

Research on energy conservation in the hotel industry under Macau's dependence on external energy

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Abstract. The Macau Special Administrative Region has a special urban form. It is located on the coast of the Pearl River Delta, with a land area of only 33.6 square kilometers. The population living here is close to 700,000. It is the region with the highest population density in the world, and its energy mainly depends on imports. With the new coronavirus epidemic, Macau's tourism industry has been hit hard, and energy expenditures have risen with changes in the international situation. As an important economic support industry in Macau, the energy conservation development of the hotel industry is extremely important. Since 2007, Macau has launched "The Macau Energy Conservation Week, in conjunction with many departments and tourism companies in Macau, and the establishment of the Macau Green Hotel Award in the same year, have had a profound impact on Macau's energy consumption savings and improved the efficiency of Macau's hotel industry in terms of energy use. In pursuit of the goal of carbon peaking, the hotel industry in Macau has generally passed the ISO 50001:2018 Energy Management System (EnMS) certification, and most hotels have exceeded the Energy Use Intensity standard assessed by the Cornell Hotel Sustainability Benchmarking Index. Under the concept of green energy and other concepts, the hotel industry in Macau has now begun to use renewable energy for hotel use. Top hotels in Macau decreased by an average of 23.6% in 2021. After the return of Macau's sovereignty, Macau's unique political attributes and urban characteristics have different standards for the energy use of the entire industry and the characteristics of laws and regulations, which make it have different standards from mainland China. Based on preliminary research on the energy saving and environmental protection of the hotel industry in Macau, this research collects statistics on the energy saving data of the hotel industry and finally proposes improvements based on the energy utilization and environmental protection of the Macau Special Administrative Region and similar coastal peninsula cities.

1. Macau relies on external energy sources

Ninety percent of Macau's energy supply relies on imports of electricity, and its oil and gas are entirely imported. Under the background of the global energy crisis and the current stage of climate change, saving energy and developing sustainable energy use have become priorities. The focus is now that in the past 20 years, the city of Macau has experienced rapid growth. According to the data of the World Factbook, the urban population of Macau has reached 100%. Electricity has shown a rapid growth trend. Except for a small amount of electricity that can be supplied by local waste-to-energy plants, the rest of the electricity needs to be imported from the mainland. The local electricity supply is very small in total. Figure 1 shows the total electricity production and imports in Macau from 2016 to 2021. It can be seen from the figure that except for the local electricity supply in 2017, which increased relatively, the

rest of the electricity suppliers are relying on external energy (Figure 2).

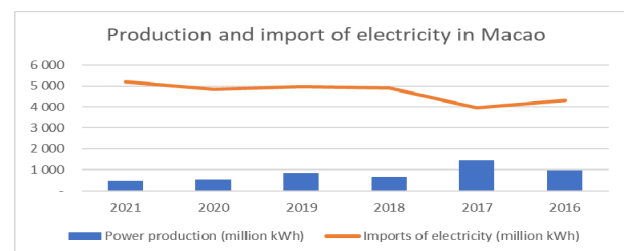


Fig. 1. Electricity production and import in Macau (Image source: drawn by the author after collecting data from the Macau Statistics Bureau)

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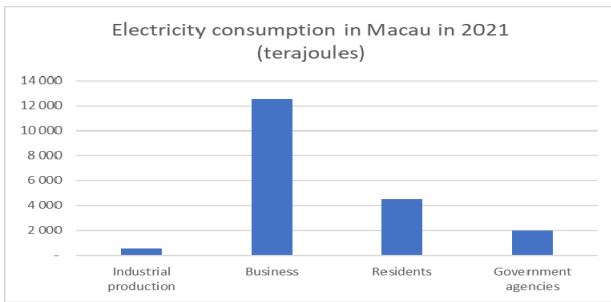


Fig. 2. Electricity consumption in various industries in Macau. (Image source: drawn by the author after collecting data from the Macau Statistics Bureau)

1.1 The progress of energy and environmental protection in Macau

Building-related energy consumption accounts for an important part of Macau's total energy consumption (Song et al., 2018), ensuring Macau's energy security and reducing energy consumption for Macau's financial sector. Therefore, since 2007, relevant institutions in Macau have been working in related fields and formulating policies to provide medium- and long-term energy planning for Macau (Table 1).

At the same time, the formulation of energy-saving standards also provides the hotel industry with exact environmental protection indicators to guide relevant

enterprises to formulate relevant standards for improvement Require:

- Materials used in the building
- Lighting system
- Air conditioning and ventilation system
- Electricity
- Elevator
- Use of renewable energy

It can also be seen that Macau has had corresponding requirements and standards for renewable energy since 2009. Macau government agencies and relevant associations are also actively looking for environmental protection measures that are more suitable for Macau. At the same time, we can see Macau's demand for sustainable energy, hoping to further improve Macau's urban comfort and build and consolidate Macau's proposals. The concept of a "leisure city", but there are also relevant scholars who hold objections to it, believing that Macau, as a miniature city, is full of high-rise buildings. Solar energy efficiency is not high due to adverse shading effects caused by adjacent buildings, coupled with a very low ratio of roof area to house floor space. In addition, Macau has no onshore or offshore wind farms that can supply stable power. This means that Macau is unlikely to become a sustainable energy-efficient city in the short to medium term.

Table 1. Regulations and standards related to energy conservation in hotels in Macau.

Policies, Regulations and Standards on Energy Conservation in Macau Hotels	Target	unit	years
Macau Green Hotel Award	Jointly realize the goal of "Building a Low-Carbon Macau and Creating a Green Life"	DSPA	2007
Macau Building Energy Consumption Optimization Technical Guidelines	Utilize limited resources in the construction sector to obtain maximum economic benefits with minimum energy consumption	GDSE	2009
Macau Environmental Protection Planning	As the regional development orientation of "World Center of Tourism and Leisure", it will promote the development of Macau into a green and low-carbon city suitable for living, business and tourism.	DSPA	2010
Environmental and Energy Efficient Products and Equipment Funding Scheme	Subsidize the replacement of energy-efficient or water-saving products to commercial enterprises and societies	DSPA	2011
Air Pollutant Emission Standards for Boilers in Industrial and Commercial Sites	Reduce environmental pollution and protect residents' health	DSPA	2022
Green Building Evaluation Standard (Macau)	Guide the healthy development of green buildings	China Green Building and Energy Saving (Macau)	

Source: drawn by the author after investigation

1.2 Hotel energy options for tourism recession

Due to Macau's unique urban history and small land area, hotels that have sprung up on a large scale after land reclamation activities have become the mainstay of Macau's economy. Since the hotel industry in Macau is one of its largest industries, it has become one of the

largest industries in Macau. To guide, the Macau DSPA (Environmental Protection Bureau) started to set up the Macau Green Hotel Award (DASP, 2021) in 2007 to improve Macau hotel industry's awareness of environmental protection, improve environmental protection measures, and guide the hotel industry to improve energy utilization. Between 2019 and 2021, a

total of 57 hotels won the honor of the Macau Green Hotel Award (Figure 3). It can also be seen from this that the environmental protection of the hotel industry needs greater financial support to be completed, and it is more difficult for small and medium-sized hotels to eliminate energy-consuming products and save energy.

In the renewable energy development plan promoted by the Macau government, apart from the waste-to-energy plant, the use of solar energy to generate electricity, as clean energy, can provide lighting and commercial water heating for hotels. The use of residential buildings in Macau has problems such as

limited space (João, P. 2021), but in the hotel industry with a large battlefield area, it is quite different. It is also one of the main ways to upgrade sustainable energy equipment in Macau's hotel industry. The Macau government conducted a solar photovoltaic test in 2014 and found that Macau can obtain more than 1,000 full-load power generation hours per year (GCS. 2021). The relevant laws and regulations of developed countries such as Japan, Portugal and France establish Macau's own regulations, improve the application of solar power generation to the grid, and support the upgrading of related industries.

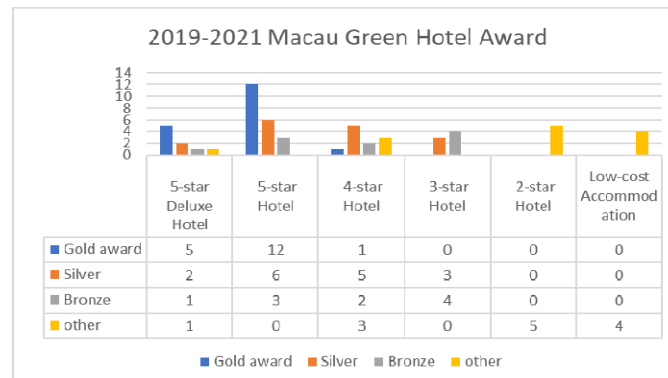


Fig. 3. 2019-2021 Macau Green Hotel Award. (Image source: drawn by the author after collecting data from the Macau Statistics Bureau)

2. Analysis of the energy saving scheme of the Macau hotel industry

With the development of the international community and the consumption of the earth's resources, public health events and economic development are full of variables, especially the commitment of various countries to carbon neutrality, and the concept of sustainable development plagued by the new coronavirus epidemic has gradually attracted the attention of investors from all over the world. The United Nations proposes that "Environmental, Social and Governance" (ESG) should be considered for investment, hoping to promote sustainable development of society and economy. From the end of 2019 to the first half of 2021, the concept of ESG rating attracted a total of US\$410 billion in capital inflows, and many international rating agencies have also implemented ESG ratings (IPIM. 2021).

2.1 Sands China Ltd.

In Sands China's 2021 ESG report, Sands' greenhouse gas emissions were 508,958 tons this year, a 32% drop from the 2018 baseline. Compared with 56.4 in 2018, the water consumption per square foot of Sands has dropped to 38.4, a total decrease of 31.9%, and the waste conversion rate has also dropped from 15% in 19 years to 13%, which is a relatively stable waste conversion rate. The reuse of plastics and packaging and the use of sustainable materials increased from 2% in 2020 to 49% this year, and the conversion of food waste (employee cafeterias) increased from 15.1% in 2020 to 18.4%. Overall, the company-wide food waste conversion rate in China is stable at 6.3% per year. Based on this, the energy savings of its hotel industry also show a downwards trend (Sandschina. 2021).

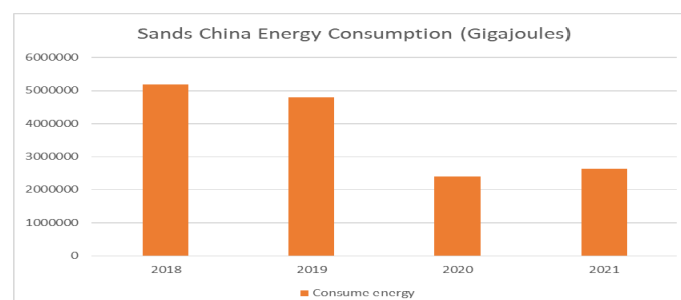


Fig. 4. Sands China Energy Consumption (Gigajoules). (Image source: drawn by the author after collecting data from Sands China)

2.2 Melco Resorts & Entertainment Limited

Melco Resorts & Entertainment Limited has also begun to refer to the implementation of ESG plans in the 2021 Melco Sustainability Report and has achieved a number of goals in 2021; 94%, 86% and 80% of the procurement is from Macau, Manila and Cyprus, respectively. One hundred percent of purchased bedding and bath products are certified by OEKO-TEX®, and 92% of chemical products are in green and yellow grades. In terms of power savings, the City of Dreams increased its power savings from 3,015,877 kWh in 2019 to 19,559,473 million hours in 2021, achieving a nearly 6-fold increase

and a 25% reduction in overall energy density. In terms of greenhouse gas emissions, the City of Dreams decreased from 8,974 tons of carbon dioxide equivalent in 2019 to 2,461 tons in 2021, and the Group's Scope 1 and Scope 2 greenhouse gas emission densities decreased by 7% and 8%, respectively. In terms of water resources, the perfect filtration system of the House of Dancing Water at City of Dreams has achieved permanent circulation of repool water, and water consumption has also dropped from 1,922,544 cubic metres in 2019 to 798,030 cubic metres in 2021 (Melco resorts & entertainment. 2021).

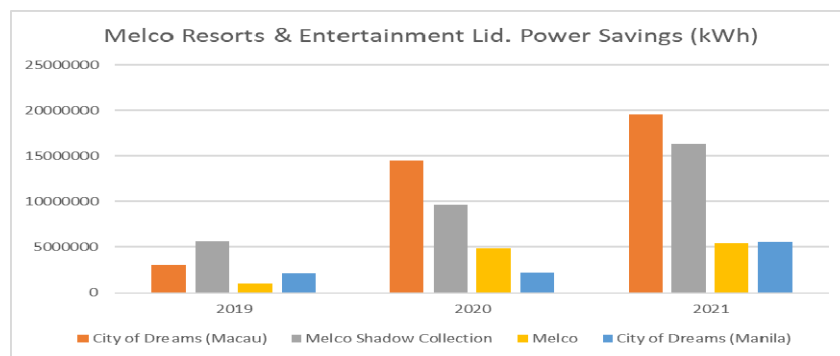


Fig. 5. Melco Resorts & Entertainment Limited Electricity Savings (kWh). (Image source: drawn by the author after collecting data from the Melco Resorts & Entertainment Limited)

2.3 Wynn Macau Ltd

Wynn Macau's water consumption dropped from 2,471,480 cubic meters in 2019 to 1,956,255 cubic meters in 2021. Electricity consumption fell from

270,158 MWh in 2019 to 235,934 MWh. At the same time, Wynn was selected as the "Typical Case of Carbon Neutrality in the 2nd Green Economy Development Forum 2021" (Wynn macau, limited. 2022)

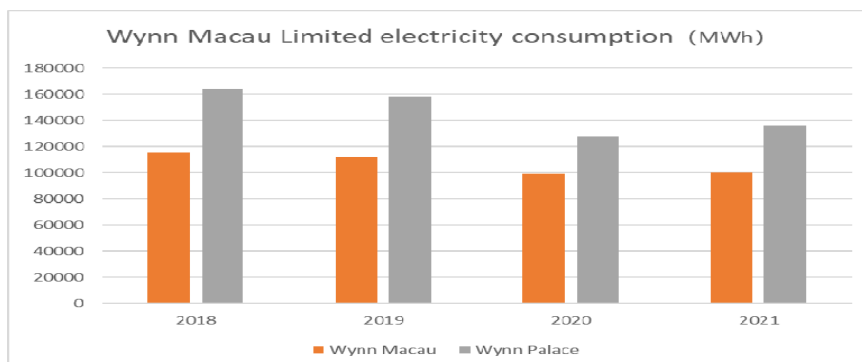


Fig. 6. Wynn Macau Limited Electricity Consumption (kWh). (Image source: drawn by the author after collecting data from Wynn Macau Ltd.)

3. Discussion and analysis

3.1 The issue of sustainable energy in Macau's hotel industry

First, energy conservation and the use of sustainable energy in Macau have already begun, but currently only large hotel groups can better afford the cost of retrofitting using new energy. To complete the overall change in energy use in the hotel industry in Macau,

favorable government support is needed at this time. Since the promotion of sustainable energy by the Macau government and the continuous promotion of solar photovoltaic power generation, some hotel industries have chosen this method to strengthen the use of sustainable energy (Table 2), but the effect is not good. An analysis by the hotels of the Green Hotel Awards found that the current high-end hotel industry in Macau relies more on the use of solar energy to obtain sustainable energy.

Table 2. 2021 Macau Green Hotel Gold Award Hotel's Environmental Direction.

2021 Gold Award Hotel	Energy	Carbon emissions reduction (compared to 2020)
The Nüwa Hotel Macau	Energy-saving electronically commutated motor, covered by solar photovoltaic power generation	45%
Hotel Okura Macau	Install solar photovoltaic panels on hotel rooftops to replace some fossil fuels	--
Sands Macau	Building management system update to control power consumption	13%
MGM COTAI	Install a solar water heater	13%
Morpheus	Use natural light instead of lamps	--

Source: drawn by the author after investigation

The top hotels in the competition have reduced their carbon emissions by about 23.6% on average, which is an improvement compared with 17.3% in 2020. If the annual growth rate of 6% can be maintained, the goal of sustainable energy utilization and energy conservation in Macao will be easier to achieve. However, there are currently 118 hotels in Macau, and five-star hotels account for only 29% of all hotels. There are still many small and medium-sized hotels that do not have enough space to arrange enough new energy installations or do not have enough funds for sustainable energy renewal. This is one way that the Macau regional government can focus on supporting the hotel industry during the epidemic in the future.

3.2 Controlling Issues of Sustainable Energy

Due to the limitation of Macau's urban area and sea area, it is difficult to build renewable energy on a large scale. At the same time, sustainable energy represented by solar photovoltaics faces the shortcomings of poor sustainability and poor grid connection effects. The feasibility of the power generation mode in the hotel industry is not high. The generator set equipment required for wind power generation will have bad visual effects on the area where the hotel is located, which further leads to the adoption of a single solar photovoltaic power generation mode in the hotel industry. The proportion of electricity generated is very small. According to 2019 data, 84% of the energy used in the world is nonrenewable energy (Opeyemi, B. M. 2021). According to data provided by Ember, the low-carbon electricity used in Macau in 2020 is almost 0 (Ember. 2020), which is a huge challenge for the Macau government to use new energy in the future. How to change the current coverage of sustainable energy use and guide residents to use clean and sustainable energy is to further improve the goal of Macau to achieve a green and leisure city.

4. Conclusion

In conclusion, the sustainable energy opportunities currently promoted in Macau are effective. The hotel industry, which is the mainstay of Macau's economy, is widely implementing the further development of sustainable energy, which is very beneficial to Macau as

a way to reduce its dependence on traditional energy as much as possible. However, to achieve the expected effect, considerable investment and subsidies are needed. At the same time, the current difficulties faced by new energy sources are difficult in other parts of the world. In mainland China, there is a vast territory and space to promote the photovoltaic industry, but in Macau, there is a small area with very large difficulties. At present, there are quite a few objective factors in the predicament faced by Macau, but there are also many areas worth improving. As one of Macau's largest economic industries, the hotel industry can combine Macau's waste incineration power plant to achieve a higher sustainable energy proportion. Solving the kitchen waste and domestic waste generated by the hotel industry will further improve the power generation efficiency while steadily subsidizing Macau's existing photovoltaic grid-connected strategy, improve the promotion of sustainable energy in small and medium-sized hotels, and increase the proportion of Macau's own power supply. On the other hand, the hotel industry is a profitable business activity, and companies often fall into more choices when weighing the benefits of business, the environment, and energy protection. Therefore, it is also suggested that relevant government departments issue and implement policies to support the hotel industry in energy-saving operations and allow them to achieve guaranteed income at the same time. With the encouragement of government policies, the sense of responsibility, operational efficiency and energy-saving effectiveness of enterprises will need to be further improved.

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