INFRAMATION

# Go Green with Thermal Imaging

*Peter Hopkins*
*SoCal Infrared (www.socalinfrared.com)*

## ABSTRACT

Going Green seems to be the "buzz word" today, but what does that have to do with Thermal Imaging? Actually, it has a lot to do with it! Buildings in the U.S. alone account for 39% of U.S. Energy Consumption and another 29% to Industry. The U.S. Department of Energy attributes heating and cooling costs as 40-60% of that bill and an inefficient home simply causes the heating and cooling systems to work harder. In fact, it is stated that one-third of all heat loss in a building is due to air leakage. Thermal imaging allows us to see what our eyes cannot (air infiltration, duct leakage, plumbing leaks, roof leaks etc.) and when used in conjunction with other tools like a Door-Fan, also known as a Blower door, you can't help but see where all that wasted energy is going. It is our intent, with this paper, to show you the many ways you can help your clients "Go Green with Thermal Imaging".

## INTRODUCTION

A simple search of "Define: "Go Green"" on Google will yield 488,000 links but none seem to identify the actual definition of what "*Going Green"* means.

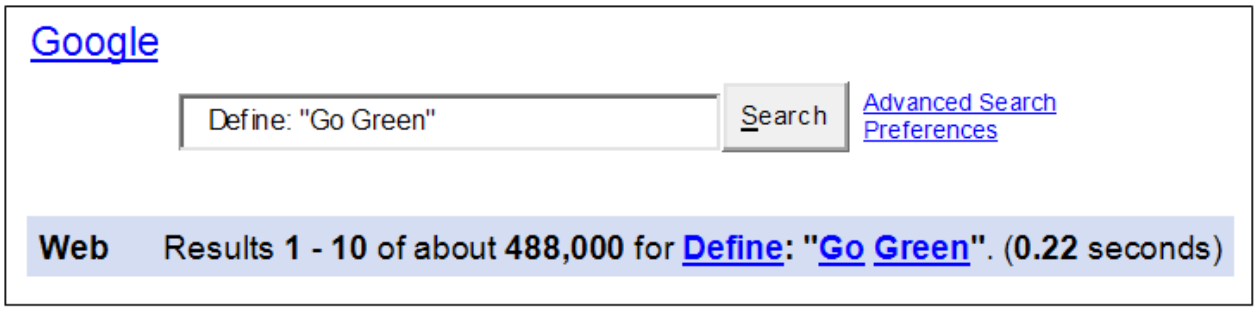


*Figure 1. Google search*

This might be very similar to what we have gone through in years past in the search of defining words such as "*Organic, Natural, or even Low Fat*". What do these words really mean? In our quest for defining *"Go Green"*, we came up empty handed on a fixed definition, but everyone seems to agree, it is a buzz word that gets attention. A search for "Go Green" alone will yield over 10 million links. The easiest answer we came up with is a takeoff from the word "Environmentalism" as defined on Dictionary.com as *"Advocacy for or work toward protecting the natural environment from destruction or pollution"*. In effect, "Going Green" is a method that we are trying to make better choices so that how we live today will have the least damaging impact on our planet in the years ahead. Utility rates and rising fuel costs appear to be the driving factor for "Going Green" and believe it or not, you have likely done one or more green practices as a result of the media attention you have received thus to date, whether it is utilizing public transportation versus driving or simply having adjusted the setting on your home thermostat in an effort to save on energy costs.

In our paper, we have decided to apply "Going Green" to thermal imaging and show some of the methods we have used in an effort to ***"Go Green with Thermal Imaging"***. In an effort to apply thermal knowledge to proven energy efficient practices, our paper will follow a document readily available from the U.S. Department of Energy website titled "ENERGY SAVER$, Tips on Saving Energy & Money at Home". http://www.eere.energy.gov/consumer/tips/

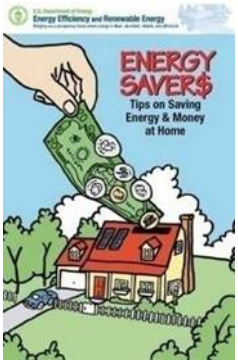


*Figure 2. ENERGY SAVER$ PAMPHLET*

You can tell a client their house is leaking, but for them to truly believe it, they may need to see it or have felt it to begin with. This is where thermal imaging comes in. They will now be able to visually see the effects of a leaking home or a failing system. Have you ever heard the following terms: "Seeing is believing", "The Proof is in the Pudding" or "A Picture is Worth a 1000 Words". Thermal imaging allows us to see what our eyes alone cannot.

## SAVE ENERGY AND MONEY TODAY

It has been stated that a typical U.S. family spends more than $1600 a year on home utility bills, unfortunately a large portion of that energy is wasted due to inefficient appliances or leaky buildings. By following some simple prescribed methods in the Energy Savers handbook, they claim you can save up to 25% on your utility consumption.

The following chart explains where your typical energy dollars go.

Following the "Energy Savers" handbook, we will show you how thermal imaging puts the *proof in the pudding.*

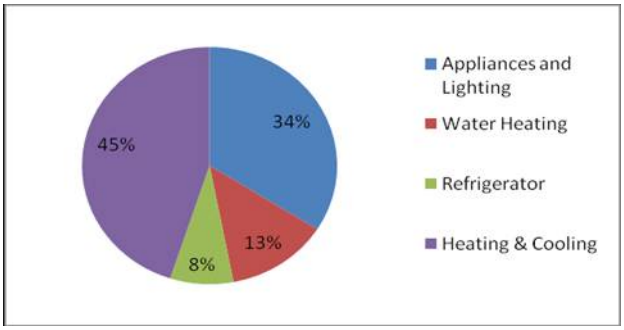


*Figure 3. Energy Chart*

## YOUR HOME'S ENERGY USE

As stated in the "ENERGY SAVER$" handbook: "The first step to taking a whole-house energy efficiency approach is the find out which parts of your house use the most energy", or as we see it, which areas are failing to perform. Often this can be the difficult part as many areas you just cannot visualize. A thermal inspection can help you see the energy leaks and know right where to carry out your repair methods. It is also an excellent method to verify repairs were completed.

## INSULATION AND SEALING AIR LEAKS

Building envelope deficiencies appear to affect the largest percentage of utility costs as heating and cooling operation accounts for 45% of consumption. Missing insulation or leaks in the walls cause the heating and cooling units to compensate by running longer to make up for these deficiencies. By identifying these problem areas via thermal imaging, you can reduce your heating and cooling costs and live more comfortably.

### INSULATION
### ATTIC ACCESS: BEFORE & AFTER INSULATING

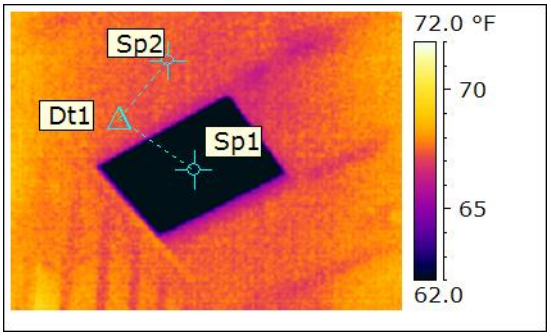


*Figure 4a. No Insulation*
*Image.Date 2/20/2006 Image.Time 10:00:17 AM*
*Temperature difference: Dt1 -6.4*

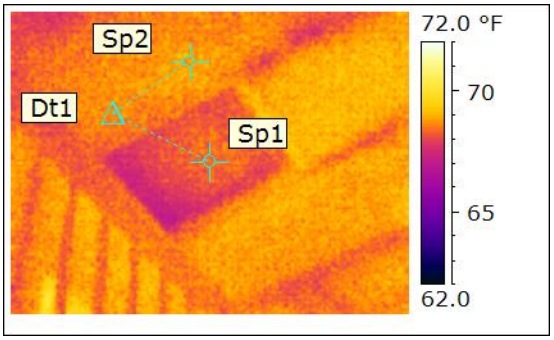


*Figure 4b. Same image taken 45 minutes later*
*Image.Date 2/20/2006 Image.Time 10:47:37 AM*
*Temperature difference Dt1 -0.6*

In the image above, you can see how easy it is to tell when you have no insulation on the attic access cover (a great opportunity for heat to escape). In reality, you can see this without an infrared camera by simply going into the attic but if you're like many of my clients, they have never removed the access door or entered the attic. This is a very common area where insulation is missing. We have visually identified this condition on thousands of homes that we have inspected over the years. The image to top right confirms the benefit of insulation after repair in only forty five minutes time. Notice the temperature delta's between both images.

### EXTERIOR WALL: MISSING OR DEFECTIVE INSULATION

*Figure 5a. Visually you cannot see missing insulation*

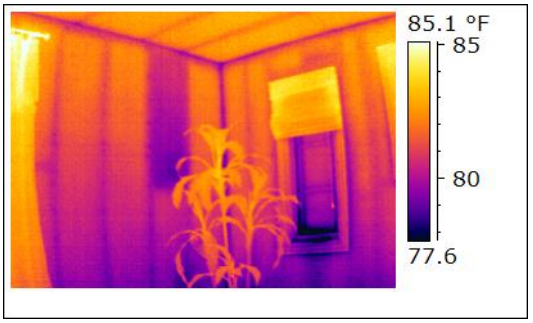


*Figure 5b. Thermally it is very easy to identify*

"You Can't Correct what You Don't Detect"! Outside of destructive testing, infrared is one of the most effective methods of identifying missing or inappropriately installed insulation in a home or business. An infrared camera brings to light the affected area which allows you to carry out repairs in an effective manner.

### AIR LEAKS: WEATHERSTRIPPING FAILURES AND BUILDING LEAKAGE

An excellent method of identifying Building leakage is through the use of a Door-Fan in conjunction with an infrared camera. By depressurizing a home, the building leaks appear out of nowhere, sometimes in places that you may have suspected all along. Once again, "Seeing is Believing".

Recessed lighting installed in homes today are "IC/AT" Insulation Contact Air Tight style but as you see in image below, some of the contractors are installing lights to previous style which required a 3" gap due to

overheating. These older types of can lights were like having big holes in the ceiling for all your conditioned air to escape. The can lights needed the gap as the fixtures would get just too hot and would possibly ignite due to overheating. As you can see in the image below, they left a pretty good air space that was not needed as this was a new home and the light fixtures were the IC/AT type.

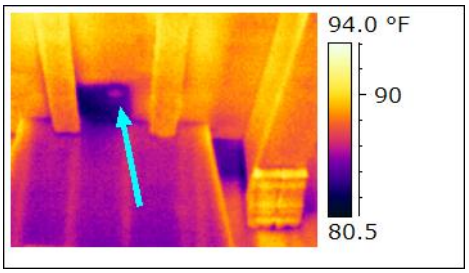


*Figure 6. Thermal image showing gaps around can light*

Performing a Door-Fan test will bring out even the smallest of leaks. A bunch of small leaks can equal one large hole.

*Figure 7a. Door-Fan Testing*

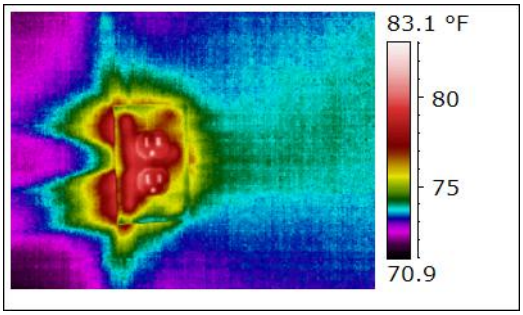


*Figure 7b. Electrical Outlet Leak*

The image to above right shows an electrical outlet during a Door-Fan test. Installing a rubber gasket behind the plate or caulking can help reduce conditioned air loss.

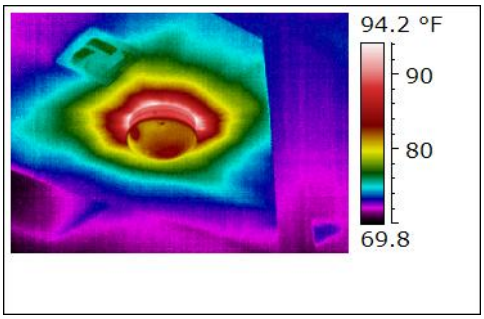


*Figure 8a. A light fixture not caulked/sealed at ceiling*

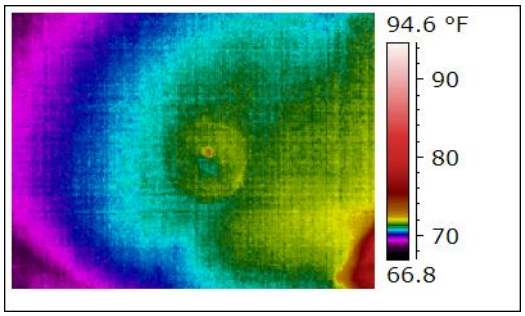


*Figure 8b. A light fixture 5 feet away that is sealed properly*

The above pictures were taken about 5 feet from each other and were the same style light fixture in a brand new home. As you can see when they leak, it shows up beautifully on the infrared camera and when they don't, they blend in with adjacent area as the image on above right. The image to right is actually the prettier picture when you are trying to save energy.

We have found that loose fill insulation (fiberglass, cellulose etc.) appears to work quite well in attics or tight places as the small areas especially around can lights will get filled more evenly rather than trying to cut batt style insulation to conform around these areas. It is easily seen thermally when they do not install the

insulation evenly or gaps are present as the patterns will vary, unlike batt insulation which typically will appear as squares when it is missing.

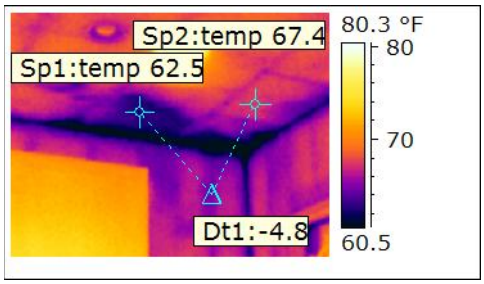


*Figure 9a. Loose uneven insulation*

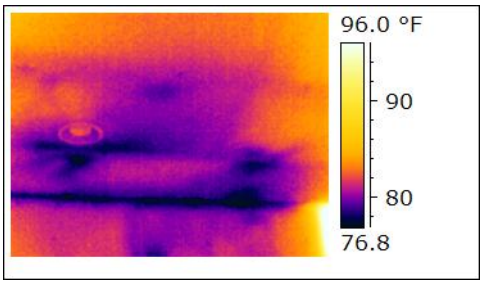


*Figure 9b. Uneven blown in insulation*

"A Picture is Worth a Thousand Words" will be news that travels fast. Just knowing that things like insulation quality can be seen with a thermal imager and with such clarity really gets the word out. SoCal Infrared had the opportunity to share this story with NBC News in Las Vegas in October 2007 during their special "Go Green". This story can be seen on our website www.socalinfrared.com.


*Figure 10a. "Go Green" with Thermal Imaging*


*Figure 10b. Peter Hopkins interviewed with NBC*

## HEATING AND COOLING

Considering that Heating & Cooling account for about 45% of your utility bill, identifying inefficient and leaky areas can seriously help reduce your energy consumption. A few of the areas we have used to identify problem areas with thermal imaging are leaking ducts, air balancing and effective cooling.

### DUCTS

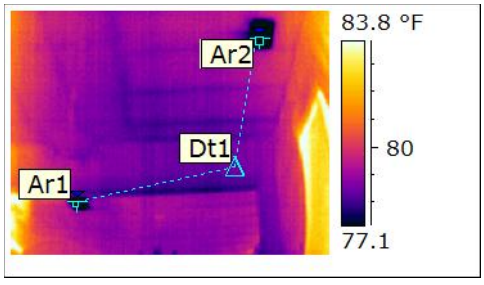


*Figure 11a. Ar1.Min Temperature 56.8 °F*
*Ar2.Min Temperature 68.3 °F*
*Temperature Difference: Dt1 -4.8*

*Figure 11b. Visual image*

In the example above, the complaint that the family room of this home was not getting cool enough. A simple analysis with infrared identified an 11 degree difference between ducts that are only about 15 feet from each other and are running on the same system. Further analysis identified that the warmer area had a single line duct split to three locations versus the other area had a dedicated line. By simply increasing duct size over

family room or dedicating more air flow, the area will be made more comfortable. Testing temperatures with infrared at each heat register and recording differences can often help explain why some rooms might be cold and some may be hot.

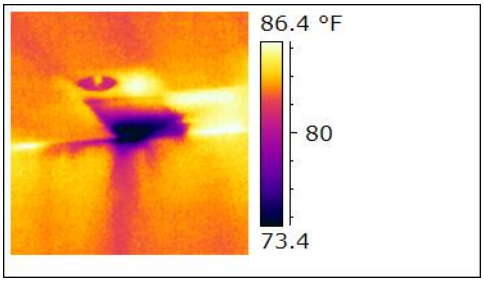


*Figure 12a. Thermal showing cold spot at ceiling*

*Figure 12b. Attic photo showing duct not installed and blowing air into attic*

An infrared survey in this home (above image) identified a cold area in a ceiling, it was later found out that the contractor had sealed over or never accommodated for installing the heat register in ceiling. The duct was discharging directly into attic.

Heating and Cooling equate to about 45% of average utility consumption and many of the existing homes have leaky ducts averaging in the 25-30% range, this can equate to a significant energy loss. The method used to identify measured air leakage rate of ducts is through the use of a duct tester although identifying the locations of the leaks might be another process in itself. Often they induce a fog into the duct fan during the test but sometimes there are locations that you simply cannot get too and as you see in image below right, an infrared camera can be very useful in this situation.

*Figure 13a. Duct testing equipment:*
*Image courtesy of Retrotec*

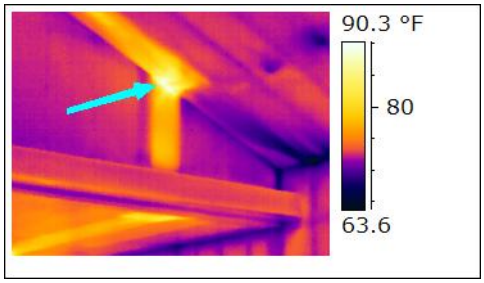


*Figure 13b. Leaky joint in duct (inaccessible location)*

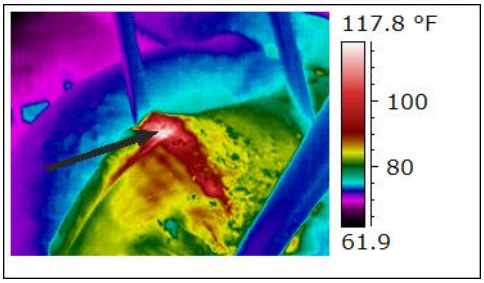


*Figure 14a. Thermal image showing duct leak*

*Figure 14b. Visual image of duct*

Thermal imaging can save allot of time as the results are immediate. By seeing the anomaly, you know where to focus your repair efforts.

**AIR CONDITIONERS**

A hot summer day will typically involve running an air conditioner, but how do you know it is working right? If you utilized the measures that are discussed above on the ducts and seal them up, you might then also want

to look at your air conditioning unit and size up its performance. Looking through an infrared camera can easily identify improper or inefficient operation. Can you tell which unit is not performing properly?

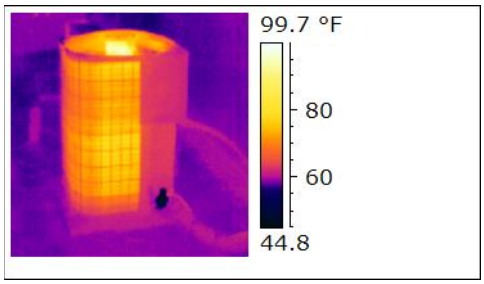


*Figure 15a. A properly operating system with even displacement of heat*

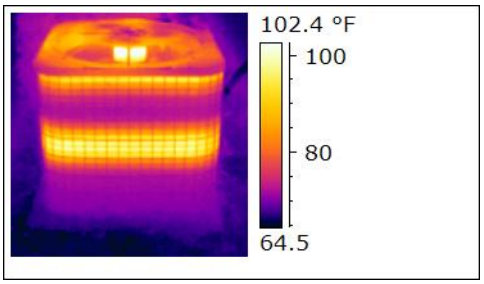


*Figure 15b. An obvious restriction*

The image to top right has an obvious restriction and if left to further operation can result in a damaged unit. This client had complained that it just was not getting cool enough. I think we have identified the problem.

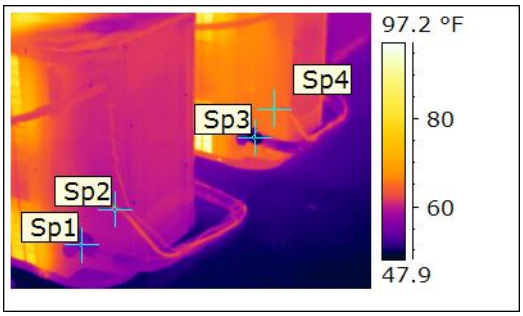


*Figure 16a.*
*Sp1.Temperature 56.3 °F Sp2.Temperature 59.9 °F*
*Sp3.Temperature 49.6 °F Sp4.Temperature 65.0 °F*

*Figure 16b. Visual*

The above air conditioning units were equally sized and running for the same amount of time. With an infrared camera by simply measuring temperatures of liquid and gas lines, you can help identify how much cooling is taking place. Often a 14-22 temperature delta t is desired, anything less or more in some cases can indicate improper operation. In the thermal image above you can see the forward unit only has a temperature difference of 3.6 degrees whereas the rear unit has a difference of 15.4 degrees. In this case, the client was complaining that the downstairs had inadequate cooling. Infrared quickly confirmed their suspicion. A proper charge on your air conditioning unit will give you the biggest return on your utility dollar investment!

**LANDSCAPING**

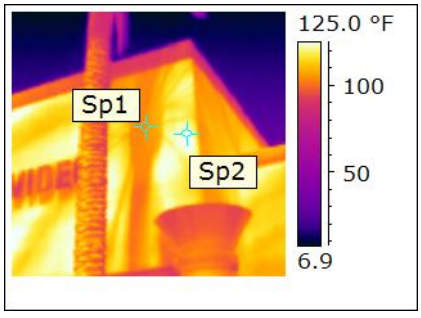


*Figure 17a. Thermal picture of tree shading home*
*Sp1.Temperature 104.0 °F*
*Sp2.Temperature 124.4 °F*


*Figure 17b. Visual Picture*

You can't argue that proper landscaping will benefit your comfort in the home. Strategic placement of trees can add an aesthetic value to your home but also savings to your heating and cooling consumption. It is stated that carefully positioned trees can save up to 25% of the energy a typical household uses for cooling. As evidenced in image above, you can see the temperature difference the shade makes on a home. Now obviously a palm tree is not the ideal tree when you desire a shade tree but for our example, it shows an easy comparison. There is over a 20 degree difference between shaded and sun exposed stucco.

## WATER HEATING

Water heating accounts for approximately 13% of your utility bill. I think we would all love to save where we can. As evidenced by images below, you can see how adding a blanket on your water heater can save you money.

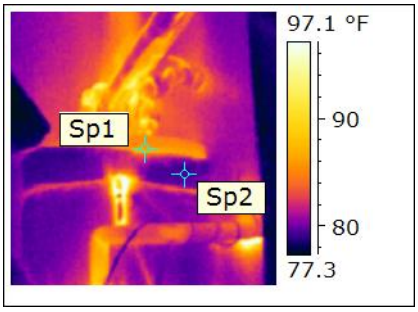


*Figure 18a.*
*Temperature readings at tank and insulated area*
*Sp1.Temperature 86.6 °F*
*Sp2.Temperature 79.5 °F*

*Figure 18b.*
*Visual picture showing insulation pulled down at top which shows tank temperature vs. insulated temp.*

## WINDOWS

As discussed earlier in this paper, the heating and cooling can account for 45% of your utility bill. One of the largest contributing factors for those high numbers can be your windows (10-25% of that amount). Single pane windows account for approximately ½ of the U.S. Households. Replacing them with highly efficient dual pane windows will definitely save your hard earned dollars. The image below was taken in a client's home where they had only replaced a portion of the windows and in this case some rooms were left with both styles. As discussed in the ENERGY SAVER$ handbook, a whole house plan is the most beneficial.

Can you tell which window is single pane? (Cold day, heater was on)

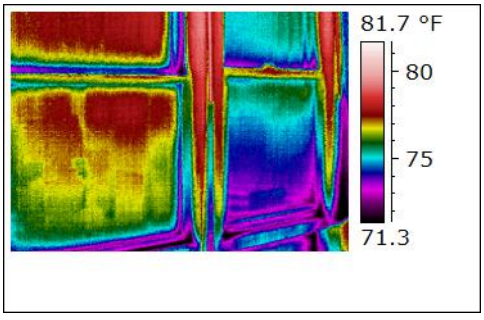


*Figure 19a. One window is keeping heat in, other letting heat out!*

*Figure 19b. Visual image*

## LIGHTING

At 11% of your energy budget, lighting stands at one of the easiest "Going Green" methods you can do to conserve your hard earned dollars. With recessed lighting being one of the more desired upgrades in homes, people didn't hesitate to get as many lights in as they can. It seemed that the Fluorescent light tubes of the 80's got replaced with 10-20 can lights. Energy codes called for fluorescent lighting in kitchen areas but home improvement contractors easily modified that requirement as a under counter accent lighting and

continued with can light installations throughout the home. At 60-100 watts per bulb, the meter would spin faster and faster. The problem with installing can lights was they were creating large holes in the building envelope. The original style can lights would get very hot and needed to dissipate heat. For this reason, insulation had to be pulled a minimum 3" away from light fixture so heat could escape. Well this is exactly what they did, allowed heat to escape, including the heat you generated from your furnace. By doing a search on the internet, there are methods of sealing your can lights and some may involve utilizing a fluorescent bulb as the heat generated from a fluorescent bulb is quite a bit less as seen in image below.

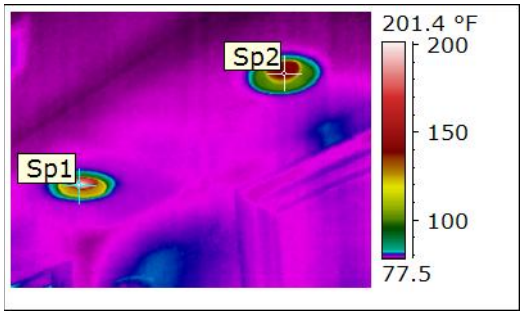


*Figure 20a.*
*Thermal view of both incandescent and fluorescent*
*Sp1.Temperature 195.0 °F (incandescent)*
*Sp2.Temperature 139.9 °F (fluorescent)*

*Figure 20b.*
*Fluorescent on right, incandescent in middle*

As you can see in thermal image, there is over a 55 degree difference between the incandescent and fluorescent light bulbs and when looked at in visual image, they appear to produce the similar lighting but obviously a big difference in the heat they produce. As a point of thought, during summer, the heat generated from these 195 degree bulbs will add to your utility load as your air conditioning unit will have to compensate for all this extra heat. Switching to fluorescent in addition to reducing your compensated cooling, will save you over 75% of your consumed wattage…a definite "Going Green".

## APPLIANCES

There is no question that upgrading appliances to new Energy Star standards will save you money. Why not keep your appliances in tip top shape and verify their proper operation. A thermal imaging camera can help you calibrate and know the temperatures when you need them (i.e. refrigerator, freezer, oven temperature, water heater). By identifying proper temperatures, you will utilize your appliances to their prescribed temperatures.

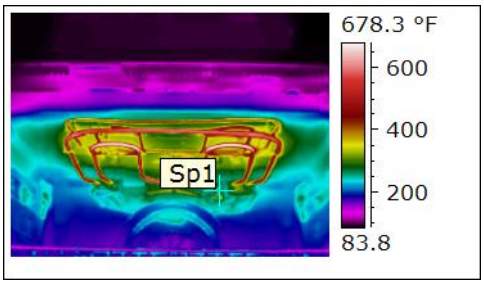


*Figure 21a. Oven Element*
*Sp1.Temperature 232.0 °F*

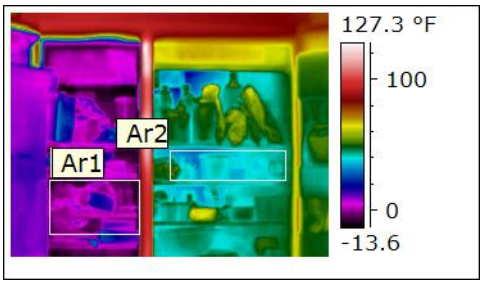


*Figure 21b. Freezer/Refrigerator*
*Ar1.Average Temperature *2.4 °F*
*Ar2.Average Temperature 38.9 °F*

Other areas we would recommend trying with thermal imaging

1. Weatherstripping at refrigerator or freezer doors
2. Oven door weatherstripping
3. Water heater output temperature
4. Water leaks at dishwasher
5. Electrical supplies for appliances
6. Laundry equipment air and water leakage locations
7. Kitchen exhaust leakage

Many times just by looking around with a thermal imager, you will find things that need attention. I cannot tell you enough how I constantly learn new ways to utilize my imager.

## HOME OFFICE AND HOME ELECTRONICS

A little bit of knowledge and you can go a long way. Recently I have made the energy conserving decision to turn my computers off when I am not using them.

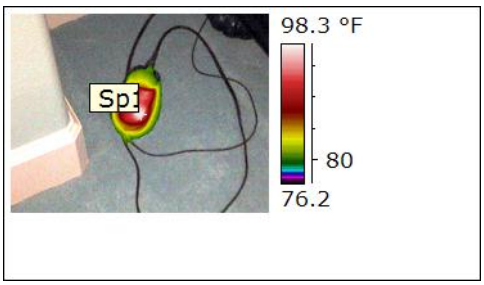


*Figure 22a. Small electronic power supplies left on unnecessarily*
*Sp1.Temperature 97.6 °F*

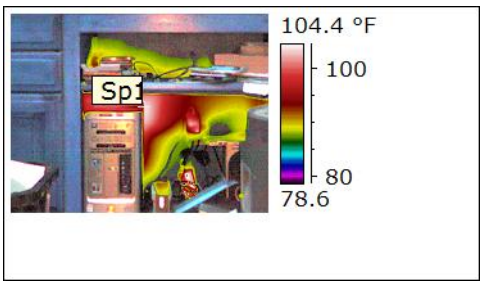


*Figure 22b. Computers left on when not in use. See the heat*
*Sp1.Temperature 101.8 °F*

I decided to take this one step further and take a wattage reading on my computer alone. I found not only via thermal imaging that these equipment pieces were generating a lot of heat, but my computer alone was costing me 4 cents an hour to be on….This may not seem like a lot but you do the math, it comes close to $30 a month of my electric bill.

As an interesting note, it is stated in the ENERGY SAVER$ book that 75% of the electricity used to power home electronics is consumed while the products are turned off.

## DRIVING AND CAR MAINTENANCE

For most families, driving is not an option but rather a requirement if we plan to have utility bills to pay in the first place. To get the largest return on your investment in transportation, it would be wise to have your vehicle in tip top shape. By utilizing a thermal imager for an overview of your vehicle, you can see several things, just like in a home where you might be wasting unnecessary consumption. A couple tips we can think of are the following.

1. Looking at your tire wear and pressure. An underinflated tire will appear warmer than the rest and the thermal pattern will be obvious.
2. Just like in a home, your vehicle has weather resistant features like weatherstripping and flashings. Review these areas for potential leakage.
3. Although it may require some initial research, there is a good temperature for everything to operate effectively; an abnormal hot spot on your exhaust can be a sign of a leak or a restriction.
4. Review of your water cooling circulation system including your radiator might show a breech or restriction in the line.
5. Air Conditioning operation and effective cooling
6. Seat heating elements for proper operation

Put your mind to a challenge and see how many ways you might be able to use a thermal imager to save.

## RENEWABLE ENERGY

Utilizing renewable energy is just plain smart. Take a look at the image shown earlier in this paper of the tree shading the building. The unshaded temperature of the stucco was 124 degrees just going to waste. Consider if you were to have solar harvesting on your roof be it water heating or solar electric panels. The suns energy is free; why not take advantage of it and "Go Green".

## SUMMARY

We hope that you have found our paper to be as interesting and enlightening as it was for us to write it. I know by taking some simple measures in my own home, that we have made an impact on our future. I hope you will find ways to incorporate "Go Green with Thermal Imaging" into your lifestyle and also hopefully others as together we can make a difference.

## REFERENCES

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## ABOUT THE AUTHOR

Peter Hopkins, a Level II Certified Thermographer is the President of InspecDoc Inspection Services, Inc., the parent company of SoCal Infrared. Peter has been in the building inspection and evaluation business for over 12 years. Currently servicing most of Southern California as multi-inspector firm with several of the inspectors certified in thermography. Peter completed a certificate major in Construction Inspection with academic honors from Palomar College in Southern California. Peter was the recipient of a scholarship from ICC (International Code Council, www.iccsafe.org) and currently holds five certifications as a Residential Combination Inspector, Building Inspector, Electrical Inspector, Mechanical Inspector and Plumbing Inspector. In addition, Peter is a Certified HERS energy rater. Peter is a Certified CREIA Inspector and a New Construction Specialist with The California Real Estate Inspection Association (www.creia.org) and has served in various volunteer leadership positions within organization. Peter has personally performed over 5000 Real Estate evaluations and over 1000 energy audits in Southern California. Peter resides in Southern California along with his wife and two children.