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POWER SAVING STATUS AT NSRRC

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Abstract

National Synchrotron Radiation Research Center (NSRRC), Taiwan has completed the construction of the civil and utility system engineering of the Taiwan Photon Source (TPS) in 2014. On the last day of 2014, the Taiwan Photon Source (TPS) has delivered its first synchrotron light with 1mA stored beam current. The machine is in commission currently. The power consumption of TPS was about 5MW then. The ultimate power consumption of the TPS is estimated about 12.5MW. To cope with increasing power requirement in the near future, we have been conducting several power saving schemes, which include adjustment of supply air temperature according to the atmosphere enthalpy, replacement of old air conditioning unit (AHU), power consumption control by the operation of chillers, power factor improvement, and reduction of power consumption during long shutdown.

INTRODUCTION

NSRRC has been conducted several major projects, such as installation of superconducting rf cavities and magnets, construction of extension buildings in the Taiwan Light Source (TLS) for years. Besides, the TPS project has been in commission process. Those projects have been greatly increased the electrical power consumption. Currently, the contract power capacities of the Taiwan Light Source (TLS) and the TPS with the Taiwan Power Company (TPC) are 5.5MW and 7.5MW, respectively.

As the price of petroleum increased, the power bill had also been raised three times since 2008. The power bill of per kW-hr was increased about 35%, 40%, and 10% in 2008, June 2012, and Oct. 2013, respectively. Fig. 1 shows monthly average power bill per kW-hr of TLS from 2011 to 2015.

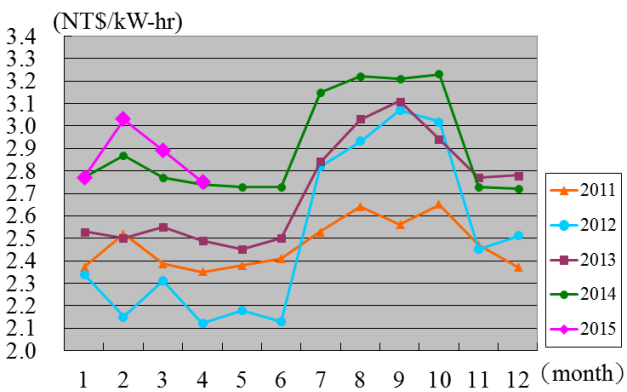

Figure 1: Monthly average power bill per kW-hr in NSRRC from 2011 to 2015.

To cope with fast growth of the power consumption and power bill, NSRRC has been conducting a series of power saving schemes since 2006 [1]. Those power saving schemes include optimization of chiller operation, power consumption control, improvement of temperature and humidity control, electrical power factor improvement, lighting system improvement, and application of heat pumps. We keep conducting those schemes and create some new ones, including modified run-around coil AHU, change of power bill calculation mode, and promotion of power saving. Some major schemes are described as follows.

CHILLED WATER PIPES CONNECTION BETWEEN TPS AND TLS

There are three utility buildings in NSRRC. The Utility Building I was constructed for the TLS 23 years ago. There are three chillers, each with 320 RT in capacity installed inside. Utility Building II was construction for the cryogenics and superconductivity systems 13 years ago. There are two 600 RT chillers and two 450 RT chillers installed inside. We had ever connected chilled water pipes between Utility Buildings I and II. It saved about 70 kW.

The civil construction Utility Building III for the TPS had been completed in Dec. 2012. Three chillers, each with 1,400 RT in capacity, had been installed inside. We had connected supplied and return chilled water pipes, each with 10 inch in diameter, between the second and the third Utility Buildings in 2013.

Figure 2 shows the chilled water piping system in the Utility Building II. The blue lines are the pipes connected between Utility Building I and II. The green lines are the pipes connected between Utility Building II and III.

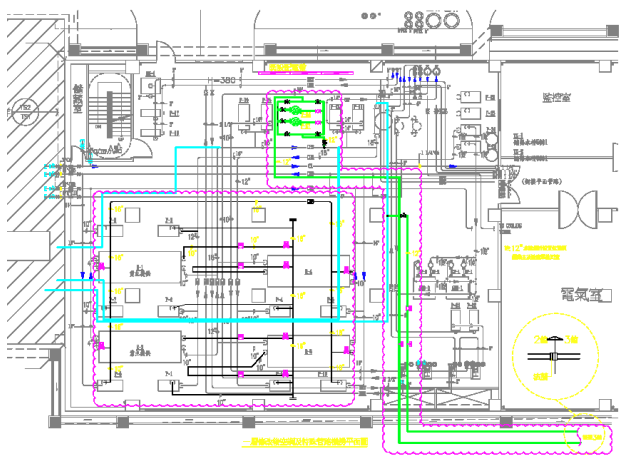

Figure 2: Chilled water piping in the Utility Building II.

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Because the chilled water may be supplied from either Utility Building II or III, we can also apply this scheme to control the either power consumption of TPS or TLS. We ever switched the valve to supply chilled water from Utility Building III to Utility Building II on Dec. 29 2014. It saved about 300kW power consumption on the chillers, cooling towers and water pumps.

CHANGE OF POWER BILL CALCULATION MODE

During a whole year's power operation, there are about 160 peak hours as the most challenging hours for TPC. To cope with the challenge of these 160 hours, TPC has its policy on the power bill.

For industrial power customers, there are two modes of power bill calculation according to the rule of TPC. One is so called "two time periods" mode and the other is "three time periods" mode. The main difference between these two modes is on the power bill calculation on week day. The former mode divides one day into peak hours and off-peak hours. The latter mode divides one day into peak hours, semi-peak hours and off-peak hours. The 160 hour is in the peak hour.

NSRRC had been charged power bill according to the "two time periods" mode for years. We changed the power bill calculation mode to the "three time period" on Jan. 2012. Due to the change of power bill calculation mode, the monthly average power bill per kW-hr of 2012 is clearly reduced from 2011, as shown in Fig. 1.

Although this scheme does not save power, it saves much money. It saved the power bill 5,967,572, 6,014,584 and 7,603,007 NT dollars in 2012, 2013 and 2014, respectively.

POWER COMSUMPTION CONTROL

TPS also set "Contract power capacity" with industrial power customers as the basic power bill. Setting an optimized contract power capacity can not only save power bill, but also provide effective power demand for TPC to operate. Surely, power customers are suggested to control their power consumption less than the contract power capacity.

Like the scheme of modification of power bill calculation mode, the scheme of power consumption control helps TPC to plan and provide electircal power efficiently. Moreover, this scheme also saves power.

Although the electrical power consumption has been largely increased for years in NSRRC, we still keep the contract capacity on 5.5 MW since 2006. Fig. 3 shows monthly peak power consumption in NSRRC from 2011 to 2015. Because of hot weather and power consumption of TPS construction added, the peak power consumptions of 2011 to 2013 were over contract capacity. Especially in July 2011, the peak power consumption was as high as 6,000 kW. Due to rf system of TPS test, the peak power consumption in Jan 2012 also reached to 6,000 kW. As the construction of TPS is completed, the peak power consumption had been reduced since 2014, as shown in Fig. 3.

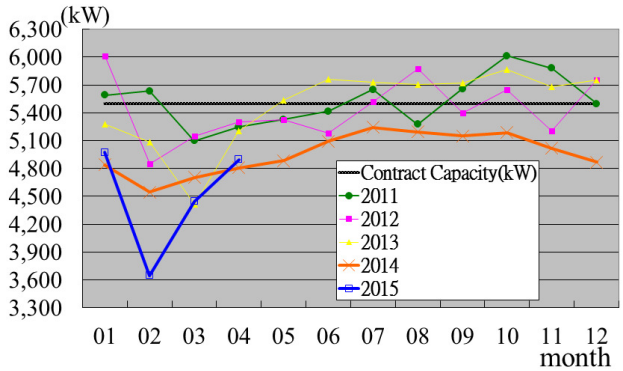

Figure 3: Monthly peak power consumption in NSRRC from 2011 to 2015.

ELECTRICAL POWER FACTOR IMPROVEMENT

We have kept improving in the electrical power factor since 2004. We applied power factor correction capacitor bank to improve the power factor as well as reduce power losses (I^2R).

The yearly average power factor was improved from 95.08% in 2004 to 100.00 in 2010. The TPC also rewards power customers with discount of power bill for their efforts on good power factor control. The saved power bill was also increased from NT 1,200,298 dollars in 2004 to NT 3,033,623 dollars in 2014, as shown in Fig. 4.

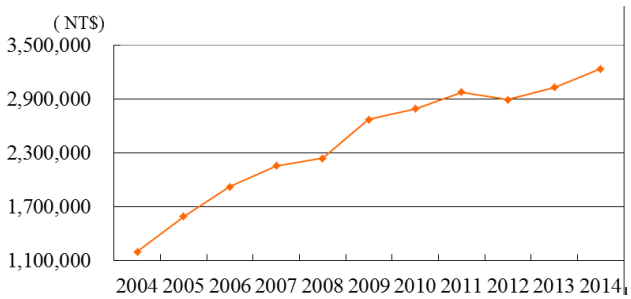

Figure 4: Power bill saved due to power factors improvement for past 11 years.

REPLACEMENT FOR THE AGING EQUIPMENT

As TLS operated over two decades, many equipment of utility system has lost initial performance and consumed more power. We have replaced those aging equipment with power-saving one. Old chillers, AHUs, pumps and fans have been replaced every year.

For example, the old AHU contains a cooling and a heating finned-tube coils for heat exchange. We proposed additional run-around coil loop applied in the AHU to play a role in heat recovery and power saving in 2012. [2] We have replaced two old AHUs with the run-around

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typed ones so far. One was installed on the TLS booster area. Compared to the traditional AHU, the run-around typed one saves about 36.5 kW.

PROMOTION FOR POWER SAVING

To supervise the power saving works, NSRRC had formed a power saving committee and held the first meeting in Nov. 2011. This committee meeting is held twice every year. Some action items of promotion for power saving are assigned in the meeting. For example, one of them is to display the real time information of total power consumption in NSRRC and each building on the public screen for the beam quality. This work had been accomplished in April 2012.

Last meeting was held on Nov. 2014. We check the reasons why the power consumption during the Chinese lunar New Year was still as high as 2,300 kW. Fig. 5 shows the power consumption history during the Chinese lunar New Year of 2014. There are two feeders A and B from TPC to NSRRC, respectively shown in white and red color in Fig. 5. The sum of these two feeders is shown in green color. The committee asked to reduce the power consumption next Chinese lunar New Year.

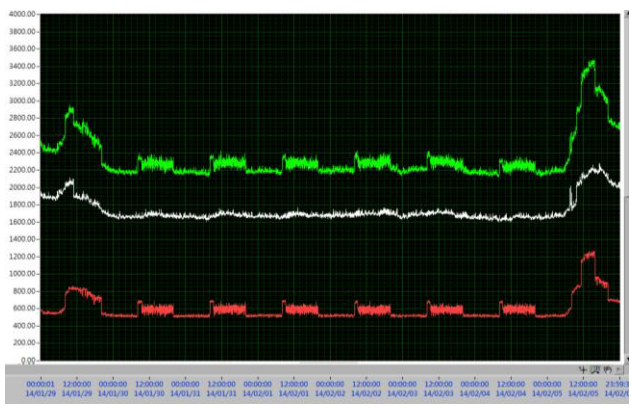

Figure 5: Power consumption history during the Chinese lunar New Year of 2014.

Figure 6 shows power consumption history during the Chinese lunar New Year of 2015. The power consumption in white line (from Utility Buildings I and II) were reduced about 200 kW, as shown in Fig.s 5 and 6. However, the booster and storage ring consumed more power than that in 2014. Therefore, the total power consumption was reduced about 100 kW during the Chinese lunar New Year of 2015.

In charge of the electrical power system and power control, we have published monthly power saving report to all staffs and users in NSRRC since July 2008. The monthly report includes power consumption and power bill from TPC of that month, of the same month last year, and of last month, and power saving project and status report.

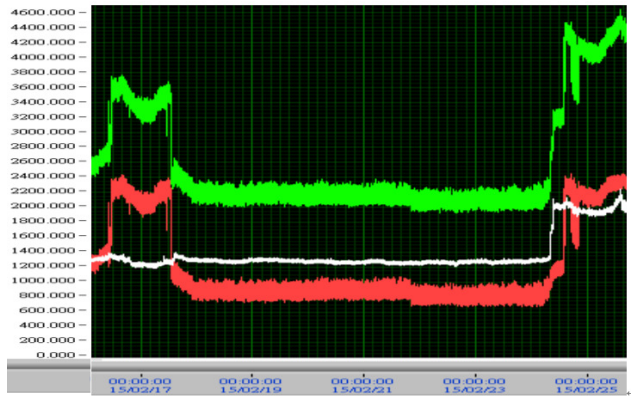

Figure 6: Power consumption history during the Chinese lunar New Year of 2015.

As the TPS has been commissioned, we also monitor the power consumption of TPS. Fig. 7 shows power consumption history of TPS on Feb. 2015. The peak power was controlled within 6MW.

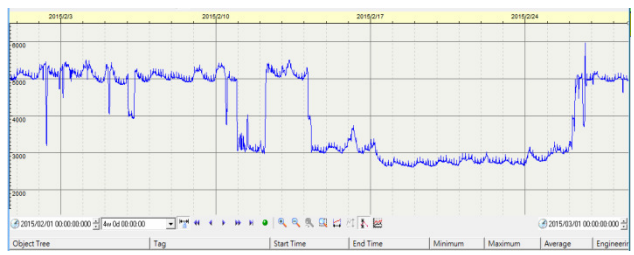

Figure 7: Power consumption history of TPS on Feb. 2015.

CONCLUSION

The power saving result of those abovementioned power saving schemes is notable. Because of the TPS construction, the growth rates of power consumption of 2010 and 2011 are 3.48% and 7.26%, respectively. But the growth rates of power consumption of 2012 and 2013 are -4.5% and -2.5, respectively.

ACKNOWLEDGEMENT

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