Taiwan Photon Source (TPS)

Operation Parameters

The major operation parameters of the Taiwan Photon Source (TPS) are shown in **Table 3**.

Table 3: Major operation parameters of the TPS storage ring

Beam energy [GeV]	3.0
Circumference [m]	518.4
Number of buckets	864
Beam current (design) [mA]	400 (500)
Beam emittance ($\varepsilon_x/\varepsilon_y$) [nm-rad]	1.6 / 0.016
Betatron tune (ν_x/ν_y)	24.18 / 13.28
Natural chromaticity (ζ_x/ζ_y)	-75 / -26
Momentum compaction (α_1/α_2)	0.0024 / 0.0021
RF voltage [MV]	2.8
Synchrotron tune (ν_s)	5.42×10^{-3}

Operation Summary

In 2017, totally 60 beam trip events occurred with a mean recovery time of 1.11 hours. The superconducting RF system contributed to the downtime of 40%, due to the gas loading issue. The summary of the beam availability and MTBF of the TPS user-model operation is shown in **Fig. 2**. (Reported by Chang-Hor Kuo)

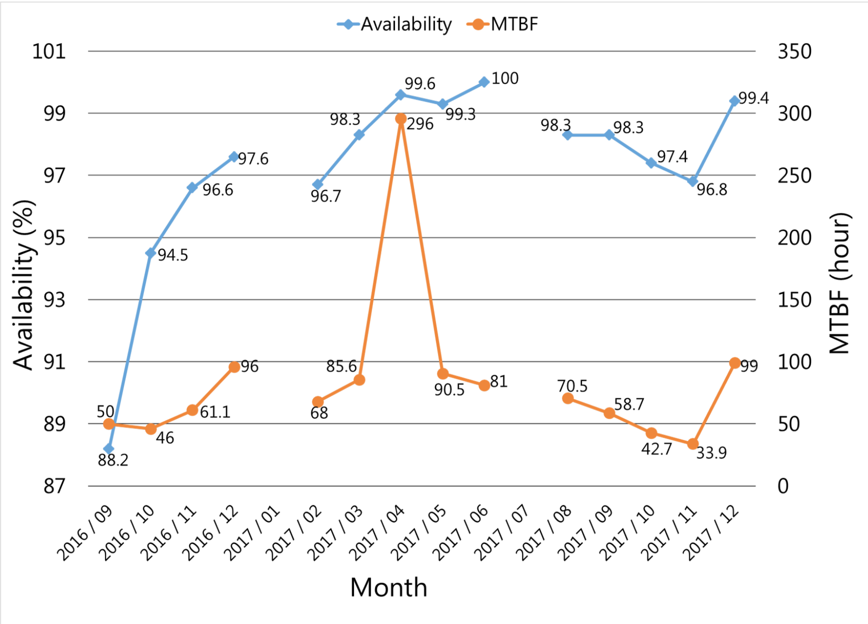

Fig. 2: The summary of the beam availability and MTBF of the TPS user-model operation.

The Rooftop Photovoltaic Systems at NSRRC

Facing deteriorating air quality issues and the availability of natural resources, renewable, clean sources of energy are getting more and more attention in recent years. This kind of energy does not produce greenhouse gases, helps distributed power generating systems, strengthen the nation energy security, and assist its long-term economic growth. For more than a decade, it becomes a trend for governments worldwide to set up the renewable energy promoting policies. Taiwan has no fossil fuel resources, so the development of renewable energy techniques and their application is always a high-priority policy of the government. Today, the renewable energy sources are only responsible for a few percent of the total energy consumed in Taiwan. Since 2016, the new government announced a new green energy policy that envisages the use of renewable energy to exceed 20% of the energy supply nationwide by 2025. It is definitely a tough challenge and requires more incentive measures to carry it out.

Among the renewable energy sources, solar panels have many advantages. They generate the electricity without carbon emission and ash/waste products, and require no input other than sunlight. It does NOT generate the radioactive waste or increases the environmental risks associated with nuclear power and there is no risk of groundwater pollution during processes like extraction of natural gas or other hydrocarbons. Furthermore, compared to all the other types of the power plants that generate the electricity via steam turbines, solar panels require little or even no water once installed.

Benefitting from the economy of scale and the technology improvement made in photovoltaic (PV) in recent years, the capital expenditure for setting up the photovoltaic system has decreased significantly over the past 10 years. These falling up front costs of construction and installation along with policy stimulation from the government, more and more people are motivated to build solar PV systems above their own homes.

To cope with the green energy policy, NSRRC initiated the rooftop PV system project at the beginning of 2016. It had many objectives not only to produce clean energy, but also to reduce the load on the air-conditioning system, beautifies the landscape of the roof and helps prevent water leakage into our ageing buildings. Owing to the tighter and tighter budget condition from the government, NSRRC decided to construct the PV system within the original budget funding.

The proposal of rooftop PV system accompanied with a report of cost-benefit analysis was submitted to the NSRRC Board of Directors for the review in March of 2016, and was approved. Financing for this rooftop PV system came from the NSRRC Establishment Fund. After a prolonged and extensive purchasing process, which included the open bid announcement and vender selection, the construction started rapidly. In June of 2017, three on-grid systems located on the roofs of the Instrumentation Building, Administration Building and Activity Center were completed. Four months later, three other systems located on the roofs of the Research, Utility and TLS Office Buildings were also completed. The photos in **Fig. 1** shows the roof landscape in NSRRC before and after the installation of the PV systems. As shown in **Fig. 1(a)** the aerial view of the NSRRC campus has significantly improved and the aging rooftops are more beautifully presented.

The capital expenditure of the PV system was approximately 50 million TWD (~1.7 million USD) The installed PV system has the total capacity of 1094.46 kWp, and is expected to generate 1.1–1.2 million kWh annually. All the electricity generated by the PV systems will be sold to the power supplier, Tai-power Company, at a negotiated price for the next 20 years. **Figures 2 and 3** show the monitoring system of the rooftop PV systems, and the energy and power produced in one day. They indicate the real-time electricity output, the daily produced energy, the accumulated energy, the carbon reduction, and the power-energy diagram of the PV systems. The energy produced by the PV systems is higher than estimated

(a)

(b)

Fig. 1: Roof landscape (a) before and (b) after the installation of the PV systems.

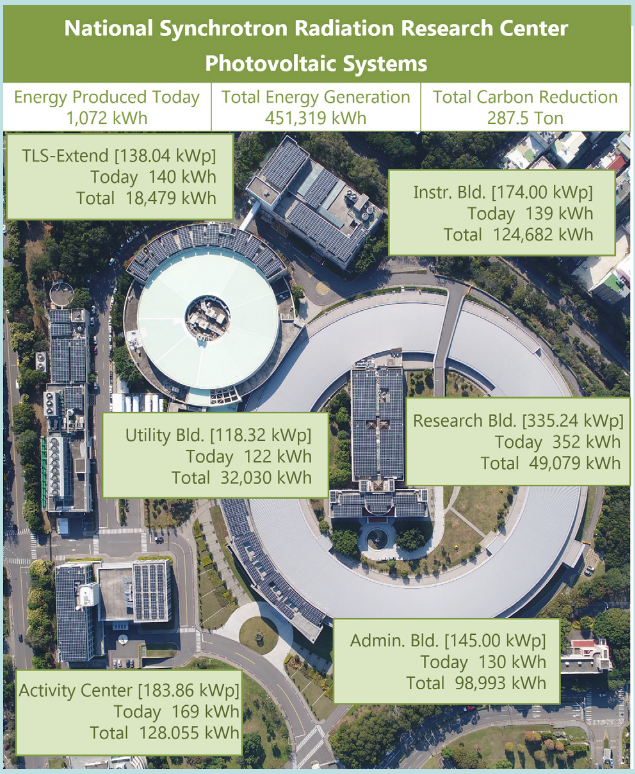

Fig. 2: The monitoring system of the rooftop PV systems.

Fig. 3: The energy and power produced in one day.

due to the good weather and high temperature recently. With this high efficiency and PV capacity, the net income though the energy selling to the Tai-power Company might reach 5.5–6.0 million TWD per year. The payback period for the capital expenditure is thus between 8 and 9 years. The profit gained once the original expenditures are paid back will be stable and reliable and used to benefit all at the NSRRC by improving the synchrotron radiation research, the encouragement of the outstanding performances, and the support of welfare activities of the staff.

The rooftop PV system project at the NSRRC has already helped the environment and will continue to for many years. However, for a beautiful earth, we must and will pay attention to the manufacturing processes of PV materials to minimize the possible pollution and establish an end-of-life recycling protocol for the existing PV panels. (Reported by Jau-Ping Wang)

This report features the NSRRC Rooftop PV System Project led by Ming-Tsung Lee and Jau-Ping Wang.

The TPS Post-Mortem System

The Taiwan Photon Source (TPS) is a low emittance and high brightness synchrotron light source, located in Hsinchu, Taiwan. The TPS operates as user mode since September 2016. From the very beginning, several electron beam trip events occurred at the TPS; those trip events mainly resulted from the failure and malfunction of the subsystem and some of these events are still not clarified yet. In order to figure out the root cause to trigger the electron beam trip, the Instrumentation & Control (I&C) group established the TPS Post-mortem (PM) System to analyze trip events. This implementation has been followed by the developments of several useful utilities, such as the trigger capture of the spontaneous firing caused by the pulser magnets, the monitoring of 3-phase line voltage provided by the power supply, the report auto-generator and the web-based interface for the quick survey. With the help of the TPS PM system, the reliability and availability of the TPS operation were improved significantly.

Figure 1 shows the infrastructure of the TPS PM system, including the beam trip detector, EPICS (Experimental Physics and Industrial Control System) embedded standalone data recorders, the data storage server and the viewer. While the beam current stored in the storage ring of the TPS decreased more than 25 mA within 0.1 millisecond, the beam trip detector will output a trip signal as the trigger. The trigger signal will be broadcasted to the beam position monitor (BPM) platforms and the data recorder via the event-based timing system for the synchronization of the data capture. Then, the data recorder will record the relevant information. The PM data stored in the data storage server are used for the report auto-generation. Based on the PM viewer graph user interface (GUI) and/or the beam trip report, we could analyze the root cause of the trip event. Up to now, the recognizable sources which result in the trip of the electron beam involve the trip of RF system, the interlock of BPM system, the interlock of vacuum system, the interlock of front-end system, and the irregular firing of the injection pulsed magnet.

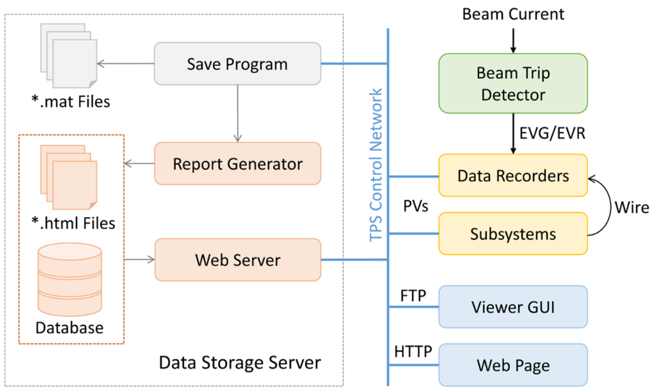

Fig. 1: The schematic layout of the TPS Post-mortem System for the diagnosis of beam trip.