even though the solar energy is free, it is very costly at current level of technology and totally foreign. It is also an intermittent and unreliable form of energy with a very low plant factor around 17%. At the same time it can also cause to reduce the revenue of utility companies and won't make any contribution during the peak consumption period while several benefits to net metering customers, utility companies and society. Also the prevailing rapid growth of net metering generation schemes must be considered carefully at the long term generation planning studies of CEB. Therefore a rational dialogue is needed among the stakeholders in Sri Lanka, and also an accurate and comprehensive look at the economic impacts of net metering, considering all the costs and benefits.

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