NEVADA SURE BET PROGRAM

Offered By: NV Energy
Administered By: KEMA Services, Inc

The Waterside Economizer (aka "Tower Free-cooling")
A Cost Effective Design Option for Larger Chilled Water Cooling Systems

In the dry Nevada climate, the **water-side economizer** (also referred to as "tower free-cooling") is an efficiency option that can save significant energy cost in buildings that are cooled with chilled water. These systems save cooling energy by circulating water that is cooled by the cooling tower directly when the outside air temperature is suitable, rather than operating the chiller. In southern Nevada, the water side economizer is commonly designed into cooling plants for larger new buildings but it can also be added to existing plants as a retrofit. Although not seen as often, this system may also be cost-effective for certain building types in northern Nevada also. Essentially the system can be designed in two configurations:

- A common configuration is the ***flat plate heat exchanger.*** The exchanger is connected to both the chilled water and condenser water loops by diverting valves that bypass the chiller. The chiller and condenser water is diverted past the chiller to the heat exchanger when the outside air wet bulb temperature is low enough that the cooling tower can produce condenser water at a temperature that is low enough to cool the water in the chiller loop to a temperature sufficient for cooling. This temperature can often be as high as 55 °F. The equipment requirements for this configuration include the flat plate heat exchanger itself as well as two large automatic diverting valves, connecting piping, and controls.

- A second configuration involves the use of a ***closed-loop evaporative water-cooler*** rather than an open loop tower for the condenser circuit. Because this is a closed loop system, the water in the condenser loop can be co-mingled with the water in the chiller loop. In this system, when the condenser water temperature is low enough for cooling, it is diverted directly into the chilled water loop. A closed-loop cooler (tower), with a circulating pump, a diverting valve and appropriate controls are the primary equipment requirements for this configuration. The flat plate heat exchanger cost (and its associated pressure drop) is avoided. The cooler is more expensive and it does not perform quite as well as the open tower used in the flat plate option, but the closed-loop configuration avoids the need for cleaning the flat plate heat exchanger and its high pressure drop.

These systems can save significant energy especially in facilities with high internal heat gains that need cooling all year round even when outside temperatures are cool. Gaming establishments, server farms, medical facilities, high tech manufacturing or other industrial facilities are particularly good candidates; but direct-cooling may also save energy costs for offices, schools, lodging or other building types.

The Theory behind the Water Side Economizer

The "dry bulb" temperature refers to the air temperature as measured by a standard thermometer. The "wet-bulb" temperature is the temperature that air is reduced to when sufficient moisture is evaporated in it to saturate it completely. In the dry Nevada climate, the wet-bulb temperature is usually many degrees below the dry bulb temperature. The difference is largest during the hot summer months. For example in Las Vegas when the outside air temperature is 110 degrees, the wet bulb temperature is approximately 68 degrees. In spring and fall months when the outside air temperature is 65 degrees, the wet bulb temperature averages about 52 degrees.

The first figure below shows the normal wet bulb temperature for the range of dry bulb temperatures in Las Vegas. The second figure shows the hours of occurrence of various temperature ranges for Las Vegas. The water side economizer can provide water at a sufficiently low temperature for building cooling more than 4,000 hours per year in Las Vegas and almost 6,000 hours per year in Reno. Avoiding the use of a chiller for that many hours will save significant energy.

Some Application Notes

Although 42-45 degrees is a common chilled water temperature setting, the chilled water temperature in Nevada's dry climate often does not need to be that low to provide comfort. The chilled water temperature may be able to be raised to 48-56 °F when outdoor temperatures are below the design temperature. Chilled water temperature "reset" should be considered as a control option for larger chilled water systems. Raising the chilled water temperature improves the chiller efficiency – especially at part loads. It also increases the number of hours that the waterside economizer can effectively replace chiller operation. Reset also helps to smooth the transition from chiller to economizer operation.

The water side economizer adds to the cost of a new plant. It also uses higher cooling tower fan and possibly chilled water and condenser water pumping power when it is in operation. As variable speed chillers are now available with very high part load efficiency, the designer should consider the tradeoff of hardware costs of the heat exchanger/closed circuit cooler, valves and piping of the "free-cooling" design against the costs and potential energy savings of a very-high-efficiency variable-speed chiller. The added costs may not be justified by energy savings. A value-engineering study is recommended for economizer systems when considered with a very high efficiency chiller. In Nevada, the water side economizer is effective nearly the same hours that an air side economizer is effective. This does not mean that the water side economizer should be installed in place of an air side economizer. Both the air ***AND*** water side economizer should be considered for most building types.