Sri Lankan Power Crisis and Future Energy Management

Electricity is one of key services that support a development of any country. Without any exception, Sri Lankan industries totally rely on reliable, competitively priced and sustainable power generation system for the growth of their industries. It is well known fact that during last three decades the power generation sector in Sri Lanka is not living up to the expectation of the Industry, services, and public needs in terms of quality, reliability and capacity.

Unfortunately, even today CEB believes that the monopoly given to them in the Ceylon Electricity Board act will save them from any criticism and they are invincible. But all the engineers and employees of CEB need to realize that they have actually not performing up to the expectation of its customers. Today all service sectors, factories and "able public" operate their facilities with standby power-generating system. A future of CEB becoming a standby power supply for industrial installation is not far away from today. The surge in imports of generators, after an announcement of power cuts clearly shows the level of trust people has on CEB. As an engineer the current electricity crisis is really a shame for whole community of professionals. Now public has started to openly criticize whole power sector. The mismanagement in CEB and public unrest towards electricity had provided an opportunity to infiltrate both good ideas of visionaries and very bad hidden agendas of opportunist in to the country.

Even though Ceylon Electricity Board blame politician for not implementing the installation of new power plants as per their plans, "Does CEB really need an additional power plant to solve the current crisis?

Generally it is known fact that Sri Lanka is having abnormal power demand curve. As per the latest demand data published by CEB, country had a maximum demand of 2543 MW and the minimum demand is 1200 MW on 19th February 2020. If we further study the historical data, it is evident that the lowest demand of power is on decreasing trend while the peak demand is on increasing trend. The historical data published by CEB on daily power demand curve from year 2018 for period of 8 years is illustrated below to understand the electrical demand in the country.

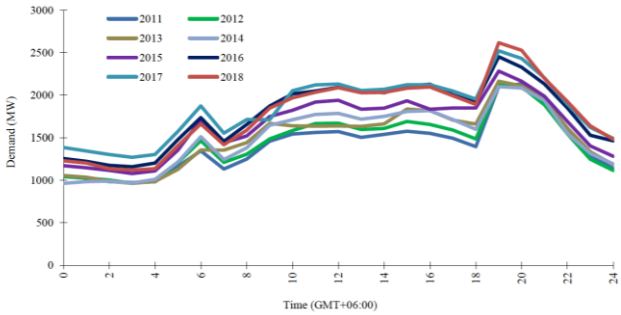

Figure 1: Change in Daily Load Curve Over Last Year

Source: Long term generation Expansion Plan 2020-2039

So as an engineer we need to understand that the lowest power demand is equally important parameter in an electrical system as highest power demand in an electrical system in its decision for adding new power plant.

The lengthy heating and cooling down cycle of coal power plants, it is know fact that the coal power plants are not designed for quick grid connection or disconnection from the transmission/distribution grid. So Sri Lanka having an installed coal power plant at Putnam with the generating capacity of 900MW reflects that our lowest power demand could not be lower than 900 MW. Thus, due to this inherent feature of coal power plant coal power plants are designs to operate as base power plant in all over the world. Generally coal power plant that operates continuously for year until it is stopped for the schedule maintenance. Following comparison of global energy contribution clearly indicates the dominance of fossil fuel energy in the work for next 20 years.

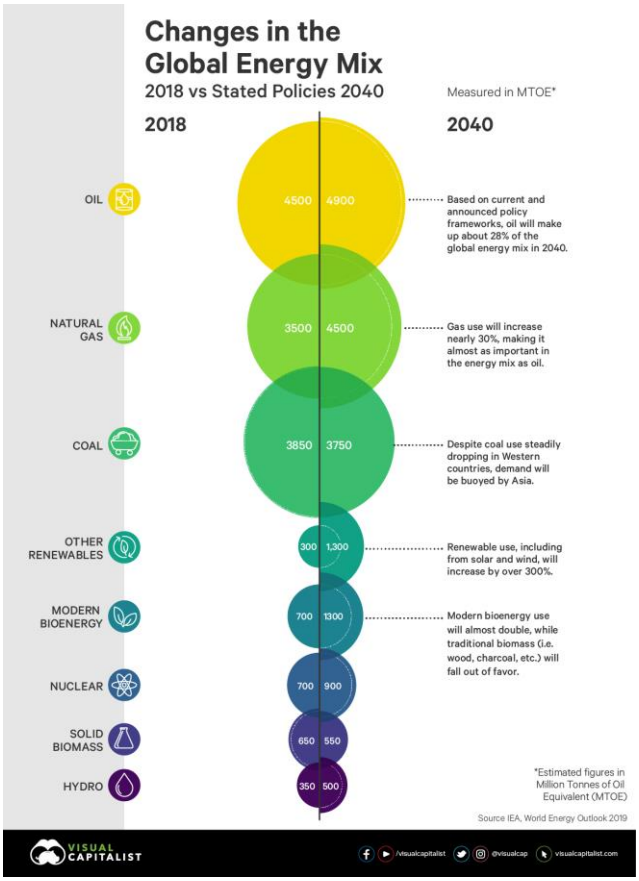

Figure 2:World Energy Mix- 2018-2040

Based on CEB historical details, the largest coal based thermal power plant capacity that Sri Lanka could install in the country could not exceed 1200 MW. In other words even it is decided by the CEB, Sri Lanka could built coal power plant of 300 MW only. However from economic scale of power plants based on source of fuel, it is identified that the economic scale for coal power system is 500 MW.

So as IESL, we need to question that on what basis that CEB had decided to implement 3 coal power plants and LNG power plants within next 5 years?

How Sri Lanka Could Get Over the Current Power Crisis?

The answers to the existing power crisis are to be found from our historical power demand data only. IF we study the power demand data as per the most recent data published by CEB, we could identify that we have total of installed power plants that could cater power demands of excess of 2500MW. But we are not utilizing even half of installed capacity during 12 hours of day. We as a country operate very expensive power sources to generate power during peak demand period.

However as per the graph given below, if Sri lanka could implement a proper energy generation, storage and utilization system that store considerable energy during daytime and deliver the surge in demand for of maximum 6 hours in the evening, we do not need any additional power plants.

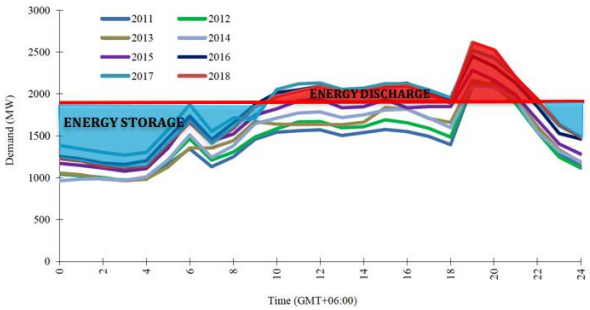

Figure 3: Change in Daily Load Curve Over Last Year

Why Energy Storage is More Suitable in Meeting this Power Crisis?

1. Cost for installation of energy storage system is cheaper than installation of new base thermal power plant
2. With the help of well designed energy storage we could operate all thermal power plant at optimum level and improve the efficiency and reduce the cost of power generation
3. Energy storage can be installed around the country at each substation and reduce the peak transmission losses due using low transmission current
4. Improve the reliability of whole electrical system having installed backup like UPS
5. Add high flexibility for the system operators
6. Can be used for 15 years until the power demand increase in the country for us to go for economical thermal power plant
7. No need of additional operational labor
8. Minimum impact to the environment and no need of lengthy approval process

What is Energy Storage?

Energy storage system ensures continuity of energy supply and improves the reliability of the system. Energy storage systems can be in many forms and sizes. The size, cost, and scalability of an energy storage system highly depend on the form of the stored energy.

Energy can be stored as potential, kinetic, chemical, electromagnetic, thermal, etc. Some energy storage forms are better suited for small-scale systems and some are used only for large-scale storage systems. For example, chemical batteries are well suited for small systems ranging from watches and computers to building backup systems but are still expensive when megawatt scales are considered. Pumped hydro system on the other hand, which stores huge amounts of energy in the form of potential energy of water, can be found only in large power systems.

The chemical energy storage systems include batteries, flow batteries, and fuel cells. Mechanical (kinetic and potential) energy storage systems include pumped storage hydropower, flywheels, and pressurized gas storage systems. Thermal energy can be stored as a molten salt and is also mainly used for large-scale systems. Magnetic energy can be stored in superconducting magnetic storage systems, which is still a relatively new and expensive technology

Today it is very popular for electrical industry to use chemical storage like batteries for the design of energy storage system.

World Investments in Energy Storage

Figure 4: Typical Grid Connected Energy Storage

Energy storage system is one of popular trend in the world energy system today. The graph below indicates the investment scale in leading developed countries for the chemical storage system (battery) in their electricity grid. The growth in investment had grown exponentially and it is a reality chemical storage is the future for the stable power grid.

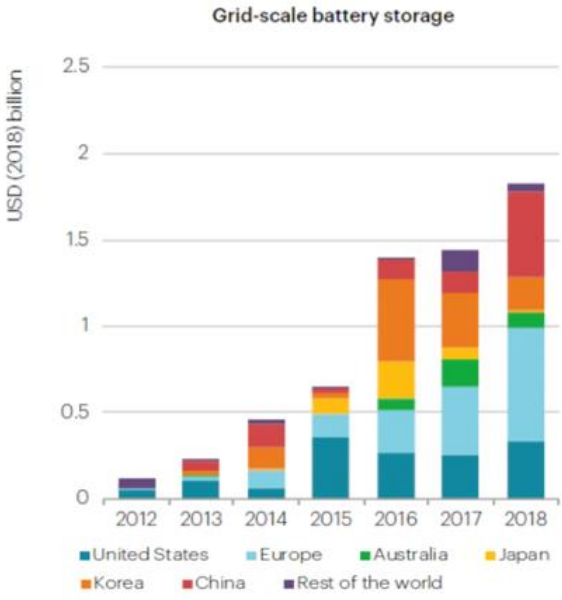

Figure 5:Investment on Energy Storage by Countries

The national renewable energy Laboratories of USA had done detailed study on energy storage system using batteries (chemical storage) and the respective cost of system implementation and prediction is given below our reference to find the scale of investment.

	Normalized Cost Reduction			4-hour Storage Costs (2018$/kWh)		
Year	Low	Mid	High	Low	Mid	High
2018	1	1	1	380	380	380
2019	0.89	0.93	0.97	339	355	369
2020	0.78	0.87	0.94	297	330	359
2021	0.72	0.82	0.93	275	313	353
2022	0.66	0.78	0.91	252	297	347
2023	0.60	0.74	0.90	229	280	341
2024	0.54	0.69	0.88	207	264	336
2025	0.48	0.65	0.87	184	248	330
2026	0.45	0.63	0.85	172	240	324
2027	0.42	0.61	0.84	160	232	318
2028	0.39	0.59	0.82	148	224	312
2029	0.36	0.57	0.81	136	215	307
2030	0.33	0.55	0.79	124	207	301

Table 1: Cost of Energy Storage Prices

As at year 2020, we are expecting $ 330 investment for every kWh in average for battery storage that can last for 15 years in service. Sri Lanka needs to understand is that the cost of battery storage system not only build energy storage in our system but also it helps us to make our power plant more efficient in operation and save more fuel and resources.

The below graph provide the information of the lifetime of the batteries and conversion efficiency of chemical storage which is next important parameter. So we are not far away from identifying a battery that last more than 15 years which is essential for us to cover the investment and also have the system efficiency more than 85% for utility scale operation.

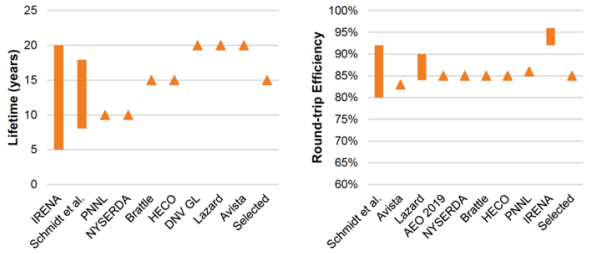

Figure 6: Expected Life time of the Energy Storage and Conversion Efficiencies

Generally all the batteries need a routine inspection and maintenance for there prolong operation and extended life expectancy. As per the same study it is evident that for variable operation and maintenance the cost of maintenance can be very low and most of energy storages designed today are maintenance free.

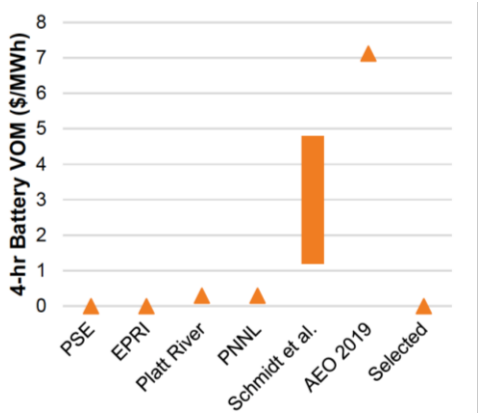

Figure 7:Cost of Energy Storage Maintenance

Why Renewable Energy in Sri Lanka is not an Option in Meeting Future Power Demand?

Today the renewable energy power plants installed in Sri Lanka could not be considered as an addition to the national grid. The historical data clearly show that, except for few biomass and hydro power plants, none of renewable energy power plants were being able to produce power with more than 30% plant factor. This means any renewable any power plant were generation power less than 8 hours per day and balance 18 hours of the day is supported by the power generated through CEB power station either coal, diesel, or hydro power station.

Even though one could argue that renewable energy is performing very well in other parts of world why it is not possible in Sri Lanka, the real fact is whole of Europe is electrically connected and the EU has very large thermal power generation as shown below covering more than 70% of total energy generation.

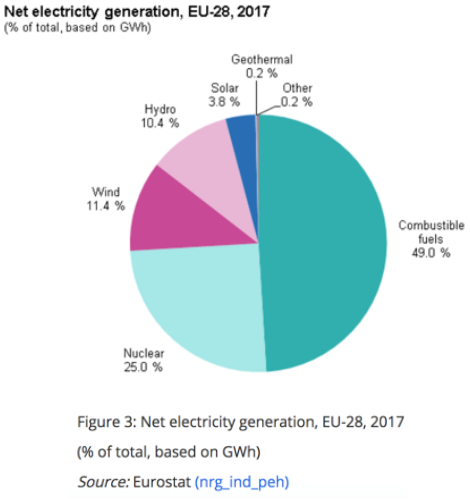

Figure 8:Net Electricity Generation, EU 28,2017

Therefore it is note worthy that all renewable energy power plants installed today in Sri Lanka are burden to CEB and renewable energy system had become parasite who live with the assistance of thermal power installed in the country but yet to be blame them for pollution.

Figure 9:Wind Turbine and Solar Power System Installation

Any engineer who understand the system control philosophy in grid connected electrical distribution system, knows that these renewable energy neither operate independently no reliable in their power deliveries. The power generation from these system change instantly with the changes in the environment.

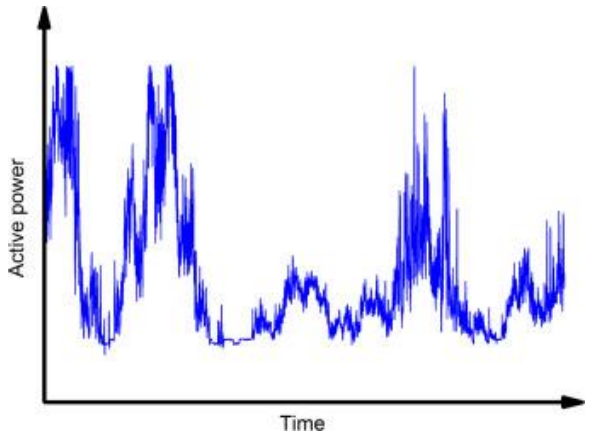

Figure 10: Active Power Delivery from a Renewable Energy Plant within a Single Day

However the renewable energy system could be developed as productive contributor of power to CEB if they were built with minimum of 6 hours of energy storage to cushion these variations in power generation with time. Therefore CEB should focus on converting existing and all new Solar and Wind power plants with energy storage to release the burden on power quality. This will open window for CEB to issue flat tariff for all renewable energy where they have overcome the inherent power quality and fluctuations.

Figure 11: Renewable Power Stations Build with Energy Storages

Conclusion

Sri Lankan power generation system is in crisis in meeting the peak power electricity demand in the country for last two decades. The consumer pattern in the country has greatly attributed to this problem. The Ceylon Electricity Board being forefront in power generation, transmission and distribution in Sri Lanka believe that they could easily solve the issue by setting up some additional power plants in near future. However an independent study of the daily power demand curve clearly shows that Sri Lanka has adequate power plants to meet the consumer demands at least for next few years.

The study further highlights that the gap between power demand and power generation during peak hours in the country could be easily solved using decentralized energy storage systems. Hence through this article, the writer expect to bring it to the due attention of CEB to conduct a detail analysis on energy storage requirement at each major substation in Sri Lanka and review the chances of optimizing the operation of existing power plants and delay any major capital investment in to new generating stations until the lowest energy demand develop further for the country to invest in suitable capacity thermal power station.