Quarterly news bulletin – March 2019

We continue with news about one of the aspects[1] discussed in the last quarterly bulletin – recent additions to electricity generation based on unconventional location of solar panels. Here, we focus on installations at public locations that do not require diversion of land -- on the roofs of railway station platforms (and also on trains), airports, and sports stadia. We also look at an innovative solar-energy combined with water-harvesting device.

Railways: The Indian Railways have been trying to increase the use of renewable energy both for traction (i.e. running locomotives) and for non-traction (i.e. workshops, maintenance depots, stations, platforms). While meeting the traction needs would require huge investment and infrastructure, meeting the non-traction needs is relatively easy – through its own installation of station-rooftop and train-mounted solar panels, as well as collaboration with private players for using railway land for solar plants and windmills.

In January 2019, it was announced that solar panels would be installed on the rooftops of general coaches[2] of intercity trains (running for two days) of the Northern and Southern Railway regions; this would enable longer trials of the panels to be conducted in different weather conditions. The Railways will also provide roof-top solar panels for 50% of the narrow gauge coaches plying on some routes[3] of Northern Railways. Thus far, rooftop-solar panels have been provided for 19 coaches of narrow-gauge trains plying in the same region.

Rooftop-solar panels have also been provided for 23 broad-gauge[4] non-air-conditioned coaches. This is because light-bulbs and fans can be powered through the solar panels installations carried out, but air-conditioning requires additional power. The systems work during sunlit hours and charge batteries for a backup of four to five hours. While these hours could be greatly reduced during foggy/rainy weather, even a partial shift to solar energy reduces the use of high speed diesel and the consequent environmental impacts. Such conservation measures are additional to those planned for traction, for example, the replacement of the conventional passenger coaches with Linke-Hofmann-Busch (LHB) coaches for all long-distance trains[5].

[1] The focus was on solar-powered water-heaters and solar-powered pumps for irrigation, but generating electricity through solar panels atop irrigation canals had been included.
[2] The Indian Railways had launched its first DEMU (diesel electric multiple unit) train with roof-top solar panels in July 2017; light-bulbs and fans were powered by solar energy.
[3] These are the Pathankot-Joginder Nagar route in Kangra Valley section and the Kalka-Shimla section.
[4] These solar-panelled coaches include 13 in two trains of Northern Railways, seven in one train of Southern Railways, two in one train of Konkan Railway, and one in one train of West Central Railways.
[5] The LHB coaches are also preferable for safety issues. Since Aprill 2018, only LHB coaches are being manufactured at the Railways' coach factories.

However, roof-top solar panels would have to be adequately maintained. Besides the obvious wind pressure during the motion of the train, the panels are exposed to dust particles, and also sand in some regions. While cleaning the modules, care has to be taken to avoid eroding the thin film of semiconductors. Although advanced technologies such as water pump suction systems would be ideal for maintaining solar panels, these may not be financially viable.

The Indian Railways are now using solar panels at several stations across the country. Shown alongside are the stations at Guwahati (in Assam state, north-east India) – the first in the country to be 100% solar-powered,

Secunderabad (in Telengana state, south-east India),

and Jaipur (Rajasthan, north-west India).

Airports: The airport at Kochi (Kerala state, south-west India) managed by Cochin International Airport Limited (CIAL) is the first ever fully[6] solar-powered airport in the world. From 12MW in August 2015, the current power level is about 29MW. The "plant" generates adequate energy during the sunlit hours for the airport requirements throughout the day. The management is implementing other environmentally beneficial activities, too, for example, vegetables are being grown organically under the solar panels and on other available land in the vicinity. To keep pace with the increasing passenger traffic while continuing as a fully solar-powered airport, the facility is continually expanding its energy operations. Last October, the airport was awarded one of the United Nations' top environmental honours - the Champions of the Earth award for Entrepreneurial Vision.

[6] CIAL first installed a 100kW solar power plant on the rooftop of its arrival terminal block, followed by a much larger 1MW system, and then moved to complete solar dependence.

Some have feared the adverse effects of glints or glare[7] from the solar panels on pilots' vision, when landing and taking off. However, it has been found that solar panels reflect significantly less light than flat water, and the biggest glare hazard in aviation is the sun itself – particularly when it is low on the horizon[8]. Further, as most solar panels are treated with anti-reflective coating (to increase their efficiency), this prevents glare from being a serious issue.

Indira Gandhi International Airport in Delhi was the second airport in India to harness solar energy, and the first to be registered under the UNFCCC's Clean Development Mechanism. Thereafter, solar panels have been installed atop several airports, reducing their need for grid-supplied electricity and the related expenditure. The reduction in the use of fossil fuels, for the generation of that energy, and the environmental impacts from generation to provision at the consumer end, are implicit. Other measures such as rainwater harvesting that serve to lower costs and impacts, are also being implemented.

Sports stadia: Solar rooftop panels have been recently installed above viewer stands of Brabourne stadium (of the Cricket Club of India) in Mumbai (Maharashtra state). Currently the world's largest solar installation on a cricket stadium, the total capacity is 820.8kWp. Annual generation of over 1.12 million kWh is expected, leading to approximately 25% reduction in the total electricity use. (However, this total excludes the high-intensity evening floodlighting that continues to be run on diesel).

Actually, the Karnataka State Cricket Association's Chinnaswamy stadium in Bangalore (Karnataka state) was the first in India to have solar rooftop panels. Installed on the eastern stands, they have a total capacity of 400 kW. With the grid-interactive solar system, after the stadium energy requirements (excluding the floodlighting) are met, the surplus can be evacuated with bi-directional metering to the regional distributing utility (BESCOM).

[7] When the sun is reflected on a smooth surface, there is a glint (a quick reflection) or glare (longer reflection) for those on the receiving angle. Pilots encounter this sort of reflection, usually from bodies of water.
[8] The light reflected is diminished by having first hit the substrate that reflected it. When the sun is the original source of the light that is reflected off a reflective surface, the time and position of the glint or glare depend on the position of the sun in relation to the location of the viewer.

At meeting places - innovative solar energy cum water conservation: While umbrellas usually serve to protect us from the rain or from the sun's rays, they can be innovatively used in the inverse way too: to collect rainwater and solar energy. "*Ulta Chaata*" (inverted umbrella), is a device that looks like its nickname, and combines the provision of clean water and energy. It has been designed by Samit Choksi and Priya Vakil Choksi, at their Think Sustainable Lab Private Limited (Thinkphi).

Whenever it rains, water falling on the Ulta Chaata's concave canopy is collected. The turbidity of the water is reduced through active carbon filtration, i.e. by making the water flow through a bed of activated carbon, making it usable[9].

During dry months, panels fixed on the canopy absorb solar energy that is stored in a battery within every Chaata. This energy is used for the lighting system installed in the Chaata; it can also be used for various levels of programmable lighting options and a mobile charge unit, thereby making it a completely self-sustaining installation for the outdoors. A cluster of 15 Chaatas can be connected to a central operating system (or phi box). Designed to be (ideally) used in clusters controlled by one phi box, the sensors collect data from the environment and can also alert customers or maintenance staff via an app.

The device was officially called Model 1080 (i.e. the total of the geometric angles). Currently, there are three different sizes. 1080H, a home version of 4m x 4m, that has been installed in several test sites in the US and Australia; it is available as a flat-packed easily-assembled kit, can generate as much as 40,000 litres of water, and is adequate for lighting. 1080WX has a canopy measuring 5m x 5m, a water-harvesting capacity of 85,000 litres, and power capacity of 2.2 kWp. There is also a super-sized 1080XXL, measuring 20m x 20m.

These devices can be seen at over 60 locations across the country. In particular, they have been installed at railway stations and college campuses around Mumbai and Pune (also in Maharashtra state), and Bangalore. The picture shows one of the platforms at Arsikere Junction railway station (Karnataka state).

[9] According to the World Health Organization (WHO), water below 5 Nephelometric Turbidity Units is potable.

India's total solar-powered electricity generation capacity (as of 31st December '18) amounted to 28,057 MW, comprising 24,202 MW of utility-scale and 3,855 MW of roof-top scale. Tenders are announced periodically, to auction bids for the development of solar-powered generation "plants". However, during the year 2018, the tenders of Solar Energy Corporation of India (SECI) had often to be extended (postponed) for want of adequate bids. This appeared to be due to the difficulty of meeting the stipulated requirements, such as manufacture-linkage[10], as well as the low tariffs per kWh[11] that emerged during earlier auctions and the subsequent ceilings imposed[12]. Nevertheless, according to the trajectory issued by the Ministry of New and Renewable Energy (MNRE), projects around the country amounting to approximately 30 GW are expected to be tendered during this financial year (ending 31st March 2019); numerous tenders have been called for during this last month, although one cannot be certain about the actual additions to capacity[13] that will result.

While dedicated solar projects may not be taking off as rapidly as expected, due to several difficulties, innovative panel installations that ride piggy-back (literally!) on structures for other purposes can facilitate increased access to solar energy.

Antonette D'Sa
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[10] Manufacturing-linked power purchase agreement tenders require new production units; they do not allow existing entities to participate by integrating their manufacturing facilities. This entails huge investment, and with many financial institutions wary about lending for power projects, it is difficult to proceed.
[11] When arriving at a final bid price, developers have to consider several factors: input costs (primarily module prices, with import costs that have risen with the falling value of the Rupee and 25% safeguard duty), land leasing, transmission availability, and solar irradiance in the region. During 2018, there was also ambiguity regarding the rate of GST (goods and services tax) applicable to such projects. Further, there have been instances where the state and central entities have cancelled successfully-completed auctions, when lower prices emerged at subsequent bids.
[12] Tenders are usually floated with upper limits on the acceptable tariff. The lowest bid price at an auction during 2018 was Rs 2.44/kWh (US$ 0.0344).
[13] In a few cases, tenders have been very productive. For example, an SECI auction for 750 MW capacity in the state of Rajasthan (in north-western India, favourable in terms of solar irradiance), had been postponed several times since August 2018; but this February, bids amounting to 2370 MW were received, after which allocations of 750 MW were awarded, at a low price of Rs 2.48/kWh (US$ 0.0349/kWh).