Some explanations and caveats regarding thermal images.

Insulation discussions often involve images captured by a thermal camera (thermograms). The pictures produced by thermal cameras may look like photographs, *but they differ in important ways*.

In our familiar visual world one or more light sources emit light which reflects off the objects we view. In a dark (unlit) room nothing is visible unless there is something hot enough to glow, for example an iron bar heated to 1,000 °F which will glow "red hot". When a light is turned on, our eyes interpret the reflected light and shadows to let us "see" the objects and their relative positions.

The world view of a thermal camera is very different. Instead of sensing visible light (0.4 to 0.7 µm wavelength), as our eyes do, it senses "Long Wave Infra Red" (LWIR, 7.5 to 13 µm wavelength). In musical terms the "pitch" of LWIR is more than 4 octaves lower than the "pitch" of visible light.

In this LWIR range, every object is hot enough to glow even when its temperature is well below room temperature. How brightly it glows depends both on its temperature (the hotter the brighter) and on a surface property called emissivity (E), which varies varies between 0.0 (a perfect reflector) and 1.0 (a perfect "black body" radiator).

Surfaces with low E values do not glow brightly, do not absorb IR efficiently but do reflect IR well.

Surfaces with high E values glow brightly; they also absorb IR efficiently but reflect IR poorly.

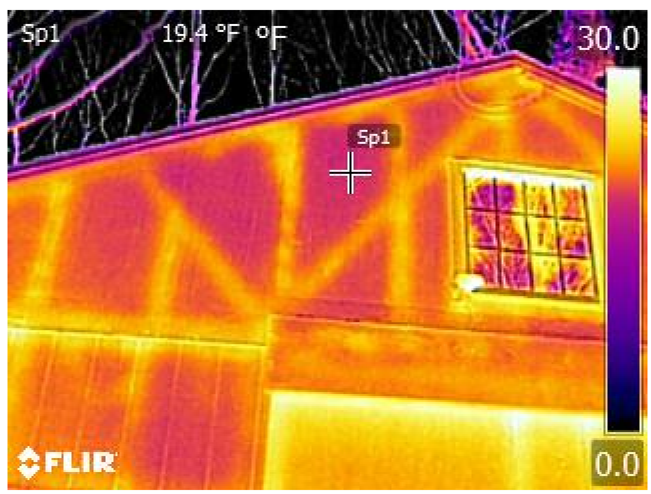
Polished metals have low E values - as low as 0.1 - thus do not glow brightly but reflect very well.

Most common building materials have high E values - generally around 0.9 - thus glow brightly and reflect poorly.

If the E value of a surface is known, then the thermal camera can calculate its temperature based on the strength of its glow. The thermal camera I use supports an E setting between 0.1 and 1. ***It is important to remember that the temperature readings will only be accurate for objects whose E value matches the camera's E setting!***

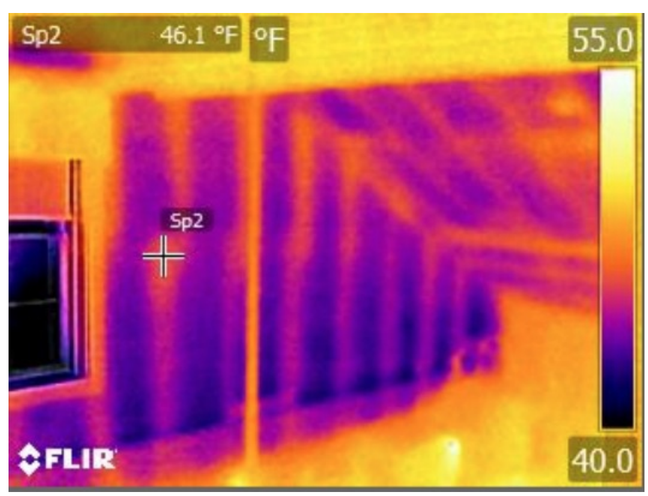
Another difference is that materials which are transparent to visual range light, may be opaque to LWIR, or vice versa. For example window glass is completely opaque in the LWIR range!

Finally, with all objects "glowing", the intense glow from a hot high-E object can illuminate a nearby object which, if it is low-E, will reflect the glow, or if high-E will be warmed by it.



The outdoors thermogram of my garage illustrate some of the capabilities and limitations of thermography. It was taken with the camera's E set to 0.95, an outdoor temperature of around 20°F and an indoor garage temperature of around 45°F.

The truss is easily visible as hotter areas - because its insulation value is lower so more heat is being lost through the wood (1/2" plywood, 1.5" truss wood, 1/2" sheetrock) than through the areas not in contact with the truss (1/2" plywood, 1" foam insulation, 1/2" sheetrock).



But note the window above whose steep angle to the camera leads it to reflect as well as emit. What is being seen there is more the reflection of the nearby trees ratther than the temperature of the glass itself... The sky above is very cold (-40°F) - no glow there. The next thermogram was taken inside the Town Hall, inside the kitchen area on the 2nd floor. Note the clearly uninsulated wall. The inner and outer wall coverings are bridged either by studs (3.5" of wood) or only by air. Since the studs' wood are a better insulator than air, their presence shows up as a warmer wall.

Summary: thermal images are very useful for evaluating insulation, but remember that apparent anomalies can result from E differences or reflections from nearby surfaces...