Better Buildings Residential Network Peer Exchange Call Series:

The Power of IR Diagnostics to Drive Home Upgrades without Incentives

October 12, 2017

Call Slides and Discussion Summary

Agenda and Ground Rules

- Agenda Review and Ground Rules
- Opening Polls
- Residential Network Overview and Upcoming Call Schedule
- Featured Speakers
  - **Phil Pollard**, Eastern United States CPM Manager, FLIR Systems, Inc.
  - **Howdy Goudey**, Scientific Engineering Associate, Lawrence Berkeley National Laboratory
  - **Brent Foster,** Building Science Diagnostic Thermographer, Northwest Infrared
- Discussion
- Closing Poll and Announcements

Ground Rules:

1. **Sales of services and commercial messages are not appropriate** during Peer Exchange Calls.
2. Calls are a safe place for discussion; **please do not attribute information to individuals** on the call.

Better Buildings Residential Network

Join the Network

Member Benefits:

- Recognition in media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- Solution Center guided tours

Commitment:

- Members only need to provide *one number*: their organization's number of residential energy upgrades per year

Upcoming calls:

- October 19: Powered Up: Batteries and the Future of Residential Energy Storage
- November 2: The Beatles, Radiohead, and Adele: Messaging for Different Generations
- November 9: Money Down the Drain: The Energy-Water Nexus
- November 16: Wicked Smart: Optimizing Diagnostics through Home Energy Monitoring
- November 30: Solar Decathlon Peer Exchange Call

Peer Exchange Call summaries are posted on the Better Buildings website a few weeks after the call

For more information or to join, for no cost, email bbresidentialnetwork@ee.doe.gov, or go to energy.gov/eere/bbrn & click Join

U.S. Department of Energy Solar Decathlon

Oct 5-15, 2017 DENVER

- 13 Collegiate teams compete in 10 contests
  - New for 2017: Innovation and Water
- Winning team best blends technology, market potential, design excellence with smart energy solar production and maximum energy and water efficiency.
- Large free public event – showcases best of clean energy technology
- Denver location: new, mixed use smart community on transit line near Denver International Airport
- Sponsorship Opportunities
- Info: www.SolarDecathlon.Gov

Register for the Solar Decathlon Peer Exchange Call:

https://register.gotowebinar.com/register/8310877229536476 19?source=announce_email

Solar Decathlon 2015 Teams in Irvine, Calif.
Credit: Thomas Kelsey/U.S. Department of Energy Solar Decathlon

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Best Practices: FLIR Systems, Inc.

Phil Pollard, Eastern United States CPM Manager

U.S. DEPARTMENT OF ENERGY

FLIR | The World's Sixth Sense®

The Power of IR Diagnostics to Drive Home Upgrades without Incentives

October 2017

DOE Better Buildings Peer Exchange Call

Agenda

- Who Is FLIR?
- Does Heat Matter?
- Why IR?
- IR Cameras vs Spot Guns

Who is FLIR?

The World's Sixth Sense™

World's Largest Manufacturer of IR Cameras

World Class Training Facility

Service Center - Billerica, MA

Dedicated Technical and Application Support

Direct Field Support

Wide Sales Distribution Network

Continued R&D Advancements

Why use IR for Weatherization?

Allows you to quickly find and evaluate poorly insulated areas

Non Contact temperature measurement

Ability to find problems in difficult to access areas

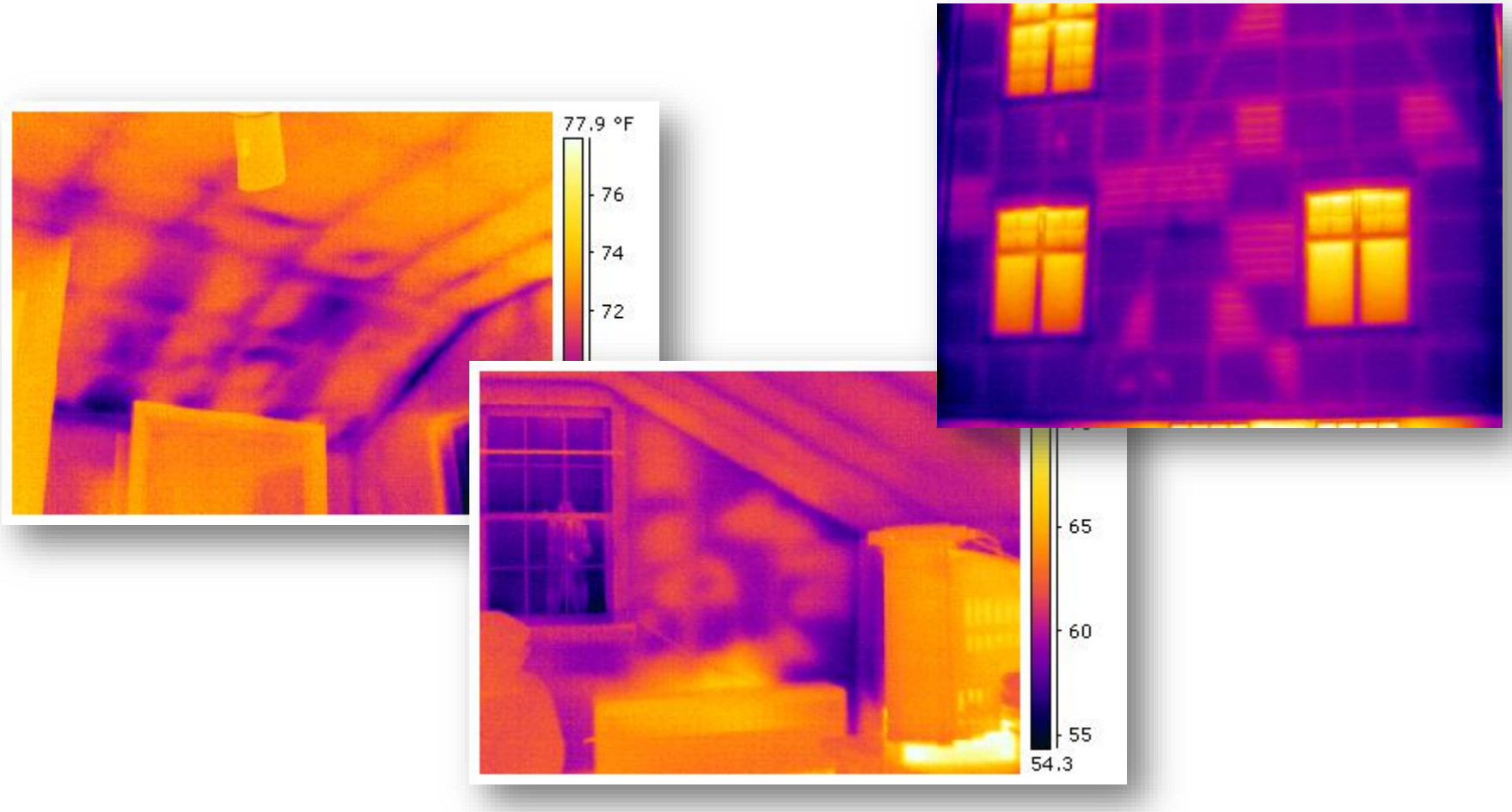
Fast, Efficient, and Precise

Allows you to Document with Images and Reports!

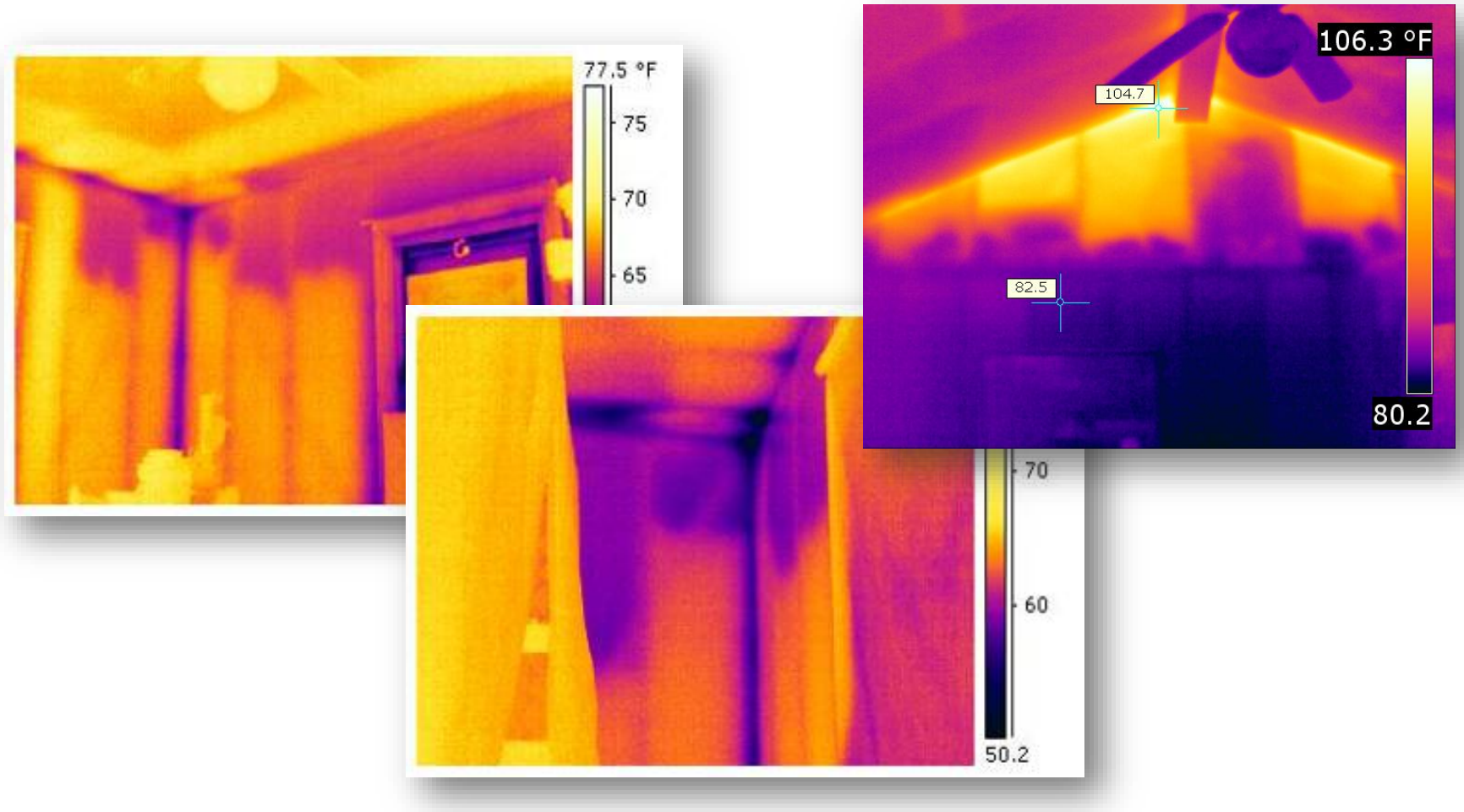
IR Applications for the Building Industry

- Missing Insulation
- Wet Insulation
- Air Infiltration
- Structural Deficiencies
- Duct Leaks
- Defective Windows
- Degraded Door Seals

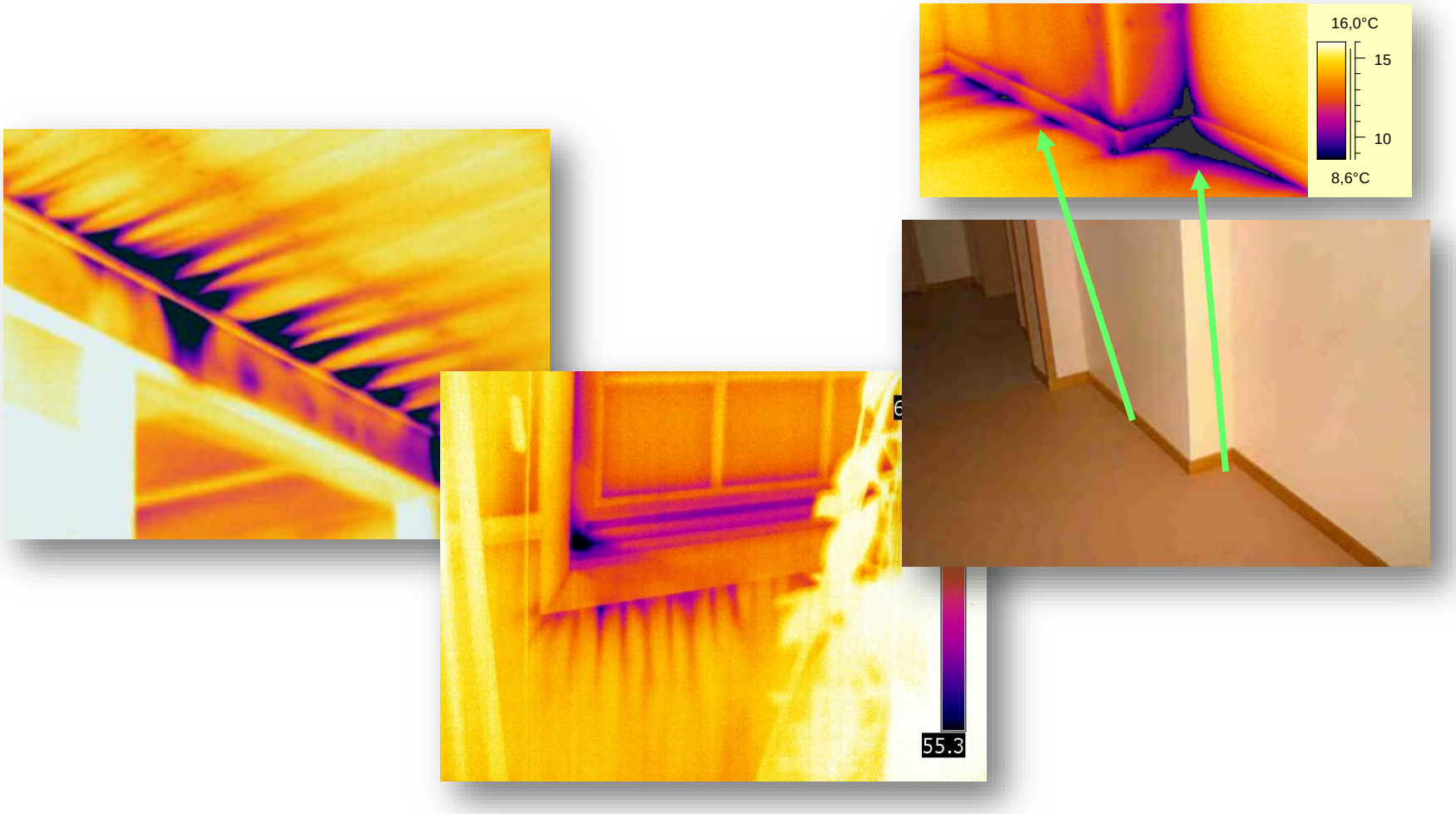
Poorly Installed Insulation



Settling or Missing Insulation

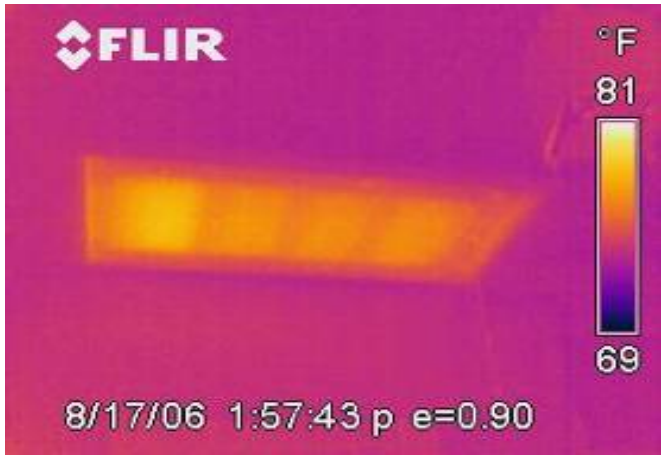


Air Infiltration Issues

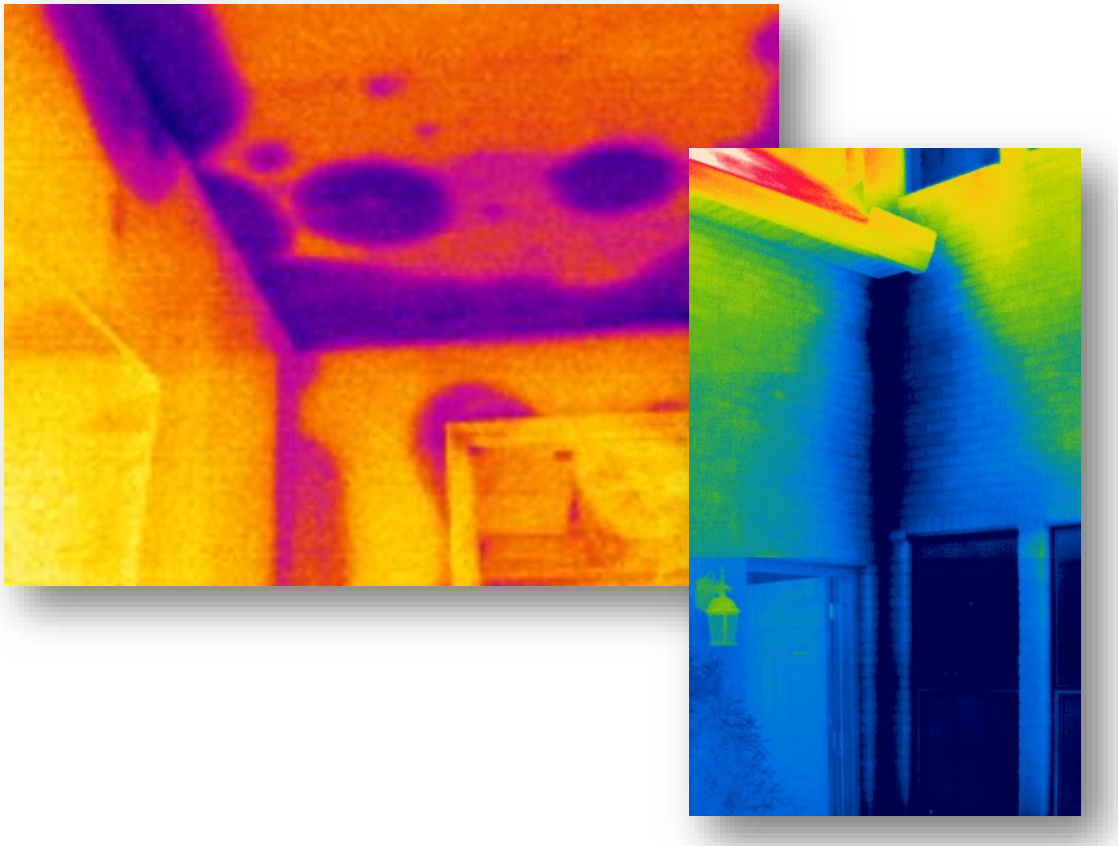


Attic Access

- The top image is a pull-down stairway.
- The bottom image is also a pull-down staircase.
- Why are these images different?

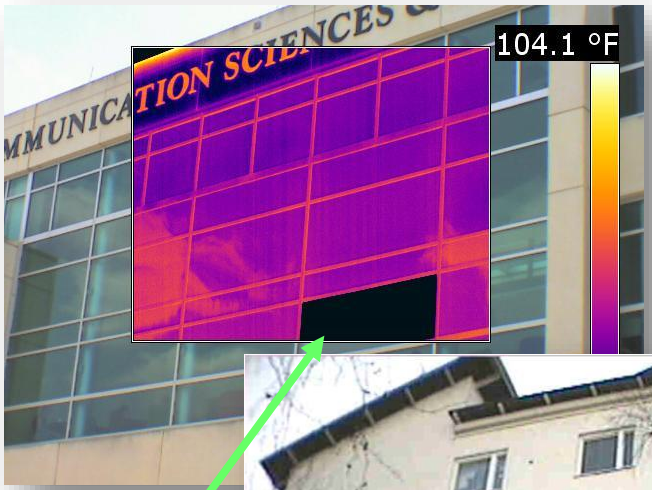


Moisture Intrusion

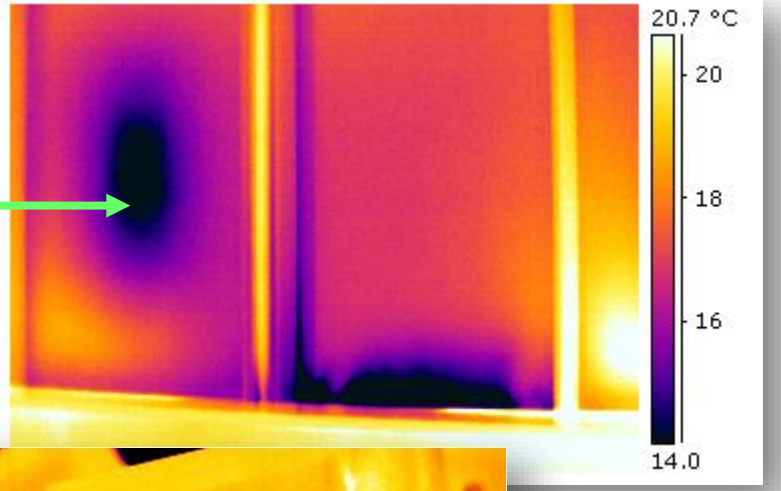


Energy Losses

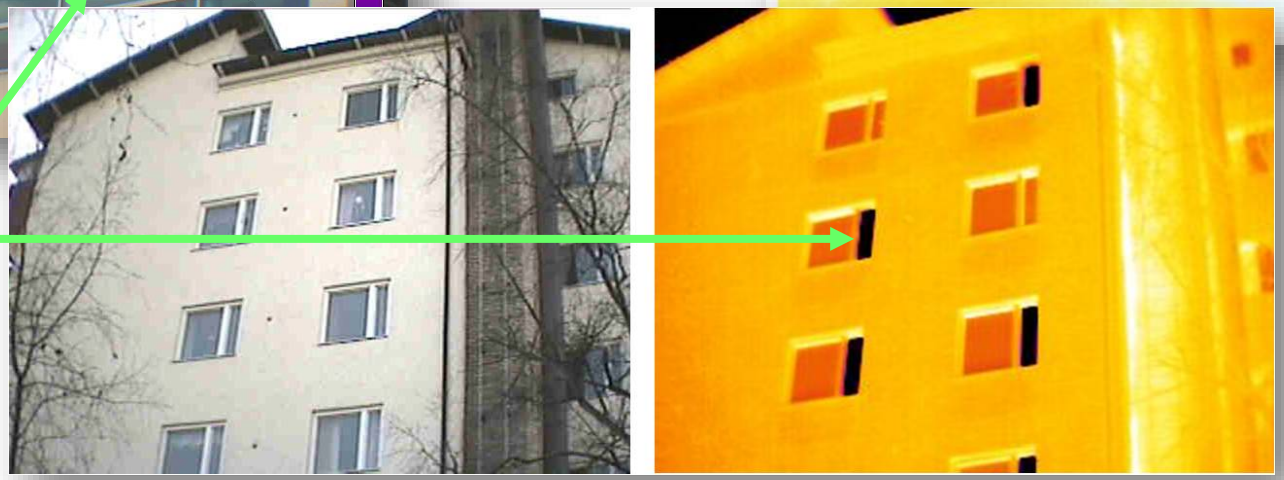
Issues with Windows



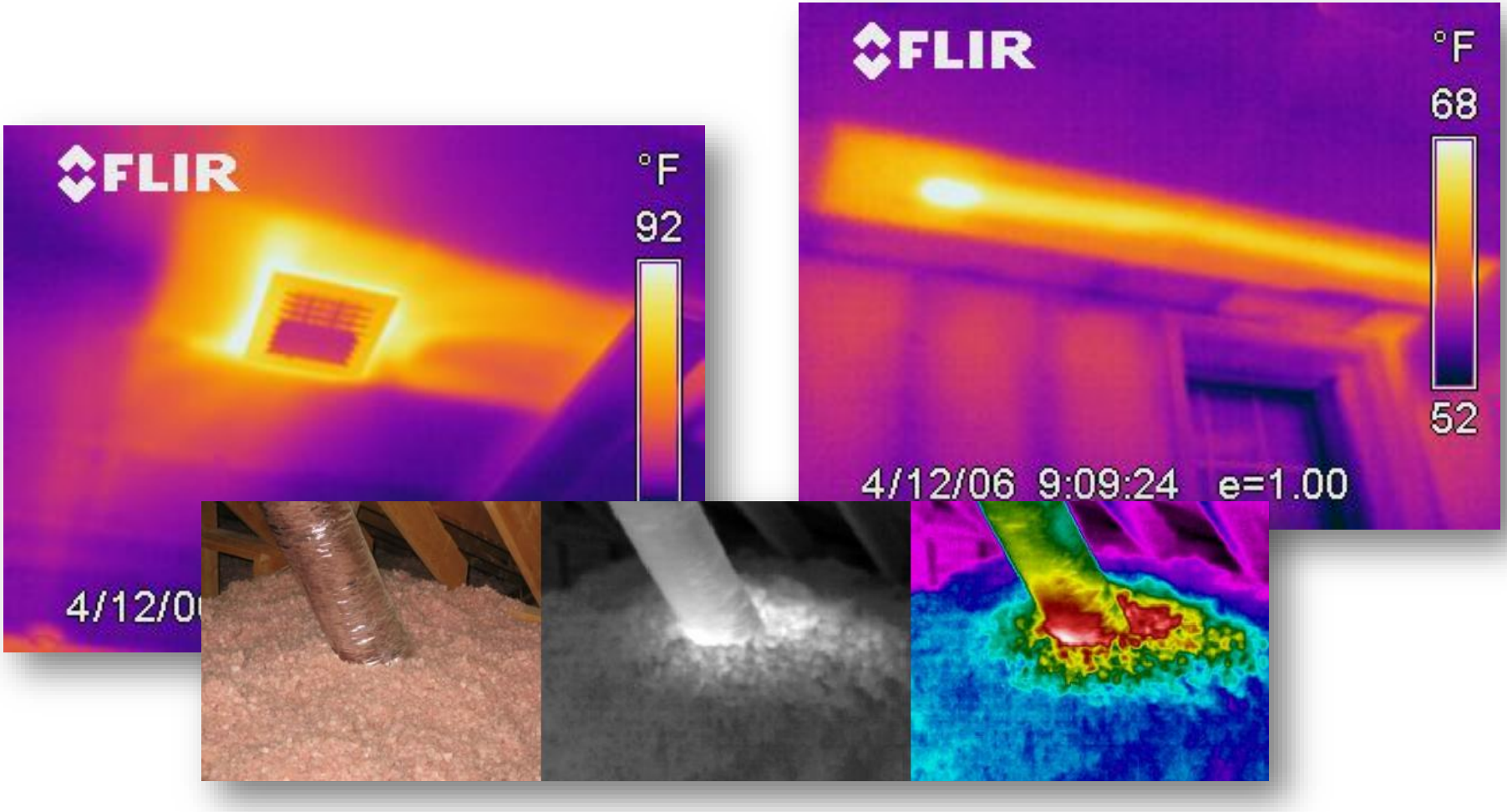
Broken window



Low-e window installed incorrectly



Duct Leakage



FLIR Cameras

Infrared Cameras for Building Efficiency

Temp Gun Style

FLIR TG165

Mobile Phone Accessory

FLIR One Pro

Pocket Camera

FLIR C2/C3

Dedicated Thermal

FLIR E Series

FLIR®

The World's Sixth Sense®

Presentation Highlights: FLIR Systems, Inc.

- **Infrared diagnostics (IR) can help homeowners understand the condition of their home and reveal any anomalies.** The infrared cameras provide temperature readings that indicate the places in the home with energy losses and identify issues such as moisture and air infiltration.
  - Some cameras are sensitive to even less than 10°F temperature differential.
- **The more pixels, the clearer the image:** High-resolution infrared cameras allow for a finer-grained look around the house and can capture smaller residential energy anomalies.
- **A picture is worth a thousand words**: Infrared imaging can help contractors provide homeowners with a quick, easy-to-grasp home energy assessment report based on the IR pictures taken during an audit.
- **Technology advances have made infrared cameras more accessible as home inspection tools.** Capturing pictures on mobile phones is one popular feature.

Best Practices: Lawrence Berkeley National Laboratory

Howdy Goudey, Scientific Engineering Associate

U.S. DEPARTMENT OF ENERGY

BERKELEY LAB
LAWRENCE BERKELEY NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

Quantitative and Qualitative Infrared Thermography

Howdy Goudey

Scientific Engineering Associate

Windows and Envelope Materials Group

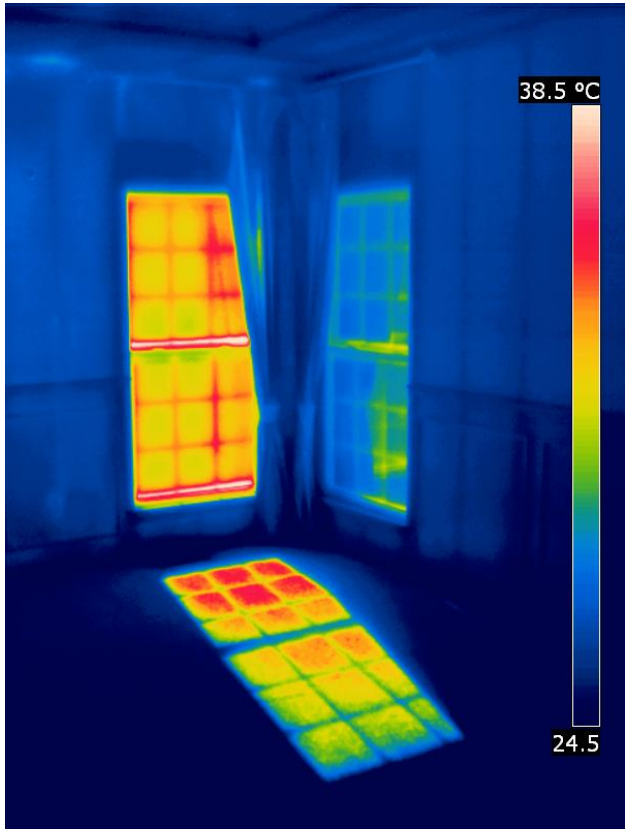
Lawrence Berkeley National Laboratory

Berkeley, CA

Oct 12, 2017

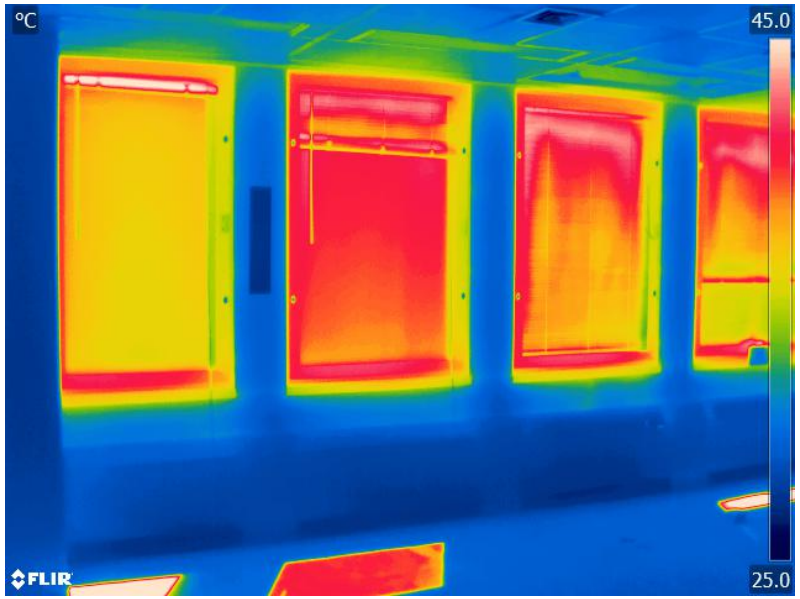
Useful IR Thermography Mindset

- IR cameras measure and visually display surface temperature patterns, not physical objects
- Heat flow driven by environmental temperature difference, or solar gain, is necessary to achieve thermal contrast for useful thermography.
- Every surface is a light “source” plus some reflection. Carefully sort it out for quantitative thermography or understand the scene for good qualitative comparisons.
- The background matters. The camera is not just measuring where it is pointed. Assess background temperature and uniformity.
- Don’t simply look at the image. Good IR thermography requires an understanding of the full context surrounding the image, including surface properties (emittance) and thermal “history.”
- Every moment is not equally suited to good IR thermography. Strategically plan for good opportunities.
- Glass is opaque to long-wave IR, transparent to short-wave IR

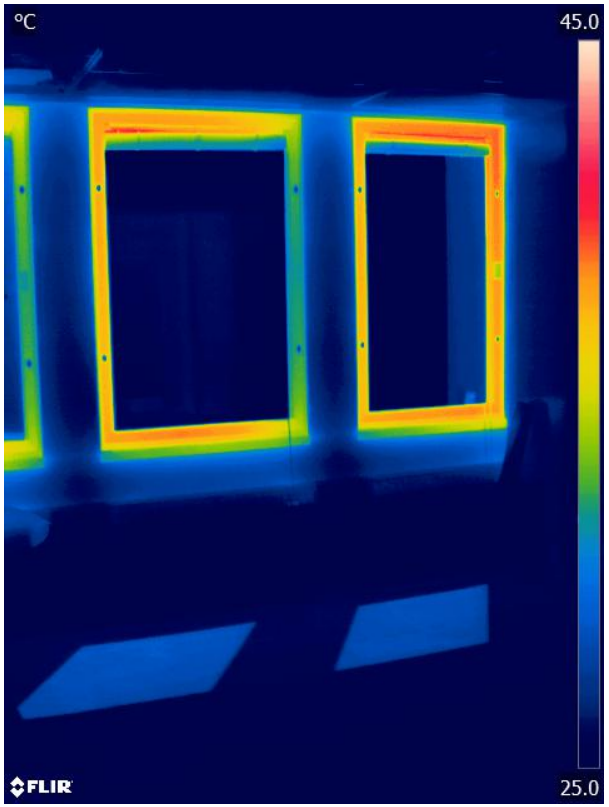


Qualitative Infrared Thermography

- Side-by-side solar transmission comparison visible in floor patch temperature
- Room facing low-e film reflects background (contrast with frame)



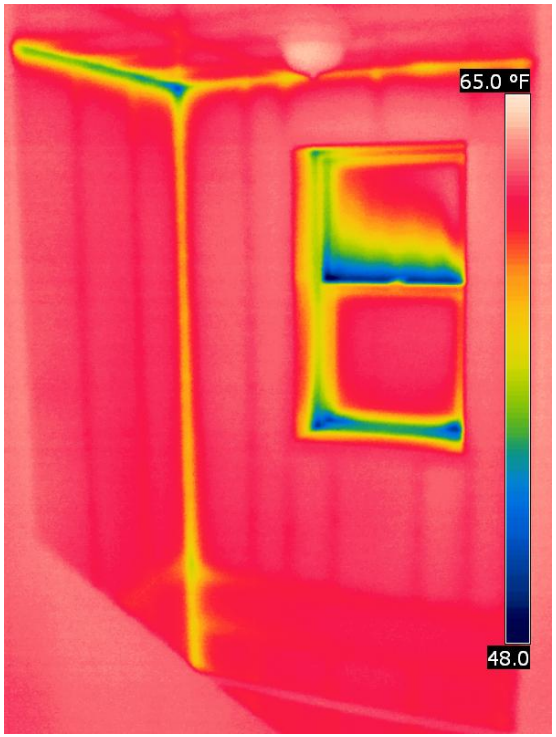
South façade **no film** in summer



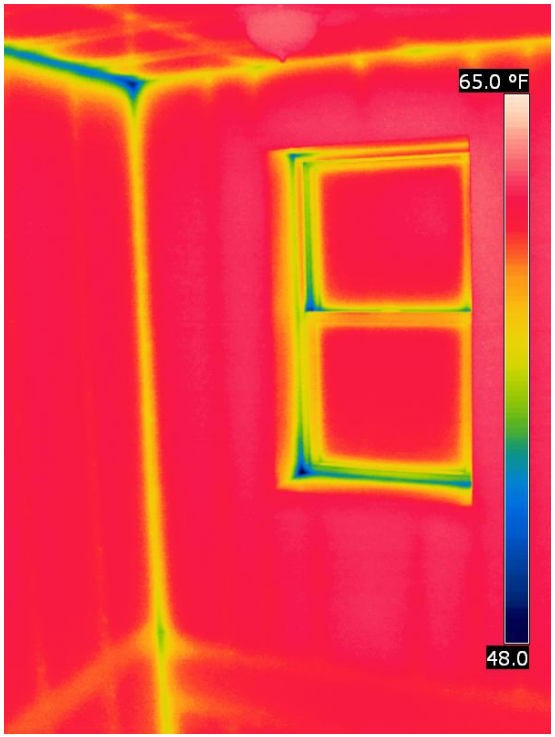
South façade **low-e film** in summer

Qualitative Infrared Thermography

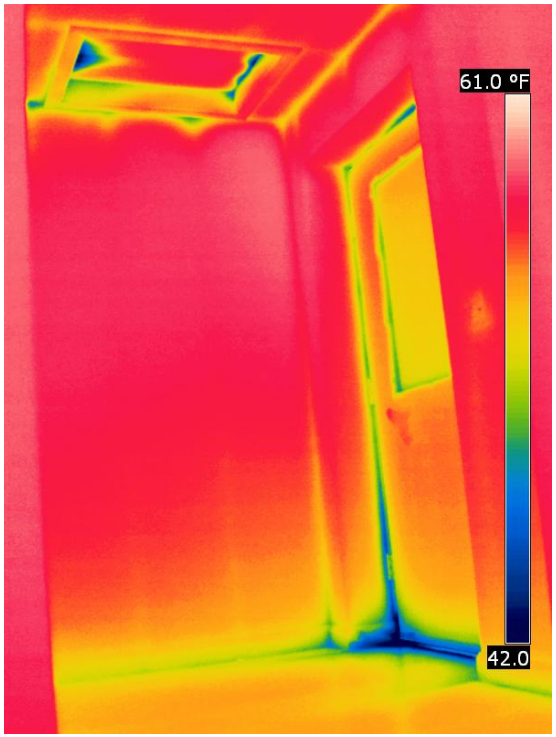
- Before and after air leakage
- Heat transfer is slow to stabilize, are the conditions similar before and after?
- Comparison images reported on the same temperature scale



Unlatched sash air leakage



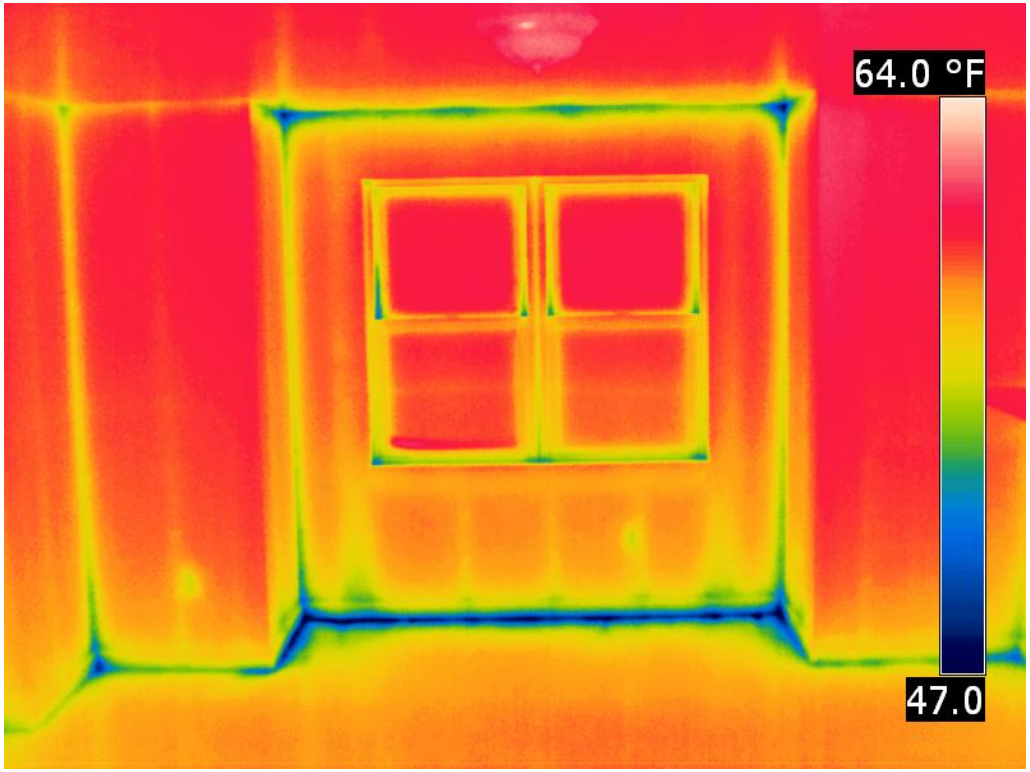
Same scene after re-latching and stabilization



Attic hatch and exterior door

Qualitative Infrared Thermography

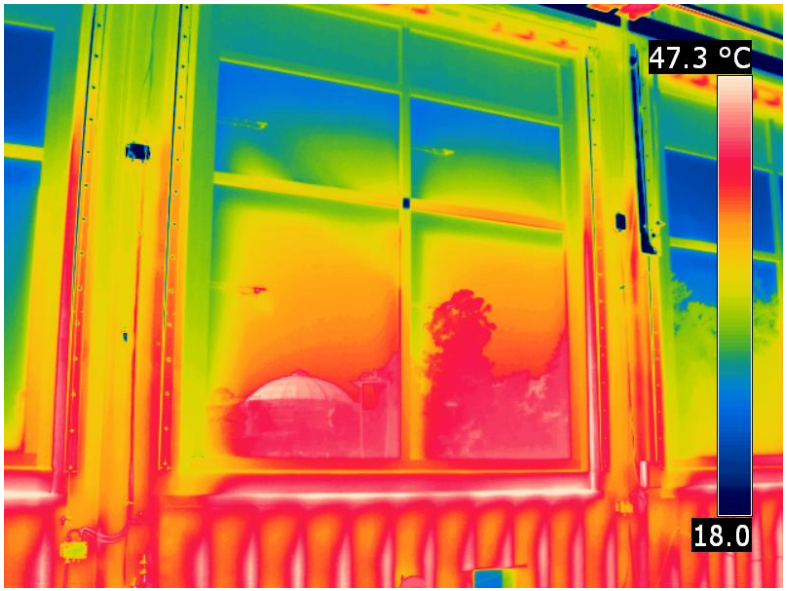
- Thermal bridging
- When walls are well insulated, studs and the details of structural connections matter



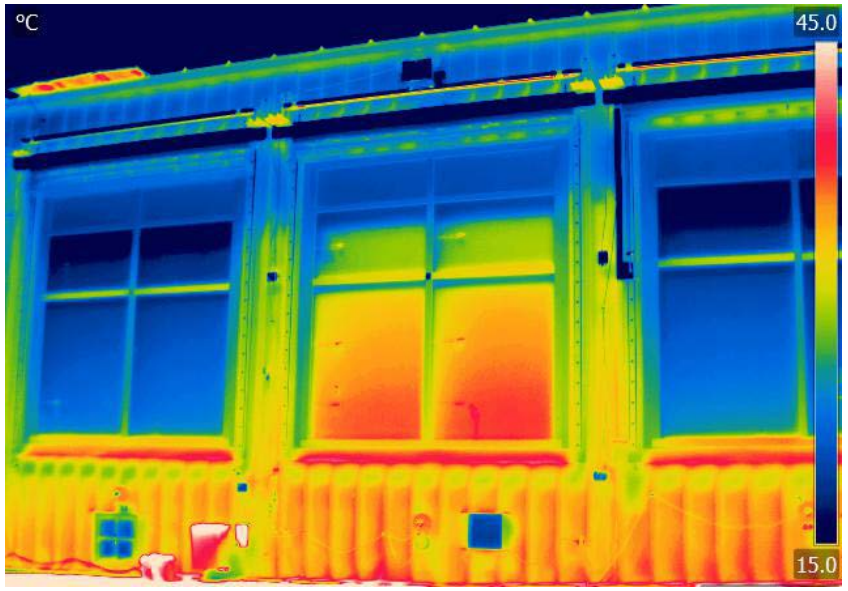
Interior of wall/window in winter

Qualitative Outdoor Thermography

- Exterior thermography more challenging for uniform background conditions
- Still possible to make useful measurements and side-by-side comparisons if care is taken



Specular background reflection in glass



Absorbing glass (center) shown warmer than adjacent windows with uniform background

Qualitative Outdoor Thermography

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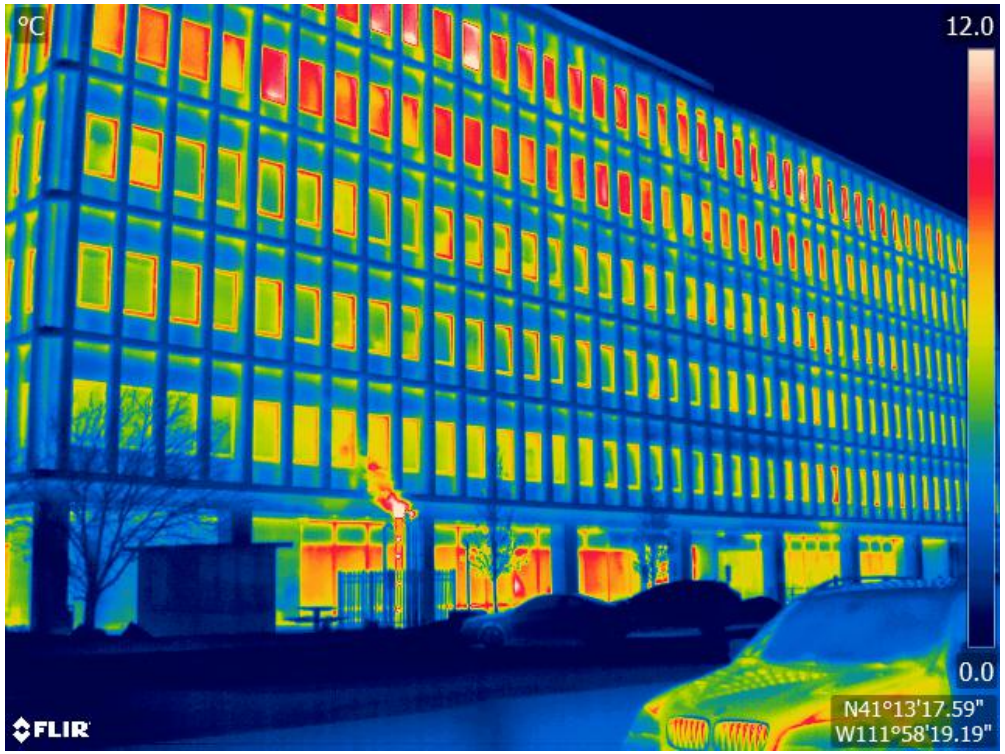


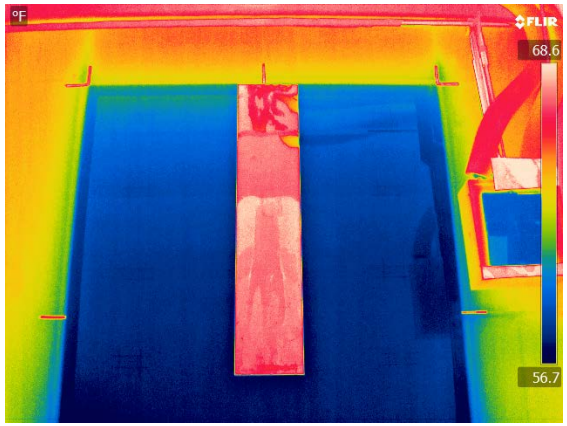
Winter exterior glass surface temperatures,
upper floors single clear,
lower floors single low-e

Quantitative Thermography

- Controlled laboratory steady-state environmental conditions (temperatures and air speeds)
- Uniform background temperature
- Reference emitter
- Location markers and point by point background and emittance correction (self viewing surfaces)

Window environmental test chambers rear doors open)

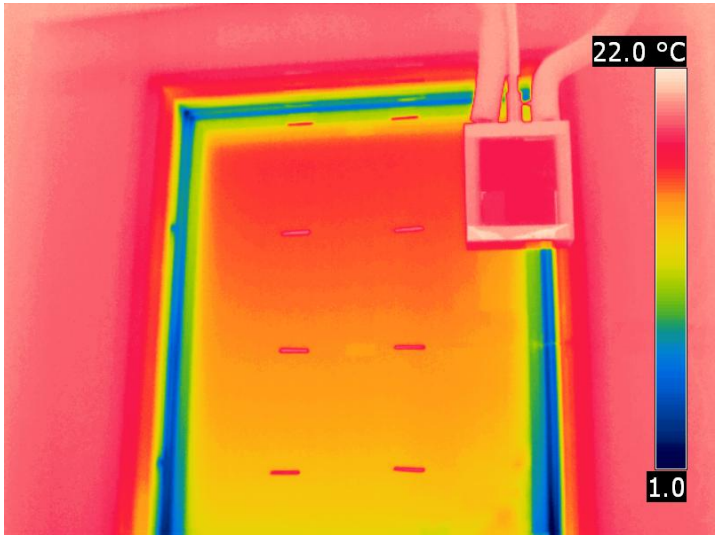
Vertical centerline mirror for collecting specular reflection from enclosure, point by point



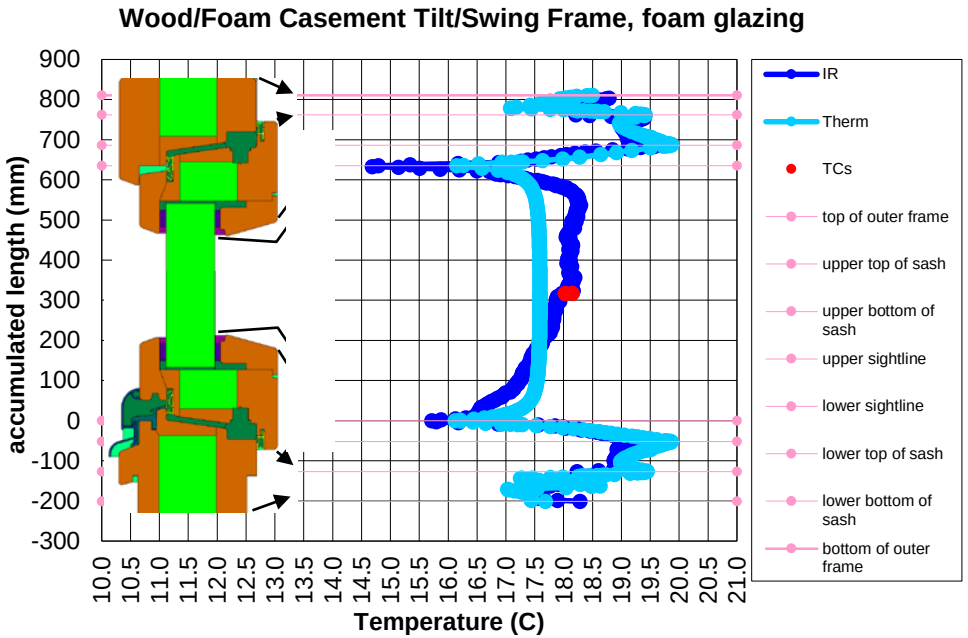
IR image of vertical centerline mirror for collecting specular reflection from enclosure, point by point

Quantitative Thermography

- Controlled laboratory steady-state environmental conditions (temperatures and air speeds)
- Uniform background temperature
- Reference emitter
- Location markers and point by point background and emittance correction (self viewing surfaces)



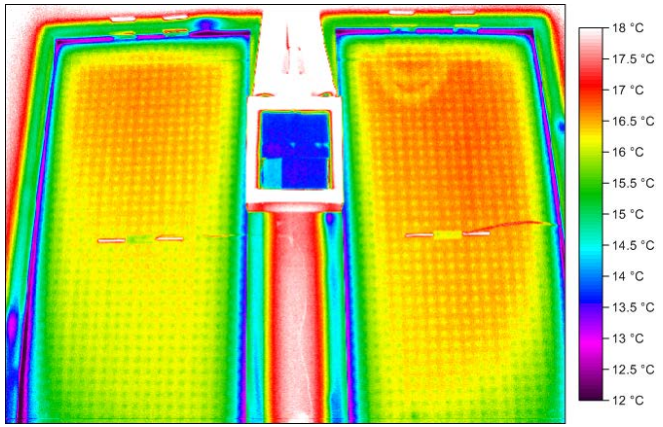
Window measured in environmental chambers with location markers and reference emitter and mirrors



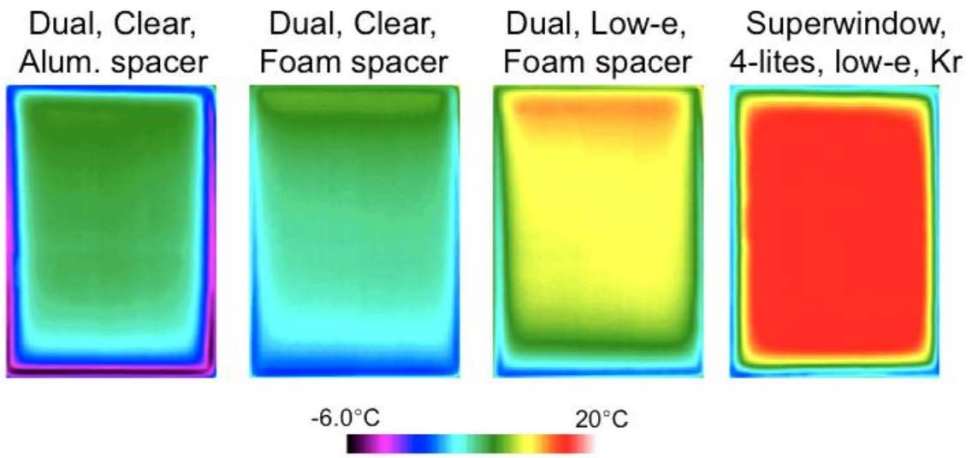
Vertical centerline data extracted from IR image and compared to thermal modeling

Quantitative Thermography

- Controlled laboratory steady-state environmental conditions (temperatures and air speeds)
- Uniform background temperature
- Reference emitter
- Location markers and point by point background and emittance correction (self viewing surfaces)



Vacuum glazing, IR surface temperatures resolve pillar conduction



Insulated glazing surface temperature performance under identical conditions

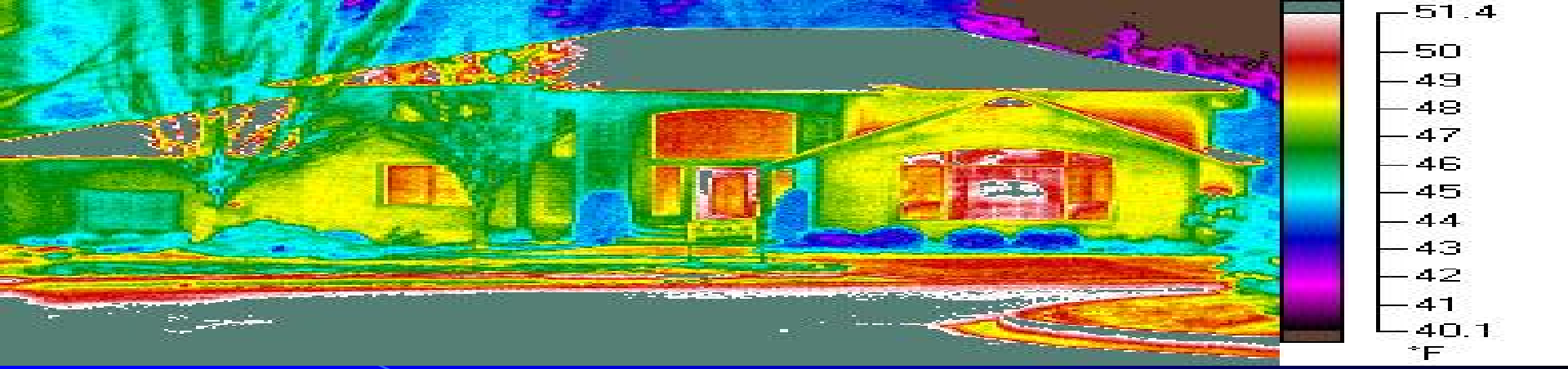
Presentation Highlights: Lawrence Berkeley National Laboratory (LBNL)

- **Full context matters when interpreting infrared thermography (IR):** Heat transfer might influence the results, therefore the entire background surrounding the image needs to be taken into account.
  - It's better to examine structures that are not exposed directly to sunlight.
  - Images taken of a building exterior are also challenging to interpret due to nearby buildings and trees.
- **Higher temperature differences in summer/winter improve thermal contrast and more accurate IR imaging.** Thermal imaging in moderate temperatures might not capture the full spectrum of a home's energy condition because the outside air is similar in temperature to the inside air.
- **Knowledge of surfaces, including their emittance and reflection, is key to providing a proper diagnostic**. LBNL is examining the performance of energy-efficient windows in a controlled environment and calculating the impact of various "non-uniformities" that might influence IR results. The goal is to create a knowledge base for necessary corrections that can be used for imaging in in the field.
- **IR allows contractors to evaluate localized performance of a home.** So, where a window may have a U-factor, which is an average value for the whole window, IR imaging can allow the contractor to confirm that the window is performing well and was installed properly, or where thermal bridging is occurring.

Best Practices: Northwest Infrared

Brent Foster
Building Science Diagnostic Thermographer

U.S. DEPARTMENT OF ENERGY



Northwest Infrared

Heat Loss Detection Expert

Brent Foster

360-786-6850

WHAT WE DO

We locate :

Heat loss

Drafts

Damaged insulation

We diagnose heat loss to keep your wallet out of surgery.

What we do not do.

We do not sell anything windows, doors, heating and or contracting.

There are two reasons a home is cold and expensive to heat!

Escaping heat (damaged insulation)

Cold air infiltration (Drafts) 45% Loss

The Two Great Myths

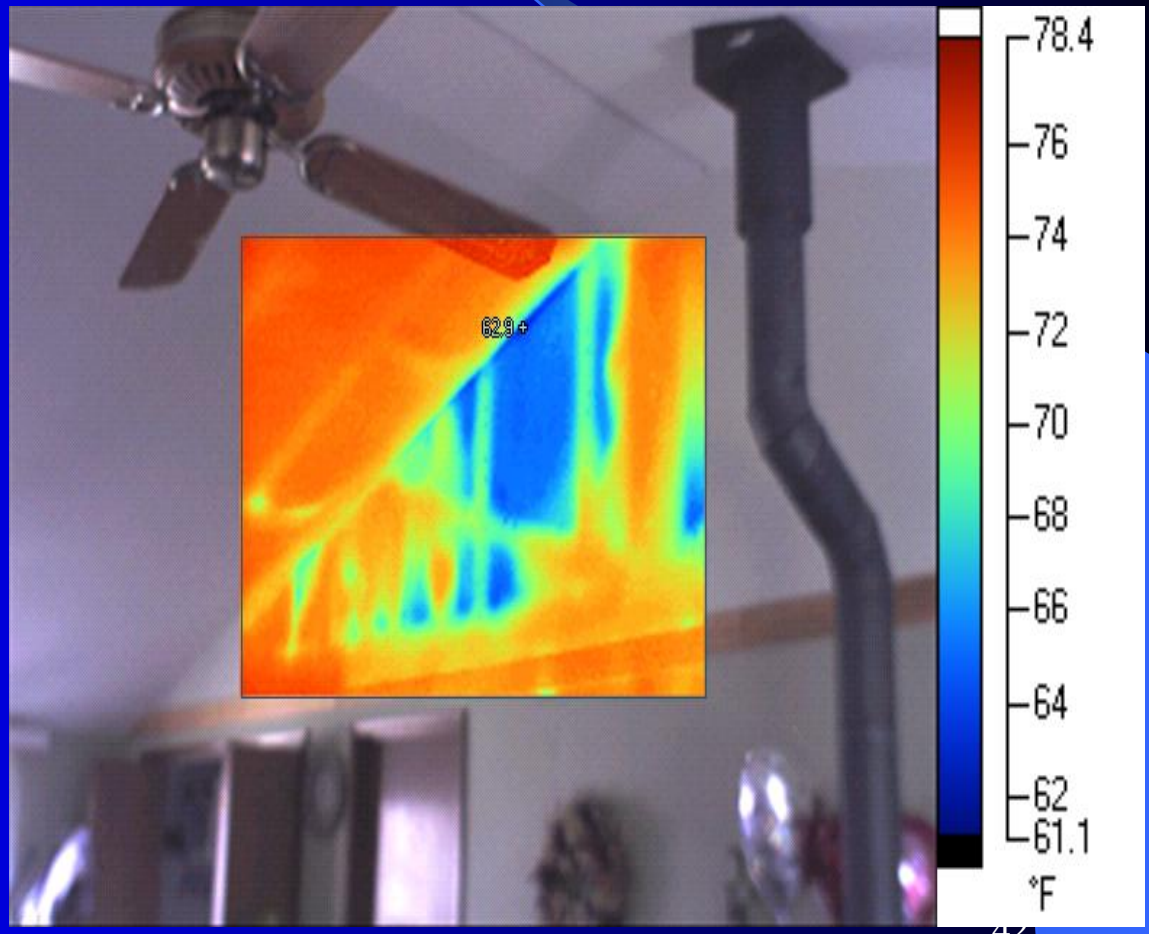
- Heat rises, doesn't it? NO!
- Heat goes from hot to cold.
- Hot Air Rises.

- My furnace is costing me money?
- NO!
- Your house is leaking and costing you money.

If your home retained heat properly you could heat it with a light bulb

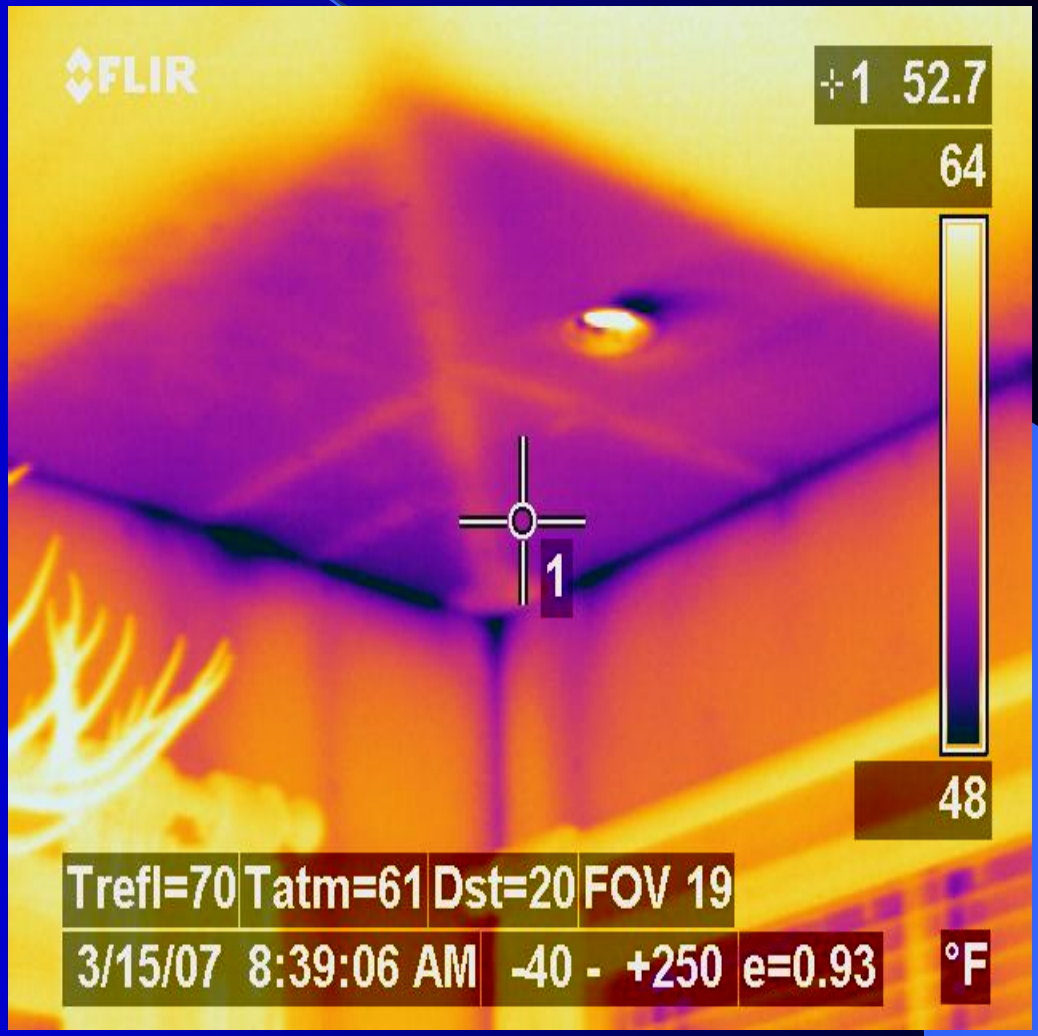
Missing wall Insulation

- The blue area is a cold wall surface.
- The heat is migrating to the cold surface.



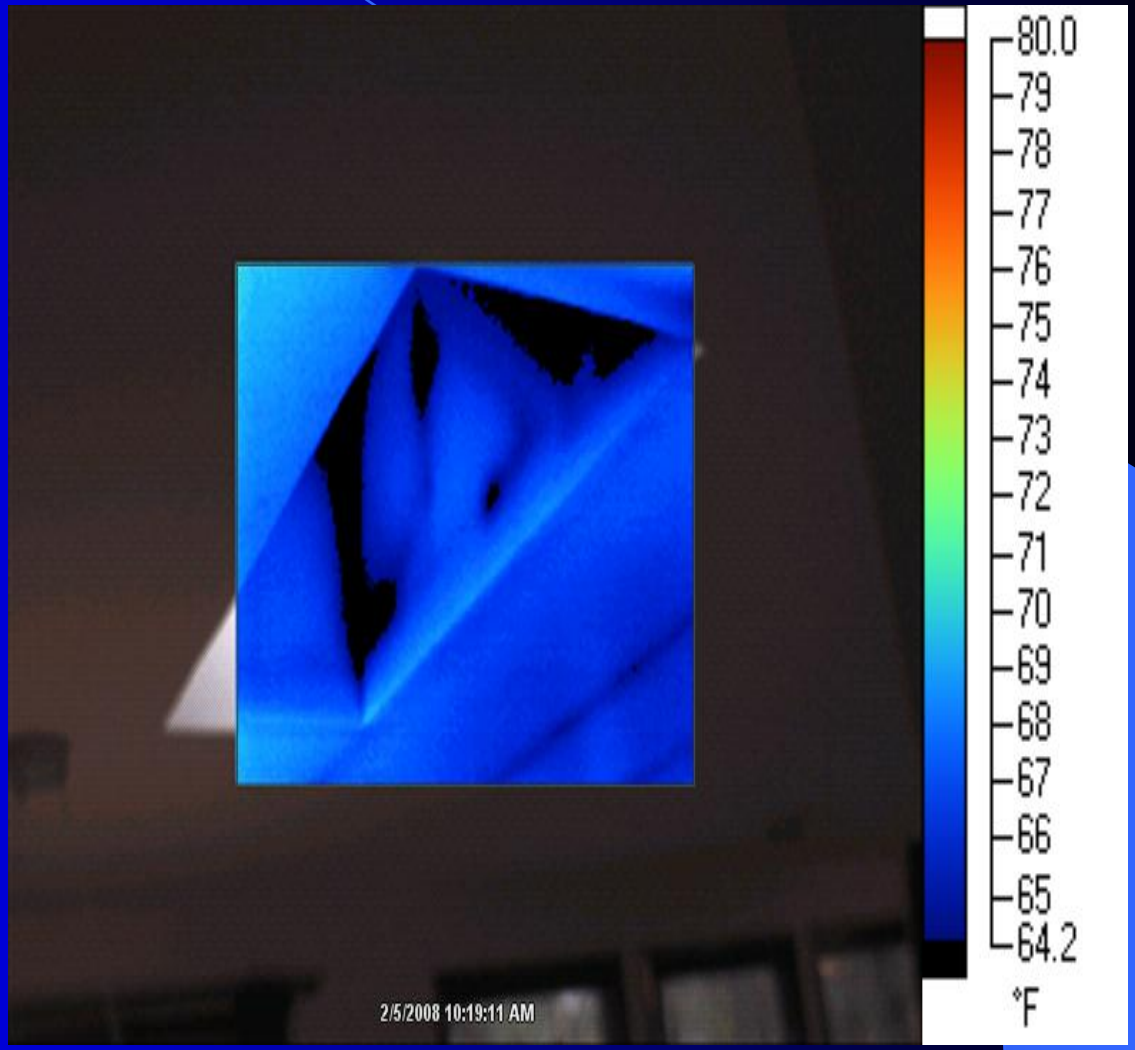
No ceiling insulation

- New house.
- No insulation in the dining room ceiling.



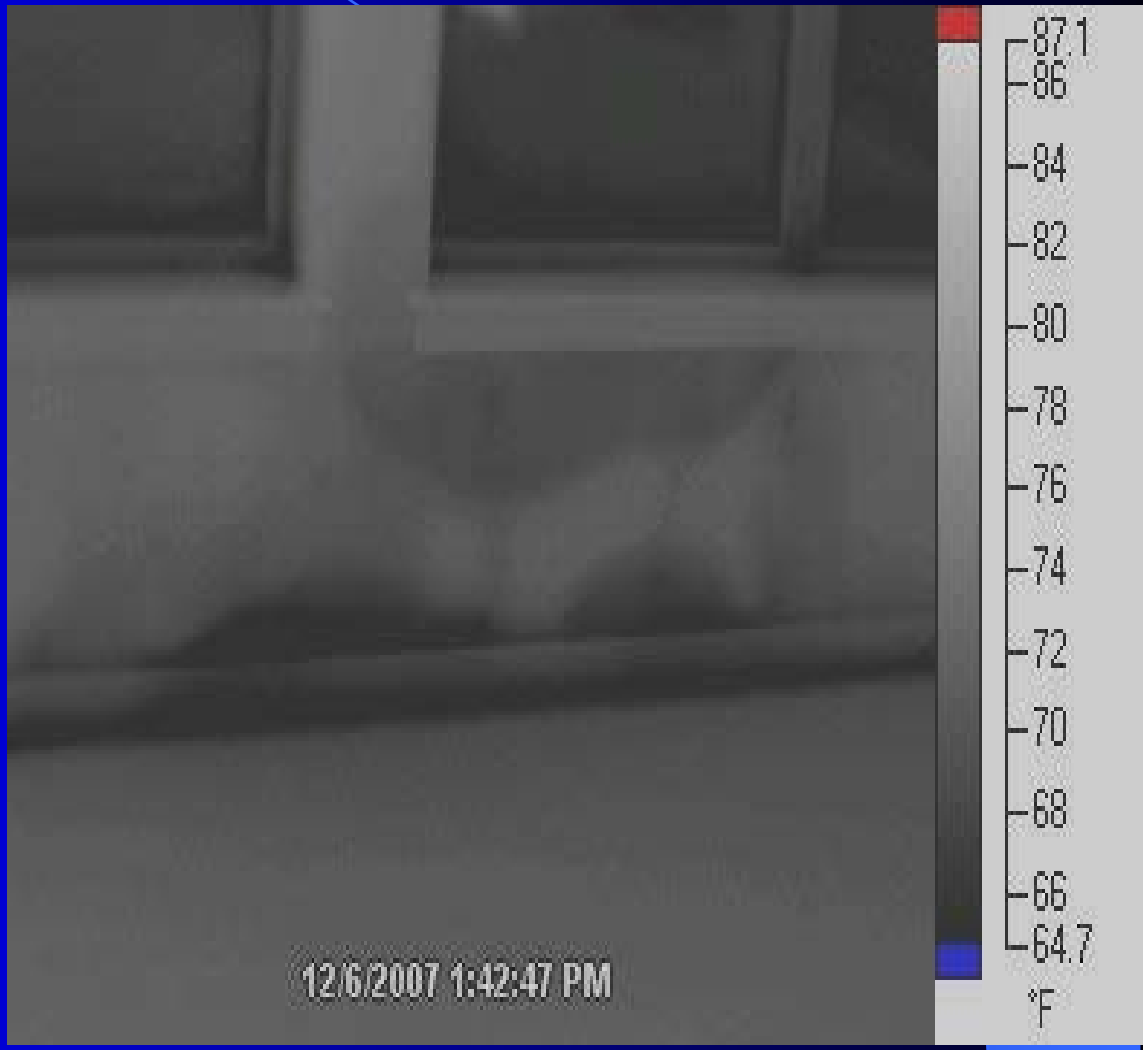
Missing insulation

- Missing insulation in skylight well.
- The black areas are missing insulation.



Wet wall Insulation

- Two year old home
- Wet insulation does not provide a thermal barrier.



Slipping Insulation

Heat ducts leak as much as 30% of the conditioned air into the attic or the crawlspace.

The sealing of residential ducts is not required by building code.

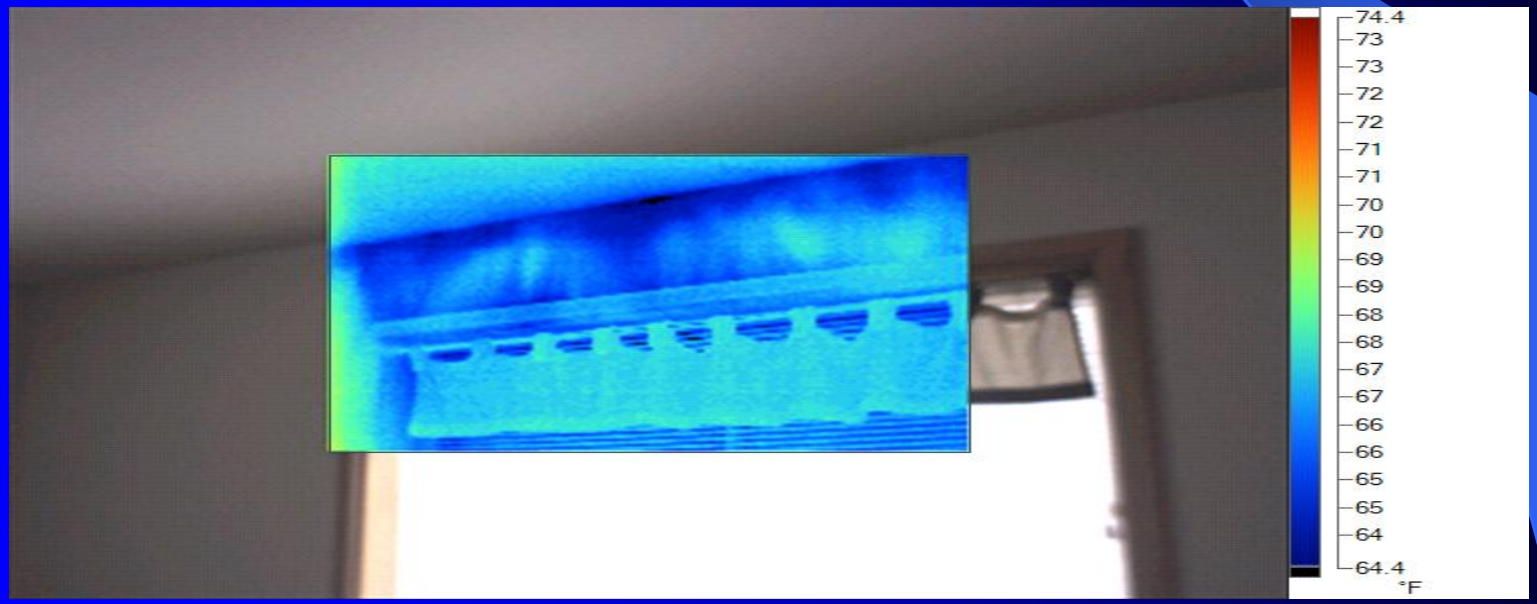
Leaking Heat duct

Air intrusion (drafts) within a home accounts for 40% of heating costs.

Where do they come from?

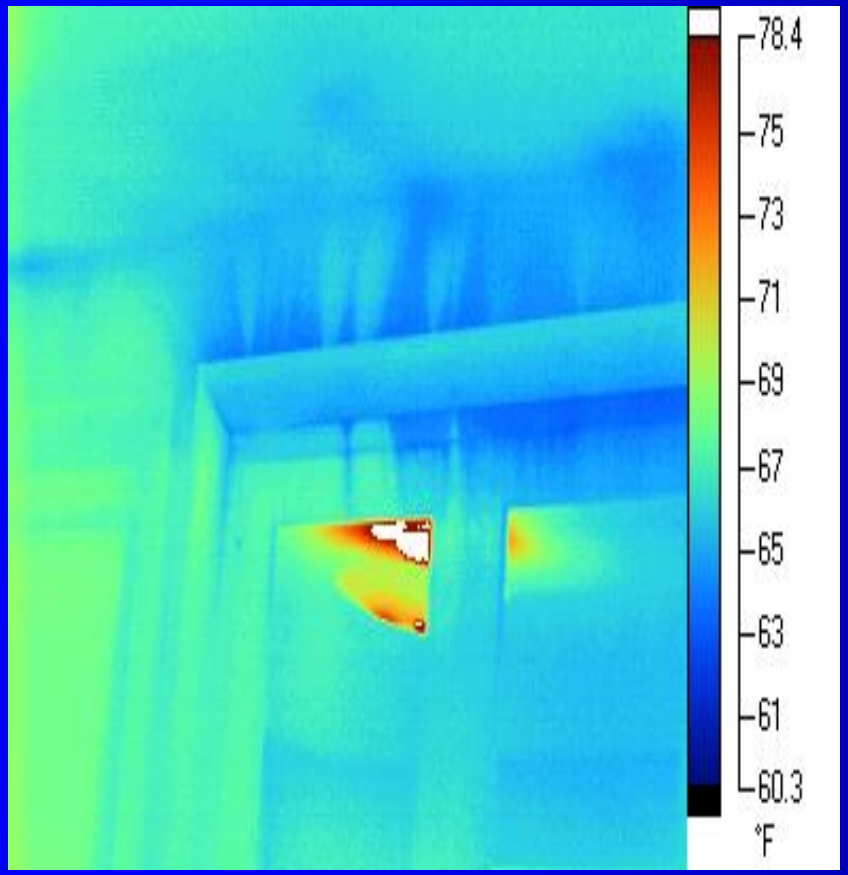
Air Leaks Under Bath Tub

Air leaks around a NEW window

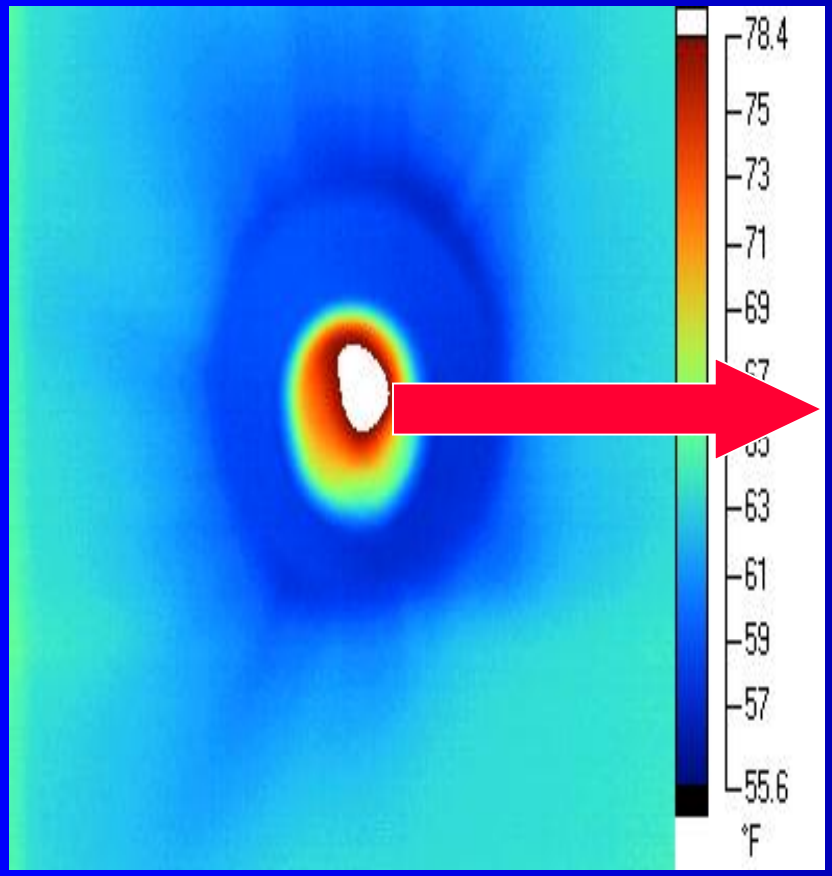


Air Leak Past Water Pipes

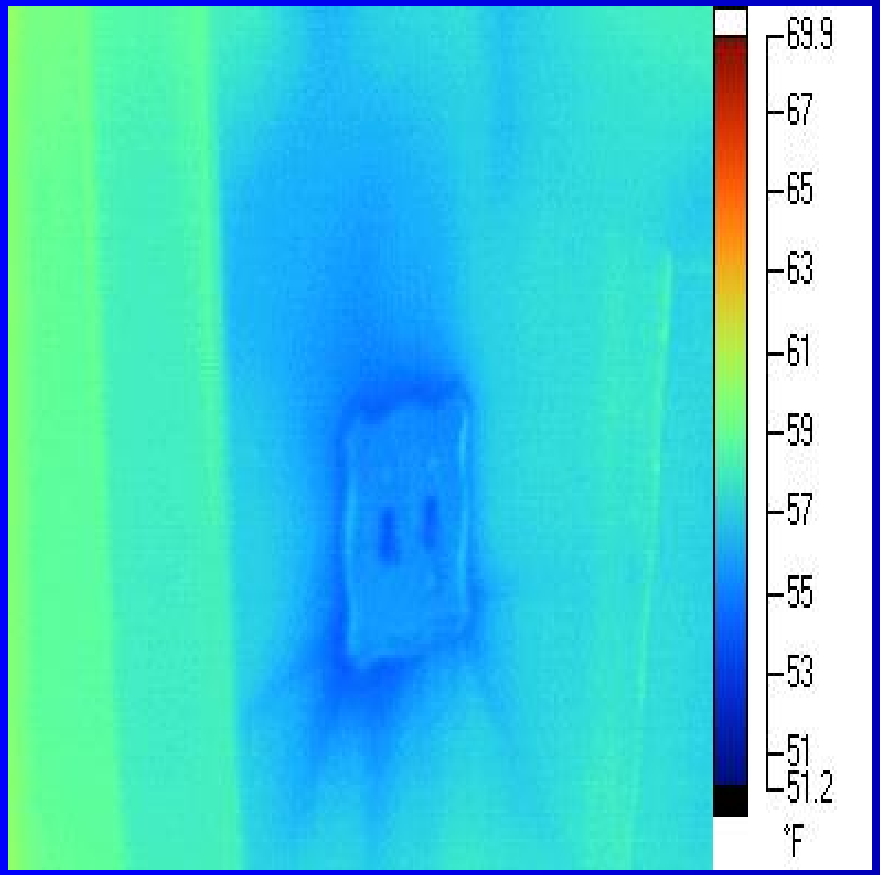
Air Leaks Around A Door



Air leaks Around A Can Light



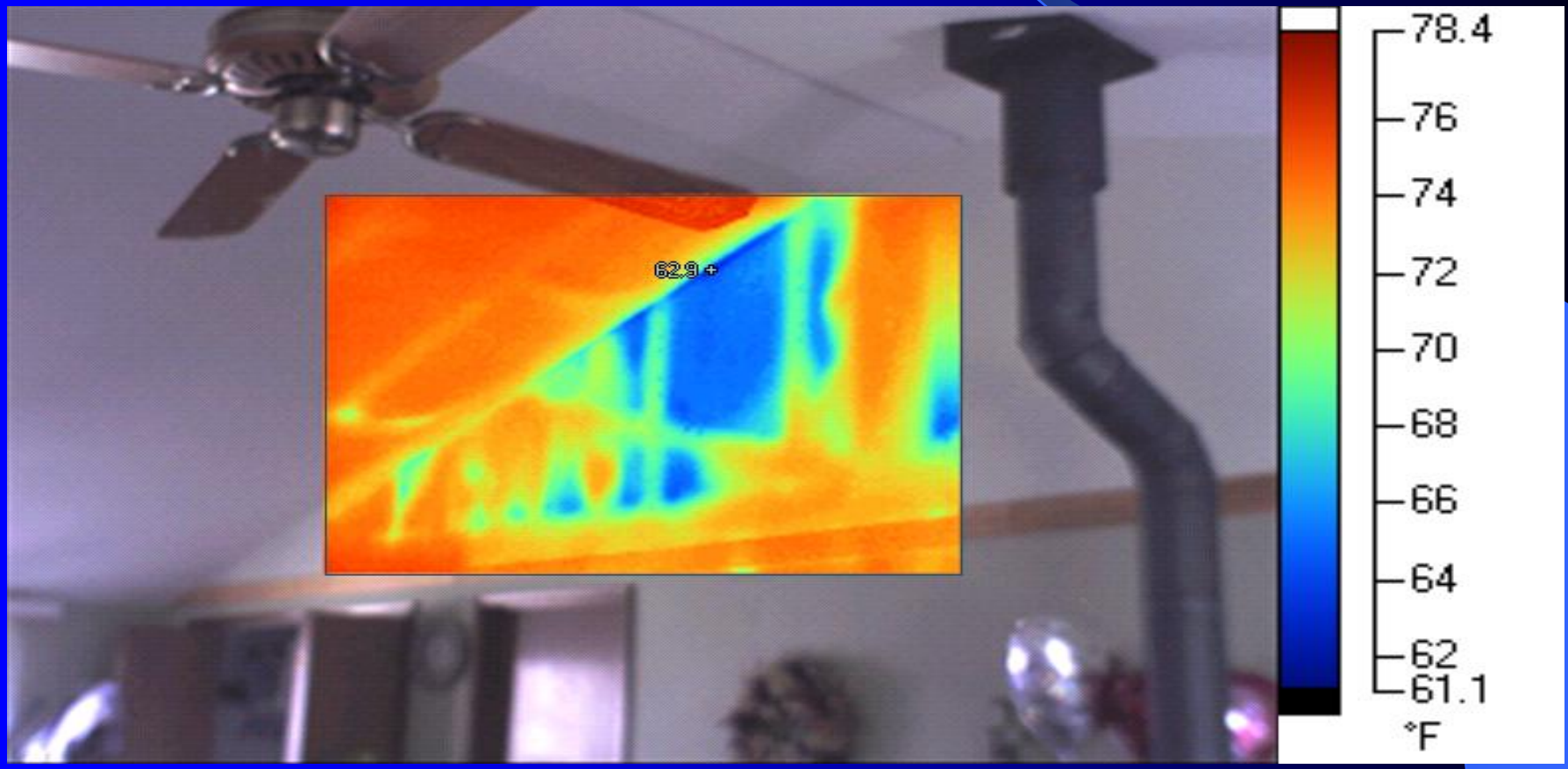
Air Leaks Around Electrical



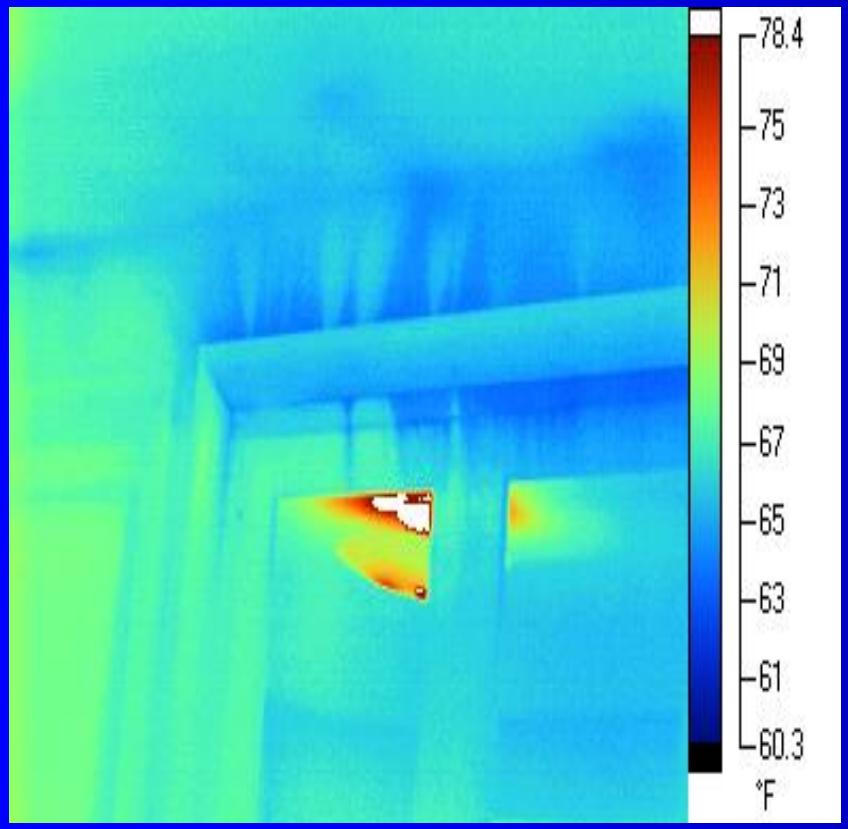
?

- Ask yourself the following questions, before going into debt to cut your heat loss.

WILL NEW SIDING REPAIR THIS DAMAGED INSULATION



Will windows for $20,000 stop cold air form going around the doors?



Will a new heating system repair a hole in the floor?

Solution

DIAGNOSE BEFORE SURGERY

Stop the leaks

and

don’t blame your heater.

Thank You
Brent Foster

Presentation Highlights: Northwest Infrared

- **"Diagnose before surgery":** Homeowners can't always easily identify the root cause of energy loss. Don't replace the furnace if the problem is the building envelope. Thermal imaging can help contractors identify and address the root of heating and cooling issues in a home.
- **IR is just a tool in the toolbox:** IR finds anomalies that need to be verified visually, mechanically or electronically as well.
- **IR is a sales tool: It helps building auditors perform home inspections in minimal time with a high degree of diagnostic accuracy.** IR enables contractors to visually explain homeowners the energy upgrades needed in their homes in a simple way that often inspires follow-through.
- **Using IR images does not mean that contractors will be able to estimate energy savings from upgrades.** Contractors cannot control changes in occupant behavior and other facts that could impact energy savings that result from upgrades. For example, a recently upgraded community housing unit saw higher energy use due to an increase in the number of tenants living in that unit.

Discussion Highlights: What are the gaps in knowledge for this topic that, if filled, would help improve work in this area?

- **Training on proper use of thermal imaging is critical:** Knowing the fundamentals of IR technology is essential, including how it works, factors that will impact image quality, and how to interpret the results.

- **For use in energy audits, IR training should focus specifically on how to recognize issues during home inspections.** For example, air infiltration may sometimes be hard to detect by an untrained eye.

Upcoming Seasonal Messaging Opportunities

Now is the time to start planning energy efficiency messaging!

Dec 31 – Jan 1	January 6	January 10
New Year	National Technology Day	National Cut Your Energy Costs Day

U.S. Department of Energy
[Article: Home Energy Audits Can Help You Keep That New Year's Resolution]

City of Columbia, Missouri
[Facebook Post]

Addenda: Attendee Information and Poll Results

U.S. DEPARTMENT OF ENERGY

Call Attendee Locations

Call Attendees: Network Members

- ABC Energy Savings, LLC
- Boulder County
- CLEAResult
- Ecolighten Energy Solutions Ltd.
- EnergyWize
- Focus on Energy
- Home Star Iowa
- Ryan Taylor Architects, LLC
- South Burlington Energy Committee
- TRC Energy Services
- Vermont Energy Investment Corporation (VEIC)
- Center for Energy and Environment
- New York State Energy Research & Development Authority (NYSERDA)
- Redevelopment Authority Of The County Of Fayette, Pennsylvania

Call Attendees: Non-Members (1 of 3)

- Alliant Energy
- Annadel Building Solutions
- Baldwin Homes
- Brendle Group
- Building Performance Raters llc.
- Building, Mind and Body, LLC
- California Public Utilities Commission
- Community Housing Partners Corporation
- D+R International, Ltd.
- Delaware Department of Natural Resources and Environmental Control
- Dimension Energétique
- EA Dynamics
- Energy Efficiency Specialist Blogspot
- FirstService Residential
- FLIR Systems, Inc.
- Green Compass Sustainability
- Greenbanc
- Home Office Training & Technology

Call Attendees: Non-Members (2 of 3)

- Home Ventilating Institute
- ICF
- Idaho Power Company
- Indow
- Insight Property Services, Inc.
- Johnson Controls
- Lawrence Berkeley National Laboratory
- Lockheed Martin
- Lutron Electronics Company
- MassHousing
- Mercy Housing Management Group
- Montana Department of Environmental Quality
- Nexant
- Northwest Infrared
- Orangeman Energy Services
- Oregon Institute of Technology
- Patriot Efficiency
- PEG LLC
- People's Self Help Housing
- Phoenix Home Performance, LLC
- Port Townsend Community Center

Call Attendees: Non-Members (3 of 3)

- Proctor Engineering
- R Family Company LLC
- Seattle City Light
- Snohomish County
- South-central Partnership for Energy Efficiency as a Resource (SPEER)
- Southwest Energy Efficiency Project
- StopWaste
- U.S. Energy Information Administration (EIA)
- Utah Governor's Office of Energy Development

Opening Poll #1

- Which best describes your organization's experience with infrared (IR) technologies for energy efficiency?
  - Some experience/familiarity – ***47%***
  - Limited experience/familiarity – ***23%***
  - Very experienced/familiar – ***17%***
  - No experience/familiarity – ***13%***
  - Not applicable – ***0%***

Closing Poll

- After today's call, what will you do?
  - Seek out additional information on one or more of the ideas – ***56%***
  - Consider implementing one or more of the ideas discussed – ***28%***
  - Make no changes to your current approach – ***16%***
  - Other (please explain) – ***0%***