

LAS VEGAS RESTAURANT HITS THE JACKPOT WITH SOLAR WATER HEATING



Nationwide, restaurants and fast food establishments spend nearly 7 billion dollars each year on their total energy consumption. More than 40 percent of this energy use goes for heating and cooling applications, such as cooking, food preparation, cleaning, and dishwashing as well as space heating or cooling. Restaurants are good candidates for using renewable heating and cooling technologies to address these needs and save money.

SIZING UP THE OPPORTUNITY

The success of the Buffet@Asia restaurant chain is based on customer volume. Its three locations are packed from 10:00 in the morning until 10:00 at night. All locations offer a wide range of inexpensive food options. This diversity, however, comes at a cost, since an all-you-can-eat buffet menu invites diners to eat from numerous fresh clean plates. Consequently, the dishwashing cycles are non-stop. On a busy day, Buffet@Asia washes 20,000 medium-sized plates.

Reducing expenses is how owner Aaron Chen keeps his prices low for his customer base. And even at today's relatively low natural gas prices, energy costs can be expensive for restaurants that use a lot of hot water and survive on very tight profit margins.

Yet when customer and solar entrepreneur Dave Zheng suggested the restaurant install a solar water heating system to lower energy costs, Chen was not immediately convinced. But Zheng, who is an engineer, made a quick assessment of the restaurant's large hot water usage and was so sure of positive results that he offered the restaurant a money-back guarantee on the cost of the system if it did not meet Chen's expectations.

Zheng designs solar water heating systems, which absorb the sun's energy to heat water. To help Chen's investment decision, a rebate was available for solar water heating installations from



The large kitchen is busy all day long preparing a wide variety of choices.

the local utility company, lowering the final cost of the installation. Zheng incorporated the rebate when calculating the potential savings for Chen.

TECHNOLOGY

For large hot water energy loads, solar energy can offer worthwhile cost savings. Unlike the more common solar photovoltaic (PV) energy systems, which generate electricity, solar water heating systems use the sun's energy to heat water. Similar to how the sun heats water in a garden hose on a hot day, the sun's energy can also be used to heat water using solar collectors. Restaurants are a good fit for solar water heating,

and many have already installed the technology across the United States.

Solar water heating systems can use either flat plate collectors (large shallow boxes) or long, cylindrical vacuum tube collectors. Each approach offers advantages, although flat plates have a much longer history. In fact, some flat plate systems properly installed in the 1980s are still in operation today. The technology Dave Zheng designed and installed for the three Buffet@Asia restaurants uses vacuum tube collectors. The system heats the restaurant's potable water and delivers it to a hot water storage tank near the kitchen.



The restaurant washes up to 20,000 dishes a day with water heated primarily by the solar hot water system.

Professor Bob Boehm, Director of the Center for Energy Research at the University of Las Vegas, is an expert in and longtime proponent of solar technology to heat domestic hot water. Because vacuum tubes offer certain advantages, Professor Boehm asked his engineering students to design a home water heating system as part of the U.S. Department of Energy's annual Solar Decathlon challenge. That year, his students won the contest among all other competing U.S. universities. Boehm was so impressed with the vacuum tubes that he installed a solar water heating system on his Nevada home similar to the one Zheng designed for the restaurant.

"I just really like the tubes. I think that they are a very elegant solution," said Boehm, whose experience in energy use reduction dates back to

his days at University of California, Berkeley where he earned his PhD in 1968.

Because of seasonal changes throughout the year, solar water heating technology employs various systems to detect potential freezing during cold months or overheating during the summer months. Zheng's design uses sensors to measure the water temperature, which activate water flow control mechanisms to provide protection against both freezing and overheating.

SYSTEM INSTALLATION

Typically, the amount of hot water needed by a building—i.e., the load—determines the number of collectors needed on the roof. Boehm's residential system, by comparison, is one-eighth the size of the restaurant's. Zheng reported difficulty pinning down the restaurant's exact hot water load requirements, "But," he said, "we knew the hot water needs were huge." He sized the system to maximize energy performance given the space limitations on the roof.

Because the sun's position in the sky changes the amount of available energy from moment to moment, most solar water heating installations warrant a solar site assessment to predict the best angle and location to position the solar collectors. Several tools are available to installers for these kinds of measurements.

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In the restaurant's configuration, eight collector panels were installed on the roof at 30° angles in order to optimize the angle of the sun on each of the 18 vacuum tube collectors. Copper pipes from the restaurant's kitchen area deliver water up to the roof where the solar collectors are located. Each panel required about one hour to install, according to Zheng.

In addition to the restaurant's pre-existing 130-gallon natural gas water heater, Zheng installed

two new additional 100-gallon solar storage tanks, which are connected to the rooftop solar collectors. To create space for the two new tanks, the restaurant removed several shelves in the kitchen area. The new solar-heated tanks feed hot water directly into the natural gas heated water tank, greatly reducing the restaurant's need to burn natural gas to heat water. Almost all solar water heating installations still need to be supplemented with conventional resources, such as natural gas or electricity.

Solar water heating systems are rated by the amount of energy they produce under an assumed set of operating conditions, usually stated in terms of British thermal units (Btus). By definition, one Btu is the amount of energy required to raise a pound of water by one degree Fahrenheit, and 1,000 Btus (1 kBtu) is the equivalent to the amount of energy contained in about one cubic foot of natural gas. Based on a rating provided by the Solar Rating and Certification Corporation (SRCC), the eight collectors in the Buffet@Asia system have the potential to save about 158 cubic feet of natural gas per day.



Dave Zheng (left) inspects the new solar hot water system with a member of his installation crew.

Zheng's team also managed the permitting process with the City of Las Vegas for the solar water heating installation. City inspectors assured the completed system satisfied the local building codes.

The installation was completed within one week, during which the restaurant remained open and operated as usual. The system has been operating without interruption since September 2013.

"We did not need to turn off the water because the solar system was able to be isolated," said Zheng. "They did not even know we were there."

COSTS

The restaurant will save more than \$300 each month on their energy bill. The total cost for the project was \$26,295. However, a \$7,500 rebate from the utility company reduced the owner's final invoice to \$18,795.

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Therefore, the energy savings will pay for the system within five years. The amount of the utility's rebate was calculated from the expected energy savings provided by the project.

For restaurants with a large hot water demand, solar water heating shields them from future price increases of natural gas. As natural gas prices climb, solar energy will provide even greater savings. While today's cost of natural gas is relatively low because U.S. supplies are plentiful, demand for natural gas is rising as more electric utilities convert to gas from coal. Climate extremes also increase demand for heating and air conditioning, as does a growing economy.

RESULTS

From the outset, Zheng promised he would pull out the entire system and return the restaurant to its previous set-up if owner Aaron Chen was not completely satisfied.

"If it's not working we said we would just take it out, so there was no harm for the business owner," said Zheng.

Still, Chen was skeptical and he agreed to pay for the solar thermal system and installation only after he saw his energy bill reduced.

Today, Chen says he is delightfully surprised. "You can use less gas and you can save money too. Why not?" said Chen.