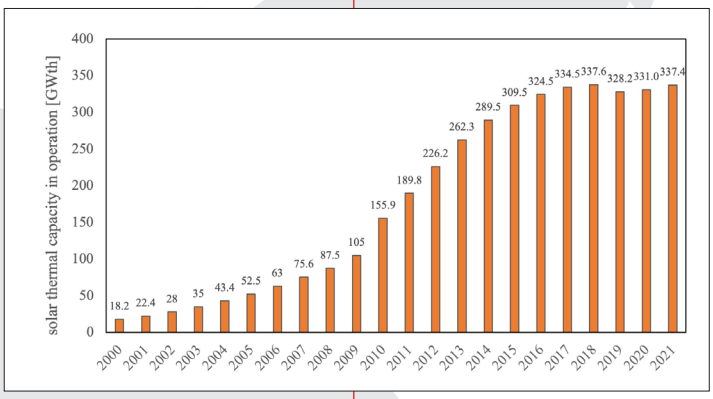
COUNTRY HIGHLIGHT

China's Solar Thermal Market Shifting from Individual Installations to Large-scale Projects

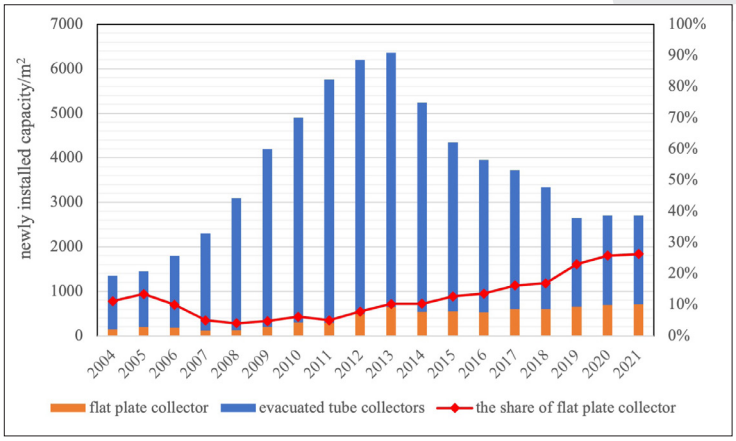
In 2021, the cumulative operation capacity of solar thermal systems in China reached 481.94 million square meters, accounting for 72.8% of the world's installed area. The installed capacity of solar thermal power generation is 588 MW, accounting for 8.3% of the global cumulative installed capacity of solar thermal power generation. In recent years, the total installed solar thermal capacity has plateaued due to competition from heat pumps and photovoltaic systems and a slowing growth rate in the number of traditional small-scale and household solar water heating systems installed. In addition, the overall solar thermal industry growth rate is on a downward trend due to the impact of COVID-19.

In 2021, China added 27.05 million square meters of installed solar thermal capacity, an increase of 0.04% year-on-year and 71.5% of the world's new installed capacity. Currently, evacuated tube collectors are the dominant product in the market, accounting for about 73.64% of the total new installed capacity in 2021. However, the number of flat plate collectors has been growing from 2004 to 2021. In 2004 it was 4.67% of the market, and today is 26.27%. The market is experiencing gradual changes in the type of collectors, from evacuated tube collectors to flat plate collectors, which are easier to integrate into building structures.

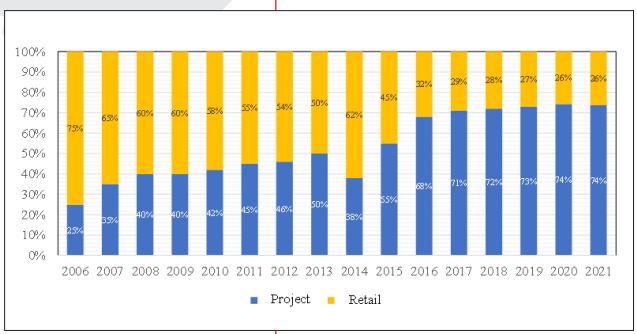


▲ **Figure 1. Solar thermal capacity in operation in China from 2000 to 2021.**

In recent years, China's solar thermal heating market has gradually occupied the main business segment of the market, of which the overall share of the project market reached 74% in 2021 and the retail market 26%. Sales of domestic hot water systems are continuing to decline.



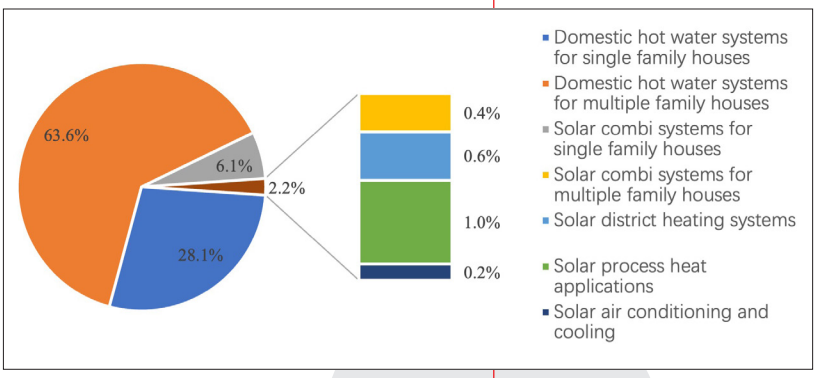
▲ **Figure 2. New installed capacity of the solar thermal system from 2004 to 2021.**



▲ **Figure 3. New solar thermal system types from 2006 to 2021.**

continued on page 6

Figure 4 shows that the largest share of the collector area installed in 2021 is domestic hot water systems for multi-family houses, which accounted for about 63.6% of installations in 2021. The share of domestic hot water systems for single-family houses was 28.1%, and solar combi systems for single-family houses accounted for about 6.1%. The share for other applications, such as solar process heating, solar air conditioning, and solar district heating, is about 2.2% in China.



▲ Figure 4. The proportion of new solar thermal systems of different application types in 2021.

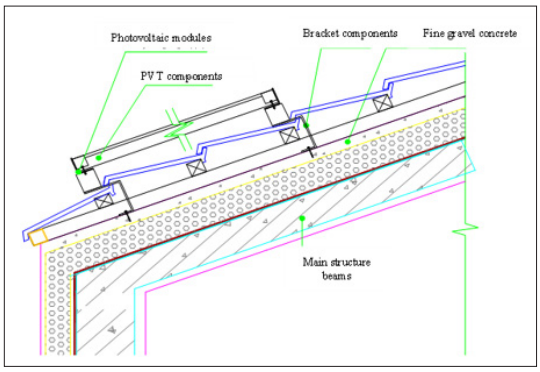
Research Highlights

In the last decade, China's policy has increased the policy guidance on using clean energy to improve the ecological environment and reduce carbon emissions. Among them, there is no more significant impact on the solar thermal industry than the official implementation of the clean heating policy in 2015 and the "carbon peak and carbon neutrality" policy proposed in 2020. The former has shown a solid impetus for the emergence of many "solar+" heating systems in rural areas in northern China. The latter has given rise to considerable research and applications for carbon reduction. Essentially, they all improve the efficiency of renewable energy use. Next, we will highlight a few solar thermal heating projects from two aspects: comprehensive utilization system of solar energy and application cases.

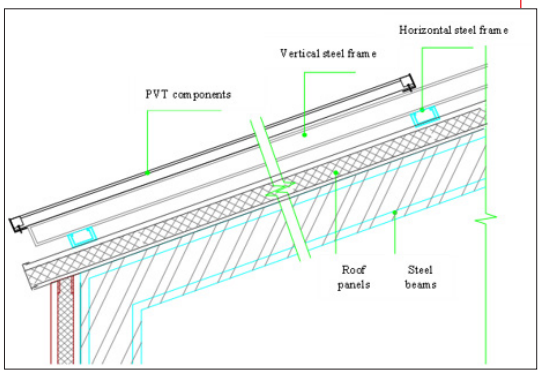
Comprehensive Utilization of Solar Energy

In response to the clean heating policy, various "solar+" heating models appeared, and relevant technology evolved rapidly. At the same time, under the guidance of the "carbon peak and carbon neutrality" policy, research on large-scale comprehensive utilization of solar energy systems is gradually springing up, dedicated to improving the consumption of wind and solar energy to meet the demand for heating.

For residential "solar+" heating systems, the Dalian University of Technology proposed a heat pump-type PVT ventilation roof and designed a PVT module array and rural residential slope roof integration component. By applying this component, the average temperature amplitude attenuation coefficient in summer increased by 10%, and the total daily heat gain and peak cooling load decreased by 54.4% and 76.7%, respectively. The PVT ventilated slope roof has significant energy savings and consumption reduction in summer.



(a) Combination of PVT modules and tile roofing construction method



(b) The combination of PVT module and color steel roofing construction method

◀ Figure 5. PVT module and roofing integrated construction combination.

continued on page 7

It is essential to optimize the control strategy of solar heating systems for large comprehensive solar energy systems. Shanghai Jiaotong University proposed an optimal allocation method for multiple energy storages for the comprehensive utilization of solar energy systems, established a two-layer optimization model for the entire lifecycle of cooling, heating and power dispatch, and studied the profitability of storage of cooling, heating, power and hybrid storage in the case of comprehensive utilization of solar energy systems operation. The calculation results show that the comprehensive utilization of an aggregated solar energy system using cooling and heat storage profits significantly.

The Tibet Langkazi project.

Application Cases

Two examples of large solar thermal projects are highlighted below – the Tibet Langkazi solar district heating project and the China Zhongchuan Xinneng Ulath 100MW solar thermal power plant project.

The Tibet Langkazi project was completed in 2018 in Langkazi County, Shannan City, Tibet, with a total heating area of 82,600 m^2 and a total heat load of 4.3 MW. The heating outdoor design temperature is -14.4°, with an extreme minimum temperature of -37° and a heating period of 251 days. The project adopts high-efficiency prominent flat-plate solar collectors, with a heat-collecting area of 22,300 m^2 and a heat storage volume of 20,000 m^3. The measured value of the solar energy guarantee rate is 93%. The project can produce about 17000 MWh of total energy, save 6,800 tons of standard coal and reduce 164,949 tons of CO_2 emissions annually.

The Zhongchuan Xinneng solar thermal power plant project.

Located in Bayannur City, Inner Mongolia, the Zhongchuan Xinneng Ulath 100MW solar thermal power plant project is the largest single parabolic trough solar thermal power plant, which has achieved continuous stable and high-load operation, generating a cumulative total of about 540 million kWh. Its optical index has reached 98%, one percentage point higher than the current international level. It has a maximum power generation of 105.54 MW and a maximum power generation of 2.192 million kWh in a single day, exceeding the design value. At a high latitude of 41.5, the operating efficiency of the localized parabolic trough collector exceeded expectations.

Conclusion

With the maturity of high-efficiency collector technology, large-scale heat storage technology and regional comprehensive utilization of solar heating scenarios continue to increase, and large-scale solar heating technology will develop rapidly in the following decades. In addition, solar thermal power generation technology has great potential for development. In the IEA Solar Heating and Cooling Programme, Chinese experts point out that solar thermal utilization is gradually shifting from single-family solar water heating to solar-based multi-energy complementary systems. And they look forward to future collaborative projects in this area.

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