THE ENERGY MANAGEMENT SYSTEM IN NSRRC

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Abstract

Taiwan has been suffering from the shortage of natural resources for more than two decades. As stated by the Energy Statistics Handbook 2019 of Taiwan, up to 97.90% of energy supply was imported from abroad. This kind of energy consumption structure is fragile relatively. Not mention to the total domestic energy consumption annual growth rate is 1.97% in twenty years. Both the semiconductor and the integrated circuit related industries, which are high energy consumers, are developed vigorously in Taiwan. All the facts cause us to face the energy problems squarely. Therefore, an energy management system (EnMS) was installed in NSRRC in 2019 to pursue a more efficient energy use. With the advantages of the Archive Viewer-a supervisory control and data acquisition system of utility in NSRRC, the data of energy use could be traced conveniently and widely. The model of energy use has been built to be reviewed periodically, furthermore, it provides us the accordance to replace the degraded equipment and alerts us if the failure occurs.

Energy Management System

The energy management system (EnMS) in NSRRC is established in accordance with ISO 50001, which enables organization process necessary to continually improve energy performance. It also supports a culture of energy conservation with the commitment from leadership of NSRRC. With the assistance of the Taiwan Green Productivity Foundation, the EnMS of NSRRC has been developed with recognized energy policy and objectives, and earned the third-party certification in 2019. Therefore, we can claim the NSRRC is a synchrotron radiation facility operated with a more energy-conserved way, also known as Green Light Source.

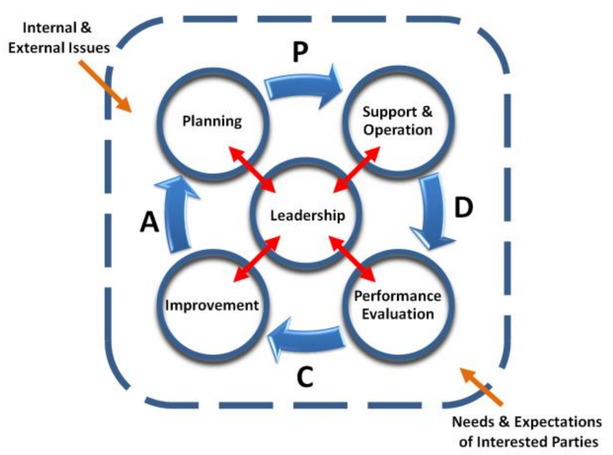
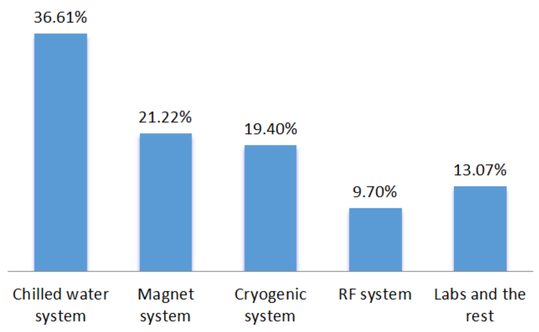


Figure 1: The typical structure of compressed air system in NSRRC.

Energy Tracing & Energy Baseline

Designation	Power Consumption (kW/unit)	Year of Use (yr.)	Consumption Ratio (%)
TPS Chiller	651	9	22.01
TLS Chiller	385	32	21.69
TPS Magnet System	880	7	13.86
TLS Magnet System	681	32	10.72
TPS Ring RF System	530	7	8.34
TPS Heat Pump	200	8	6.76
TPS Cryo. Compressor	166	7	5.23
TPS Air Compressor	151	7	3.4
TLS Ring RF System	200	32	3.15
TPS Cooling Tower	110	9	2.48
TPS BR RF System	150	7	2.36

Energy consumption of individual equipment for system rankings 2020



Energy usage percentage of different system in NSRRC 2020

The majority of electric energy consumption is consumed to operate the chillers of chilled water system. Therefore, the action plans for energy saving originate from conservation for cooling systems, like air handling unit or process cooling water system. In a summary, the downtime and uptime of the chillers and the accelerator related facilities dominate the behavior of energy consumption in NSRRC.

There is one another factor affecting the electric usage in NSRRC, which is air temperature. As we mentioned above, the most of electricity usage is for the operation of chillers. More than 35% of total electricity used in NSRRC during 2020 is used to operate the chilled water system. After analyzing the electricity usage and air temperature data, it is concluded that the behavior of electricity consumption can be classified into on/off mode and air temperature-related mode.

	Average Temperature (℃)	mode U+S	mode M	Average Power (kW)	Estimated Usage (kWh)	Real Usage (kWh)	Error (%)
TLS							
Jan	14.37	12	19	2707.03	2,283,563	2,014,030	13.38%
Feb	17.15	0	28	2200.87	1,689,512	1,478,981	14.23%
Mar	18.55	27	4	3026.95	3,005,831	2,252,049	33.47%
TPS							
Jan	14.37	25	6	4560.56	3,439,546	3,393,057	1.37%
Feb	17.15	18	10	4452.61	2,895,602	2,992,155	-3.23%
Mar	18.55	31	0	5695.92	3,988,822	4,237,767	-5.87%

NSRRC	Total Estimation (kW)	Total Real Usage (kW)	Error (%)
Jan	5,723,109	5,407,087	5.84%
Feb	4,585,114	4,471,137	2.55%
Mar	6,994,653	6,489,817	7.78%

The energy model can be described by these energy baselines originating from operation data of 2020. The data from January to March 2021 show that there are fewer errors between estimation and real usage. But some factors must be taken into consideration together. Because of the water shortage in the first half of 2021 in Taiwan, some strategies had been applied to reduce water usage, including shutting down older chillers and cooling towers. These measures not only reduce the waste of water resource, but also obtain more efficient electricity use. The overall electric usage in NSRRC is 2%~7% less than estimation as shown

Conclusion

In this article, the method of developing energy usage models in NSRRC is proposed. The errors between model estimation and real case are reliable if there is no significant load added. The energy efficiency in NSRRC will improve continually with the aid of energy management system.