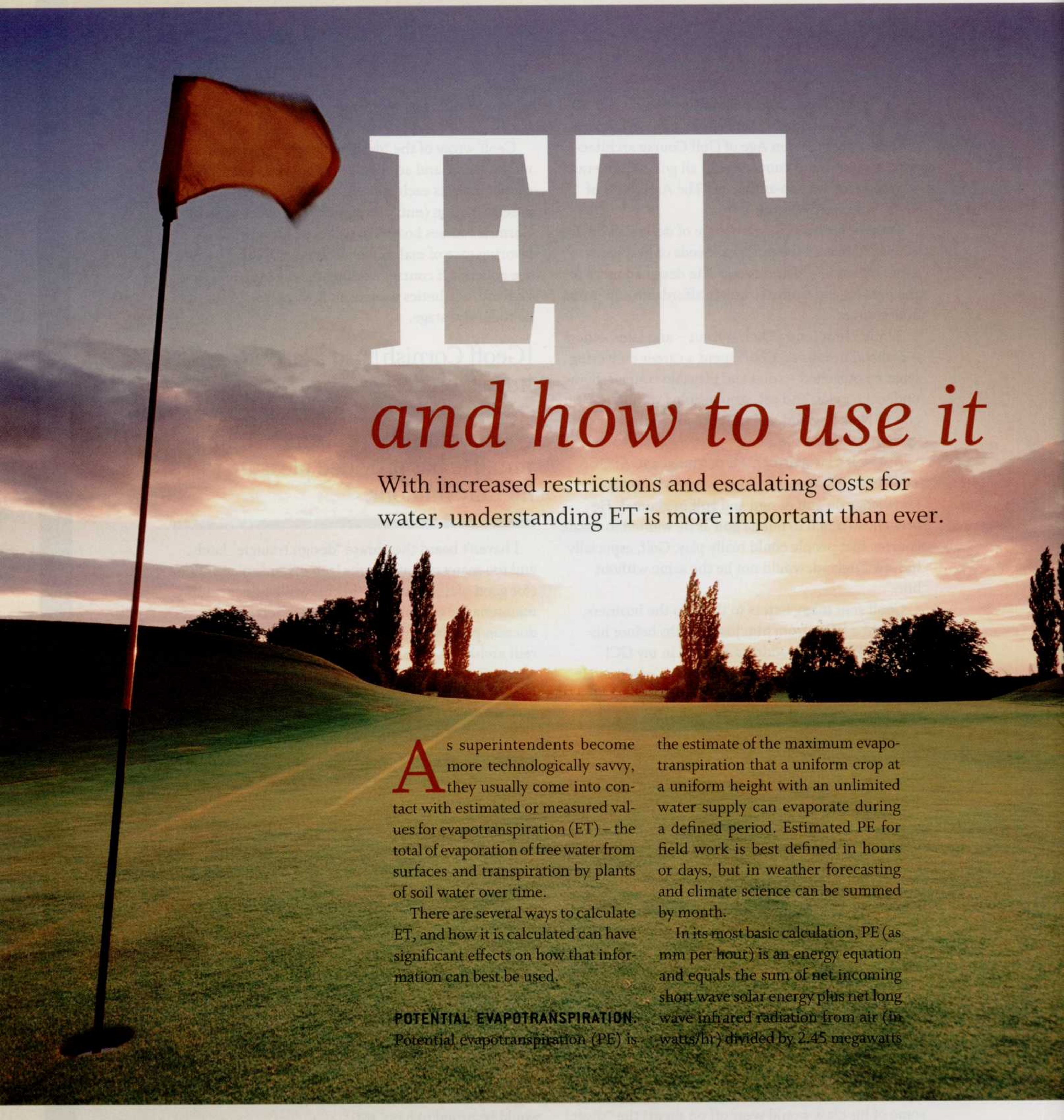
BY CHRISTOPHER SANN



ET and how to use it

With increased restrictions and escalating costs for water, understanding ET is more important than ever.

As superintendents become more technologically savvy, they usually come into contact with estimated or measured values for evapotranspiration (ET) – the total of evaporation of free water from surfaces and transpiration by plants of soil water over time.

There are several ways to calculate ET, and how it is calculated can have significant effects on how that information can best be used.

POTENTIAL EVAPOTRANSPIRATION. Potential evapotranspiration (PE) is the estimate of the maximum evapotranspiration that a uniform crop at a uniform height with an unlimited water supply can evaporate during a defined period. Estimated PE for field work is best defined in hours or days, but in weather forecasting and climate science can be summed by month.

In its most basic calculation, PE (as mm per hour) is an energy equation and equals the sum of net incoming short wave solar energy plus net long wave infrared radiation from air (in watts/hr) divided by 2.45 megawatts

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(the energy required to change 1 mm of liquid water to water vapor).

Unfortunately, the data required to make this estimate are rarely available and if they are, the conditions used to define PE are rarely met. For that reason, a PE estimate calculated from only energy readings is at best a measure of a maximum possible ET that is almost never attained.

The Penman-Monteith (PM) method is perhaps the most complicated of the PE estimation processes, but despite that complexity is the most commonly used and well-regarded of the equations, so much so that the PM equations have been adopted by the United Nations' FAO service for use worldwide in agriculture and related fields.

Unlike the basic PE calculation, the PM process takes into account several addition factors. PM adds wind speed, vapor pressure changes, air density and soil heat exchange and as a result provides a more accurate estimate of the PE from a well-watered, uniform plant stand such as a golf putting green or other sports turf surfaces. For larger plant surfaces such as fairways and field crops where water is finite and plant density and height vary, the PM equation has a tendency to overestimate ET.

ACTUAL EVAPOTRANSPIRATION. Actual evapotranspiration (AE) is the amount of evaporation that actually occurs given the constraint of available soil water. When a uniform crop at a uniform height has a limited water supply (plant-available soil water) the amount of evaporation that can occur is strictly controlled by the amount of available soil water. Available soil water is defined as the water content of a soil profile between its field capacity and permanent wilt points and by definition is a finite resource.

Unlike PE, AE is very difficult to accurately estimate. Even the use of soil moisture sensors with site temperature and RH data still require the complex use of a so-called 'water budget', an 'energy budget' and a soil's 'moisture release curves' to estimate accurately.

As a result, the difficulty that a finite water supply adds to the estimation process resulted in a different ET process called the Hargreaves Equation being developed. This equation uses significantly fewer variables to calculate ET – temperature, RH, and solar energy – and does take soil water content into account by basically looking at the net effect that AE has on these variables near the plant growing surface rather than trying to estimate AE from these variables. It is a subtle but significant difference and creates an estimation process in which available soil water plays a pivotal role no matter what site conditions the plant population is grown under. The one negative with this method is that unlike the PE/PM methods it should not be used on a time frame shorter than 24 hours.

WHY SHOULD YOU CARE WHICH METHOD IS USED? About a decade ago, any ET calculation method that got you into the ballpark was good enough. But, today with increased water use restrictions, limited water resources and steadily rising costs, in the ballpark doesn't cut it.

If your ET information source uses the basic energy method, adjust that value and your water use to an appropriate percent of the estimate (usually 40 percent to 60 percent) that produces the results you seek but does not over water in the process.

If your ET estimate is done using the PM method, then those values can almost be directly used for well-watered greens, tees and other sports turf surfaces – making sure to adjust the estimates for local conditions such as slope, orientation, transient shade, etc.

If your ET source uses the Hargreaves method, that daily value can be directly used on fairways, roughs and ornament turf areas with little change. It can also be used on well-water surfaces, but depending on management style and local conditions may require the application of additional water above the estimated ET losses.

Whatever your ET information source, ask your provider which method they use. If the method they use is unfamiliar, ask them if the ET method is a PE or AE process. If they don't know, find another information provider. **GCI**

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Key points

- There are several ways to calculate ET, and each can impact how you use water at your course.
- Potential evapotranspiration (PE) is the estimate of the maximum ET that uniform turf at a uniform height with an unlimited water supply can evaporate during a defined period.
- The Penman-Monteith (PM) method includes wind speed, vapor pressure changes, air density, and soil heat exchange and provides a more accurate PE estimate.
- Actual evapotranspiration (AE) is the amount of evaporation that actually occurs given the constraint of available soil water. It is more complex to calculate.
- The Hargreaves Equation calculates ET with fewer variables – temperature, RH, and solar energy – and does take soil water content into account by basically looking at the net effect that AE has on these variables near the plant growing surface rather than trying to estimate AE from these variables.

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