I am using more energy – is it because the weather is colder?

We all know that colder weather means that we use more energy for greenhouse heating. But how do we know if any increases in energy use are just down to the weather – or perhaps other factors are making us less efficient? This is where a technique known as ***degree-days*** can help.

What is a degree-day?

The difference between the outside temperature and the greenhouse internal temperature is the biggest factor affecting how much energy is used for heating – and this underlying fact is the basis of the calculation method called degree-days (^{o}C days).

To explain this further let's consider the example of a greenhouse which as been heated to an average temperature of 20^{o}C when the average outside temperature was 10^{o}C. The difference between the inside and outside temperatures was:

$$20^{o}C - 10^{o}C = 10^{o}C$$

If these conditions lasted for 1 day we had 10^{o}C x 1 day = 1 ^{o}C day

Similarly if they lasted for 1 week, we had 10^{o}C x 7 days = 7 ^{o}C days



Using degree-days

By calculating the number of degree-days over two periods we can compare how much the heating energy demand has changed. Again let's consider our example:

Day 1
- Average greenhouse temperature 20°C
- Average outside temperature 10°C

Degree-days = (20-10) x 1day
= 10°C days

compared to

Day 2
- Average greenhouse temperature still 20°C
- Average outside temperature drops to 5°C

Degree-days = (20-5) x 1day
= 15°C days

These calculations show that Day 2 had a degree-day figure 5°C days higher than Day 1. So theoretically the energy use on Day 2 should be 50% more than on Day 1.

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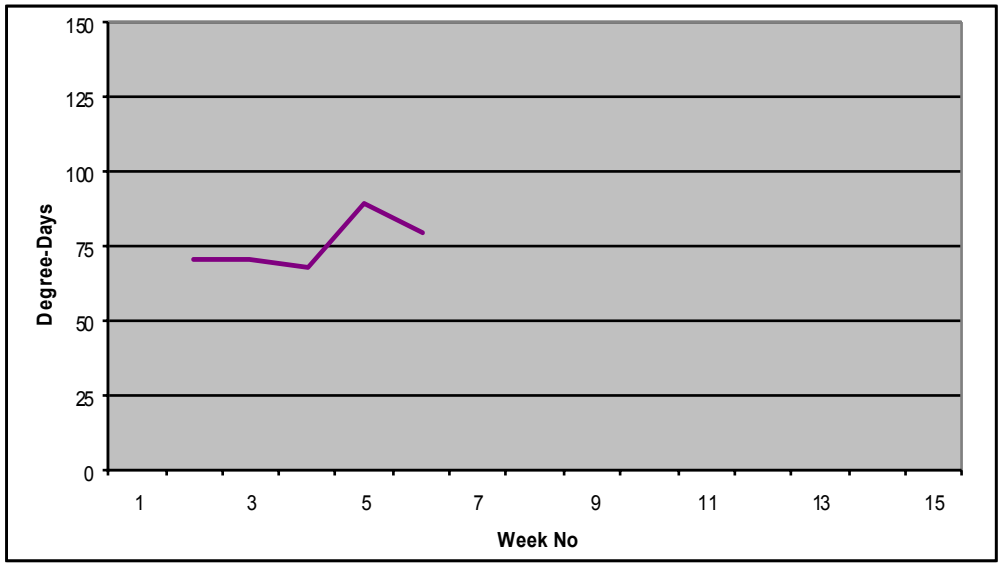
Degree-day data for R&L Holt

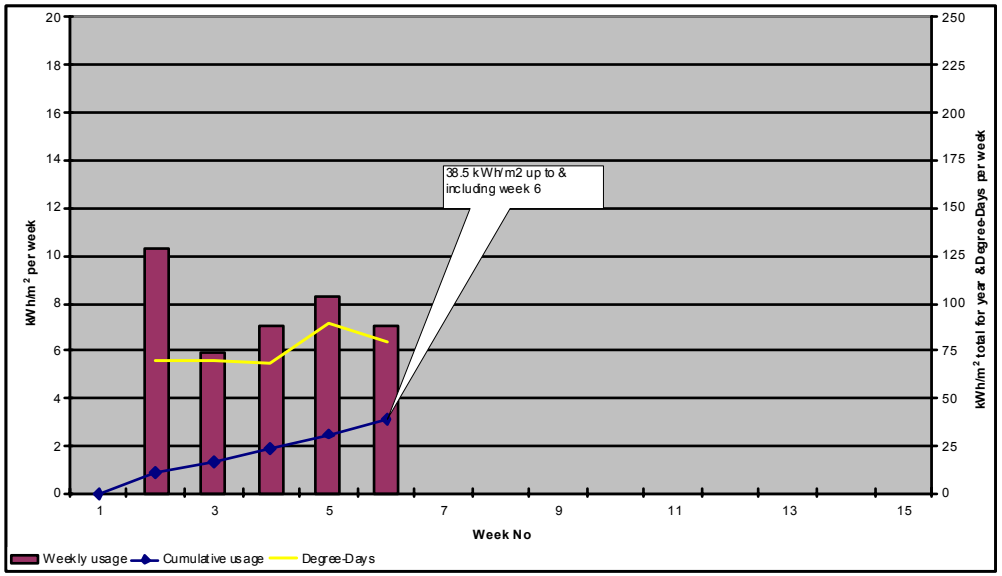
Our work at Holt's is concentrating on saving energy through better screen operation. So to tell us if we are being effective or not, we are collecting lots of background data. This includes greenhouse temperature and humidity and weather data (temperature, radiation and wind speed).

By using this data we are calculating the average inside and outside temperature data on a day by day basis. This lets us calculate the degree-day figures for the site for each day. Daily figures are then added together to derive a weekly figure. This graph shows how the weekly degree-day figures have changed for Holts so far this season.



Energy Use Data

We are also taking weekly energy meter readings so that we can track the week by week energy use of the site. The following graph shows the energy use so far this year. Figures have been calculated based on total gas use per unit of greenhouse area (kWh/m^2). The graph below now includes week 6 (w/c 4th Feb).



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Look closely at the graph and you will see that we have included an extra line in yellow. This is the overlaid weekly degree-day line for the site. What is interesting is that the shape of the energy use graph compared to the degree-day line. Because the lines are of a similar shape – i.e. when the degree-day line goes up, the energy use increases in a similar proportion - this indicates that changes in energy use are in line with changes in weather. The only exception was in week 2 when the greenhouse was heated up from cold before the crop went in.

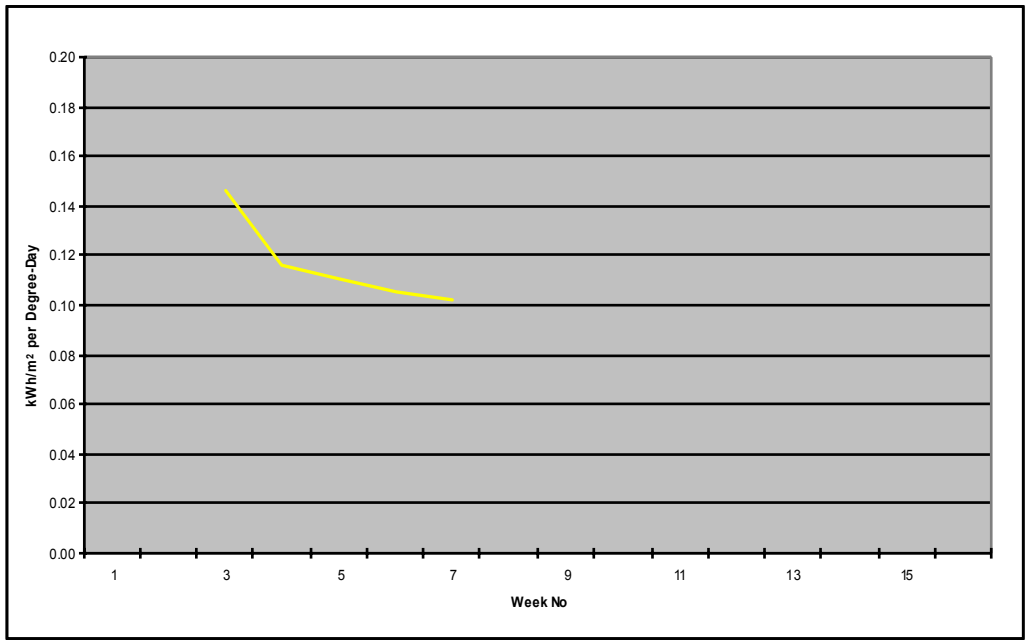
Detailed Analysis

We have already said that the degree-day data for Holts is showing the correct trends when compared to energy use, but doing more detailed analysis can give us a better insight into how energy efficiency is changing.

To do this we need to make some slightly more complex calculations that work out the energy use per degree-day (kWh/m^2/°C day).

At first sight this might look daunting, but this calculation allows us to easily see the effect of changes that have been made. The graph opposite shows the kWh/m^2/°C day data for the Holts site for each week of 2008. Again if we ignore week 2 (because of the special circumstances that week) we can see that the amount of energy being used / degree-day is decreasing. This confirms that the changes we are making to screen operation are actually saving energy!

We actually need a few more weeks of data to confirm how effective the changes have really been. But the good news is that the changes look to be having the right effect.





This more detailed analysis can also help us make some other assessments such as how simple changes such as growing your crop 1°C warmer might affect the amount of energy used.

Assuming that figure of 0.1kWh/m^2/°C day taken from the above graph for Holts is representative; we can calculate how much energy would be saved by growing the crop 1°C colder for 1 week. This is done as follows:

1°C colder x 0.1kWh/m^2/°C day x 7 days = 0.7 kWh/m^2 per week

At a gas cost of 2p/kWh, the cost of this change can be calculated to be £140/Ha per week for the Holts site.

Remember that these figures are only valid for the Holts Nursery where we are doing the current phase of the GrowSave project. To get figures for your nursery you will need to do an identical analysis to the one described above. So start collecting greenhouse temperature, weather and energy use data now and do the analysis for your nursery – and you will soon start getting better information on how energy efficient you really are.