Utility scale solar power development in Nepal

Rashmi Adhikari
GETPPP, Green School, Korea University
Nepal Electricity Authority, Electrical Engineer

Abstract

Nepal is among the richest in terms of water resource availability and it is one of the most important natural resources of the country. Currently, 72% of the population is electrified through the national grid system. The power generation mix into the grid is hydro dominated with minor shares generated from solar and thermal (accounts for less than 1%). To achieve sustainable development in the power sector it is essential to diversify power generation mix into the grid. Knowing the facts, the government has a plan to achieve a 5–10% share of power generation from solar and mix it into the grid system. Solar is the second most abundant, prominent and free source of renewable in the context of Nepal. This study mainly focuses on the grid–connected solar system, its importance, present status, government efforts, and its need. It is based on the review of literature, news published in national newspaper online news and international organization's report.

Key Words: Solar PV, Utility–Scale Solar PV, Nepal.

Energy Status of Nepal

Nepal is a small country having a land area of 147,181 km^2 and abundant hydro potential, with 83,000 Megawatt (MW). Study shows out of total available potential 43,000 MW is techno-economi cally feasible which is mentioned in Nepal Electricity Authority (NEA) Annual magazine.[6] The power generation heavily depends upon hydro, which is hydropower accounts for 93%, thermal 6.2% and Solar 0.8% of total grid-connected power generation mix.[1] Nepal is a mountainous country covered by the Himalayas. Climate change has been very prone and visible year after year, so to rely only on hydro is at high risk. One of the trusted and abundant resources is solar. Grid-connected solar power generation is in a tiny amount because of a lack of finance and innovative technical knowledge and technology. For many years past Nepal is importing more than one-third of electricity from India.

This has increased energy security risk. The country has to diversify resources used for power generation. One of the prominent technologies is solar energy. In Nepal, Solar home systems and solar microgrid are already practiced technology in rural areas. But solar home technology is only enough to light up few bulbs at the household. Microgrid technology turned out to be more expensive and unsustainable unless 80% of the total cost is supplied in the form of a grant.[3] So grid-connected solar technology is vital for large scale PV development. The average global solar radiation in Nepal varies from 3.6-6.2 kWh/m^2 day,[2] the sun shines for about 300 days a year, the number of sunshine hours amounts almost 2100 hours per year and average insolation intensity about 4.7 kWh-2 day-1 (=16.92 MJ/m2 day).[2]

Some of the significances of the utility-scale solar power system specific to Nepal are listed below:[3]

- Nepal is a mountainous country. As we know climate change is getting more and more visible in mountainous countries. Rely only on hydro is at high risk. The development of utility-scale solar power diversifies the power generation, increasing energy security.
- Nepal imports one-third of electricity from neigh-boring country of India (from only one country). After developing large scale solar and connecting it to the grid, the increase depends on its own resources.
- As solar is abundant and easily available and solar PV cell price is getting down and down in the international market due to large scale production, we can go for this technology.
- Construction to commissioning period of the solar plant is shorter than six months whereas 5 years are needed for hydro.[4] The solar power plant does not involve complex structures to construct like hydropower plants. Power could be generated and sold very easily and fast at a flat rate of 7.30 Nepali currencies per unit. Easy to recover the investment cost.
- The government has planned to achieve a national goal to make electricity as the primary source of energy and to electrify the country with 99% by the year 2030.[8] Solar would be another option after hydro that would help to achieve this plan and goal.
- Most of the hydro sites are located in the hilly

region (Nepal is divided into three regions: Mountainous region, Hilly region, and Terai region) of Nepal. To meet demand at the Terai region the power has to be transmitted through long-distance, which deteriorates of voltage and causes electronic equipment and light bulbs (deem light) not working well. Terai region is a plane and flat area with very good sunshine. So if we could install solar plants on-site and feed to grid it improves voltage level and power quality.

- It improves system voltage and in overall optimum utilization of the grid.

Historical background and attempt made on utility-scale solar power

The year 2014 has been an important period because NEA for the first time decided to construct a 25 MW grid connecting solar projects in the Nuwakot District of Nepal.[7] In 2016 there was the call for the development of a 64 MW utility-scale solar PV project through the tendering process under the boot model by NEA. Applications of 61MWout of 64 MW were received to be installed at 21 locations. They already have power purchase agreements at a flat rate of 7.30 Nepali currencies per unit. In January 2017, there was an agreement between the Nepal Government and the Asian Development Bank to invest 20 million US dollars as additional financing of the SASEC Power System Expansion Project under the strategic Green Climate Fund (GCF). Out of 20 million US dollar, 18.5 million were agreed to invest in grid-tied solar power project. The private developers who are willing to develop Grid Tied Solar Power Project are provided with viability gap fund facility with Nrs 10 per unit in addition to Power P urchase Rate of NEA Rs 6.60/unit. The approval of the board of NEA was held on June 27, 2018 (meeting number 772) in April 2018 Nepal Electricity Authority (NEA) approved the 'Standard Model Document for grid-tied solar PPA - ADB viability gap funding'. As per this again there was called for the establishment of an additional 62 MW utility-scale solar PV Project under boot model at various locations with viability gap funding and support of the Asian Development Bank. Later it was amended to provide such facility only for 24 MW with the request for the proposal on 2018 April 25. Those who were selected will get such a facility until June 30, 2022. After this normal rate PPA will be activated with a ate Rs 6.60 per unit until period of agreement. Following Table 1, 2 are the list of the agreement with viability gap funding facility:

At present, NEA is doing an agreement with solar power project as a normal process of hydropower project at constant flat tariff of 7.30 Nepali Rupee per unit. Name list of the projects that have normal Power Purchase Agreement are listed below

There have been few numbers of solar power plants that are connected to the grid and getting paid through the net metering principle. They are listed below:[3,5]

1) Singh Durbar solar power plant of capacity 1MW
2) Sundharighat 680 kW solar power plant
3) Kharipati solar plant of capacity 100 kW
4) Solar plant of Nepal Telecome 65 kW
5) Test project solar power plant at Pulchowk Engineering Campus 1kW
6) Rara hill memorial school 40 kW, Kirtipur.
7) Kathmandu Upatyaka Khanepani Bewasthapan Board 680.4 kW.

Table 1. Independent Power Producer (IPP) with power purchase agreement (PPA)

S.No.	Developer	Projects	Location (District)	Capacity (kW)	Tariff till June 30, 2022	Tariff after June 30, 2022
1	FDSN–Lama JV	Shivapur Solar	Kapilvastu	8000	Nrs16.6/kWh	Nrs 6.60/kWh
2	Sharma and Surya JV	Pokhara Solar	Kaski	4000	Nrs16.6/kWh	Nrs 6.60/kWh
3	Hansraj, Hulaschand and Company Pvt.Ltd.	Parsa Solar	Jhapa	2000	Nrs16.6/kWh	Nrs 6.60/kWh
4	Mainchuli – Roshan JV	Buluchowk Solar	Rautahat	5000	Nrs16.6/kWh	Nrs 6.60/kWh
5	Himalayan Infrastructure Development Company Pvt.Ltd. And Raman Construction Pvt.Ltd	Gandak Solar	Nuwalparasi	5000	Nrs16.6/kWh	Nrs 6.60/kWh

Source: Power Trade Department, Nepal Electricity Authority

Table 2. Independent Power Producer (IPP) with power purchase agreement (PPA)

S.N.	Developer	Projects	Location	Capacity (kW)	PPA Date	COD/RCOD	Tariff
1	Solar Farm Pvt. Ltd.	Belchautara Solar Project	Tanahun	5000	2075.04.23	2076.04.03	NRs 7.3/KWh
2	Api Power Company Ltd.	Chandranigahpur Solar Project	Rautahat	4000	2075.04.27	2076.02.26	NRs 7.3/KWh
3	Api Power Company Ltd	Parwanipur Solar Project	Parsa	8000	2075.04.27	2076.02.26	NRs 7.3/KWh
4	Api Power Company Ltd.	Dhalkebar Solar Project	Dhanusha	1000	2075.05.03	2076.03.02	NRs 7.3/KWh
5	Api Power Company Ltd	Simara Solar Project	Bara	1000	2075.05.03	2076.03.02	NRs 7.3/KWh
6	Ridi Hydropower Development Co. Ltd.	Butwal Solar Project	Rupandehi	8500	2075.06.09	2076.04.08	NRs 7.3/KWh
7	Sagarmatha Energy and Construction Pvt. Ltd.	Dhalkebar Solar Project	Dhanusha	3000	2075.06.24	2076.12.23	NRs 7.3/KWh
8	Gorkha Cogenial Energy & Pvt. Ltd.	Lamahi Solar Project	Lamahi	3000	2075.06.24	2076.12.24	NRs 7.3/KWh
9	Global Energy & Construction Pvt. Ltd	Duhabi Solar Project	Jhapa	8000	2075.06.25	2076.12.24	NRs 7.3/KWh
10	Eco Power Development Co. Pvt. Ltd.	Mithila Solar PV	Dhanusha	10000	2075.09.16	2076.01.17	NRs 7.3/KWh

Source: Trade Department, Nepal Electricity Authority

Legal provision in Nepal

The Nepal government understands that depending only on hydro (single source) is at high risk from energy security perspective. Government of Nepal has got legal provisions to flourish utility–scale solar. The constitution of Nepal 2072 clause number 51 sub–clause chapter 3 has stated that "to assure adequate and radially available energy supply and appropriate utilization of energy for the generation of renewable energy and supply of basic needs of citizen". National Energy Crisis Mitigation Plan and Ten Year Electricity Development Plan 2016 has a target to have an energy mix of 40–50 percent from storage and pump storage, 15–20 percent from peaking run of river, 25–30 percent from the run of river and 5–10 from renewable/alternative energy. As per white paper published in 2018 reviewed country's energy mix, again made some changes in the above–mentioned target. For energy security and economic

aspect, the country needs to have an energy mix in the proportion of 30–35 percent from storage and pump storage, 25–30 percent from peaking run of river, 30–35 percent from the run of river and 5–10 from renewable/alternative energy. As per the guidelines for "Development of Alternative Energy Connected to Grid 2018" people can feed electricity generated from solar, wind and biomass into the grid and get paid a flat rate of Nrs 7.30/ unit. The guide–lines have given priority to solar energy.

Main stakeholder

Ministry of energy, water resources and irrigation (MoEWRI): Ministry of Energy, Water Resources, and Irrigation (MoEWRI) is under the Government of Nepal (GoN), which is the governing body for the power sector of Nepal. It works under the policy level. Department and organization work under MoEWRI are Department of Electricity Development (DoED), Nepal Electricity Authority (NEA), and Electricity Tariff Fixation Commission (ETFC).

Department of Electricity Development (DoED): The functions of DoED are to ensure transparency of a regulation framework, to accommodate, promote and facilitate the private sector's participation by 'one window' service, providing survey license and generation license, support for inspection of technical equipment.

Nepal Electricity Authority (NEA): Nepal electricity authority is a government–owned largest public enterprises. It is autonomous and fully responsible for power transmission and distribution of electrical power throughout the country and it has its own generation too. There is significant involvement in private sectors for power generation. It is the sole buyer and seller of the country and also doing export and import of electricity to neighboring country India.

Electricity Tariff Fixation Commission (ETFC): Approval of electricity tariff recommended by Nepal electricity authority.

Way forward

Nepal is geographically divided into three regions; Mountain region, Hilly region, and Terai region. In the mountain region, very few indigenous people live and load is very sparse and solar home technology has been adopted very well in that region. Most of the people residing in the hilly and the Terai region. In the hilly region, most hydro sites are located. This could be utilized to meet demand. If we talk about the season, in winter, the hilly area is very cold and in the summer season, terai is very hot. To meet demand at terai in summer power has to travel through long–distance, so voltage quality and overall power system quality issues are very significant. Moreover, terai is plain land and good sunshine. If solar energy could be harnessed it could improve voltage quality and overall power system quality and reliability. The government of Nepal has got a plan to get an electrification rate of 99% by the year 2030, it seems impossible only with hydro because the construction period for hydro is at least 5 years. The solar plants can be installed very short compare to hydro stations. Cost of solar technology getting lower day by day due to mass production. Energy cost per unit is low compare to hydro so it is economical. All

most all hydropower plants in Nepal are Run of River (ROR) type, not reservoir type. That means power generation directly depends upon river discharge. In dry or winter (lean) season river discharge goes as low as one third. That time Nepal imports more power from outside the country to balance demand. That kind of problem could be offset by a large-scale solar power plant connected to the grid and reduce import as well as safe forex reserve. In the Nepal utility-scale, solar technology will be a second viable option after hydro. Utility-scale solar development means Nepal would be able to achieve, reliable and diversified energy.

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