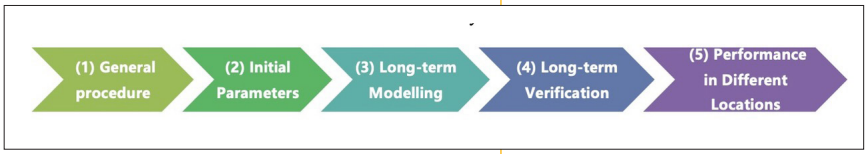
Solar Hot Water Systems and Greenhouse Gas Reduction in China

Solar thermal technologies play an important role in reducing carbon emissions. However, the assumptions that work in Europe may not work in China. To provide reference values of annual GHG emission reduction for China's SHW systems, the China Academy of Building Research (CABR) and Sunrain developed and validated a country-specific emissions reduction analysis within the SHC Task 69: Solar Hot Water for 2030 framework.

As global climate change worsens, achieving a carbon emissions peak and mapping pathways to carbon neutrality has become increasingly urgent. Under such conditions, solar thermal represents a readily available solution to dramatically reduce carbon emissions in the building sector. According to the International Energy Agency (IEA), China accounts for 73.1% of the world's total installed solar collectors, making it the world's largest market, producer, and exporter of solar thermal products. It is safe to say that China's solar thermal industry has made significant contributions to global energy saving and carbon reduction. At the same time, several differences exist between Greenhouse Gas (GHG) reductions in China and Europe (and other parts of the world).

Other countries' experiences may not be entirely suitable for GHG reduction evaluation in China. To develop an assessment method for GHG emission reduction of Solar Hot Water (SHW) systems under China's climate resources and usage conditions, CABR and Sunrain partnered to conduct a series of research activities, including (1) Development of General Procedure. This step required a procedure to evaluate the long-term GHG reduction performance of solar hot water systems. Next, the (2) Initial Parameters were defined, according to ISO 9459-2 and GB/T 18708-2002, followed by (3) Long-term Modelling. This step involved the creation of a model to calculate annual energy saving and carbon reductions. Next, (4) Long-term verification was used to improve the methods by comparing with the long-term operation data. Finally, the verified model was used to determine the 5) Performance in Different Locations. This step involves simulation of the GHG reduction of solar hot water systems in different cities in China.



▲ **Figure 1. Research activities flow chart.**

In the Initial parameters testing process, four characteristic solar hot water systems were tested to get initial performance parameters. Examples are shown in Figure 2.

▲ **Figure 2. Photos left to right: Compact system with ETC. Closed system with FPC. Testing platform at the Clean Thermal Energy Carbon Emission Test Center.**

The developed simulation method was similar to ISO 9459-2, but new software was developed (in Chinese) to make it easier for local experts to use. For verification, a carbon reduction testing field was established in Jiangsu province. The test was conducted in the Clean Thermal Energy Carbon Emission Test Center of the Solareast Group. Overall, a total of 15 types of solar thermal system configurations were installed for long-term testing. For a compact (open) system, the

continued on page 23

average daily GHG reduction is about 0.33~0.75 kg/m^2. For a pressured (closed) system, the average daily GHG reduction is about 0.14~0.50 kg/m^2. Table 1 shows the validation results from the simulations as compared to the testing results. By comparing the simulated and tested average daily heat gain, the deviation is within 12%, verifying the accuracy of software calculations.

Table 1. Comparison of simulated and tested average daily heat gain.

Type	Sample	Testing Results		Calculated Result		
		Avg. Daily Heat Gain MJ/(m^2·d)	Avg. Daily GHG Reduction kg/(m^2·d)	Daily Heat Gain MJ/(m^2·d)	Avg. Daily GHG Reduction kg/(m^2·d)	Deviation
Compact (open) system	1	3.62	0.58	3.19	0.52	**11.9%**
	2	3.18	0.51	2.97	0.48	**6.6%**
Pressured (closed) system	14	0.86	0.14	0.84	0.14	**1.2%**
	15	1.76	0.28	1.71	0.28	**2.8%**

Due to the differences in solar resources, the GHG reduction is very different in different cities. Based on the developed carbon reduction calculation software, 14 cities with different solar energy resources have been used to analyze its application effect. To obtain the national average operating effect, the average GHG reduction is weighted according to the population of each region. The average heat gain is 489.72 kWh/m^2, and the average GHG Reduction is 284.53 kg/m^2.

According to the Solar Heat Worldwide 2024, China's total installed solar thermal collector capacity is 545 million m^2. If these are all solar hot water systems, then this new analysis indicates that the annual GHG reduction will be 155 million tons. Considering that average emissions per person in China is estimated to be ~8 tons, this means that solar thermal hot water technologies alone are offsetting the entire carbon emissions of more than 19 million people in China.

Article analysis and reporting from Li Bojia, Bian Mengmeng, and Sang Wenhu of the China Academy of Building Research as part of SHC Task 69, Subtask B: Thermosyphons. Edited and contributed by Prof. Robert Taylor, SHC Task Manager of Task 69: Solar Hot Water for 2030. To learn more about this Task, visit https://task69.iea-shc.org/.