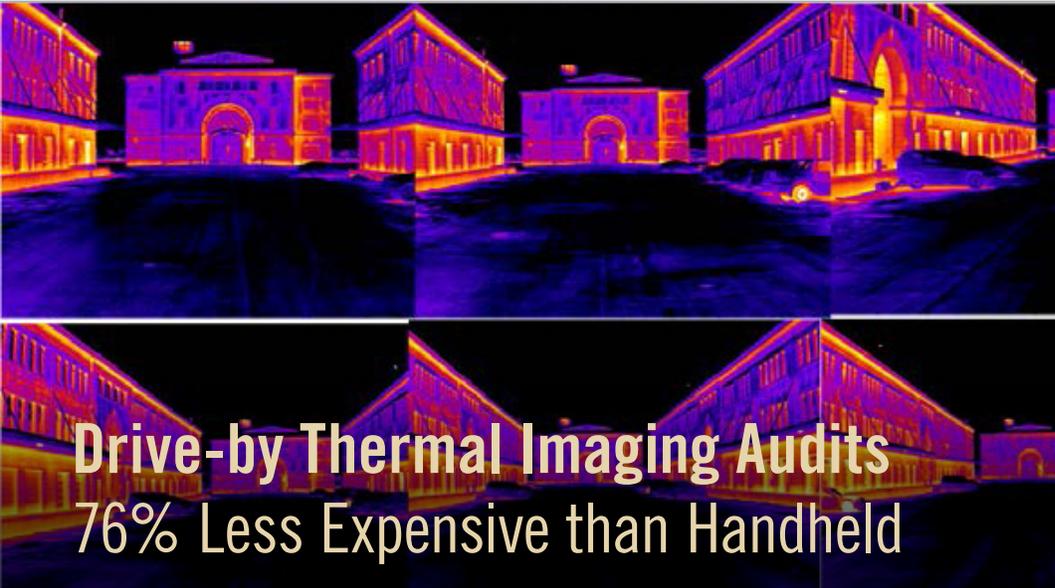


# Kinetic Super-Resolution Thermography Diagnostic



The U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL), in partnership with Essess Inc., collected thermal data from more than 250 buildings at two demonstration sites: Camp Lejeune, North Carolina, and Scott Air Force Base (AFB) in Illinois.

## ► SENSORS ATTACH TO ROOF OF CUSTOMIZED VEHICLE

Kinetic super-resolution long-wave infrared (KSR LWIR) thermography rapidly scans hundreds of buildings in a short period of time, using sensors attached to the roof of a customized vehicle.

## ► RAPIDLY ASSESSED BUILDING INVENTORY

At Scott AFB, the drive-by process scanned 278 buildings in just under four hours; an individual using a handheld device would have taken almost three weeks to complete this same scan. Data from the KSR LWIR scan is automatically analyzed to show how much energy is leaking out of the building envelope. The drive-by audit cost \$200,000 per installation, more than 76% less expensive than a traditional handheld infrared audit, which would have cost \$840,000 at Camp Lejeune and \$920,000 at Scott AFB.



## Technologies Tested

### KSR LWIR THERMOGRAPHY

- Multi-sensor roof-mounted rigs scan 100 buildings per hour, calculating building feature temperature and material emissivity.
- System includes multi-spectral IR imaging system, automated building detection capability, onboard data capture, and diagnostics system.
- Multiple data streams recorded simultaneously: LWIR thermal video, near infrared (NIR) video, light detection and ranging (LIDAR), three-dimensional (3-D) point cloud mapping data, Global Positioning System (GPS) vehicle location data, air and ground surface temperature data.
- Video cameras capture 640 x 512 pixels, with a 45°-x-37° field of view (FOV); resolution is 15 times higher than a handheld system.
- System rapidly analyzes and prioritizes multiple buildings for energy conservation measures (ECMs).
- System does not rely on camera operator's capture or analysis skills.

### Best suited to:

- Scanning at least 1 million ft<sup>2</sup> of building inventory.
- Evaluation of building repair, renovation and replacement projects as well as energy performance and compliance.
- Most cost-effective for ASHRAE climate zones 3 and higher.

### Limitations:

- Scans only 2 or 3 sides of a building.
- Indoor and outdoor temperatures must have 20° differential to scan.
- Data capture is hindered by visual obstructions—fences, trees, etc.

## ABOUT ESTCP

The Environmental Security Technology Certification Program (ESTCP) is the U.S. Department of Defense's environmental technology demonstration and validation program. The program's goal is to identify and assess innovative technologies that address DoD's high-priority environmental requirements efficiently and cost-effectively.



## Demonstration Sites: Camp Lejeune and Scott AFB

More than 250 large buildings typical of DoD installations were scanned at U.S. Marine Corps Base Camp Lejeune, NC, in ASHRAE climate zone 3 and Scott Air Force Base (AFB), IL, in ASHRAE climate zone 4. A detailed analysis was prepared for 30 buildings at each site. The KSR LWIR device gathered data on more than 2,500 distinct building features (windows, doors, soffits, etc.) at Camp Lejeune and 3,000 at Scott AFB. Infrared imagery data were merged with LIDAR data, GIS data, and GPS data, and then analyzed by Essess, Inc. to determine energy loss due to inefficient building envelopes. To compare processes, six buildings on each site were scanned with a forward-looking infrared radiometer (FLIR) i7 handheld thermal camera.

### INSTALLED COSTS\*

KSR LWIR cost is for hardware customization and logistics software optimization. It does not include equipment costs. It is independent of installation size and is cost effective only when scanning a minimum of 1 million ft<sup>2</sup> of building inventory.

Hardware Customization	\$51,861
Data Capture	\$81,567
Analysis	\$50,744
<b>TOTAL</b>	<b>\$184,172</b>

\*Cost information is for reference only. Individual sites should do due diligence to determine local costs.

Hand-held thermography averages \$0.20 ft<sup>2</sup>.

### POTENTIAL

- Developed to scan a large number of buildings and generate a prioritized list of ECMs.
- Energy leaks identified using this technology can be analyzed and prioritized for the most effective use of O&M resources.

### ADDITIONAL MILITARY DEPLOYMENTS

- Fort Drum, NY.
- U.S. Military Academy, West Point, NY.

## Additional Resources

### ► EW-201241 FINAL REPORTS AND TECHNOLOGY TRANSFER TOOLS

<https://serdp-estcp.org/Program-Areas/Energy-and-Water/Energy/Conservation-and-Efficiency/EW-201241>

### ► TECHNOLOGY USED AT DEMONSTRATION SITE

KSR LWIR Thermography, [www.essess.com](http://www.essess.com).

NOTE: Before incorporating new technology, refer to Unified Facilities Criteria (UFCs) and other appropriate guidance to ensure compliance with current requirements. <https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc>

## Demonstration Results

### ENERGY SAVINGS

- ECMs for 30 Camp Lejeune buildings identified \$100,000/yr in envelope-related energy savings.
- ECMs for 30 Scott AFB buildings identified \$300,000/yr in envelope-related energy savings.

### OPERATIONS

- Comparison with handheld process showed KSR LWIR street-side building scans are representative of other sides and provide adequate information for planning purposes.
- Personnel must provide installation GIS and energy data for analysis.

### SECURITY

- Data is uploaded to Amazon Web Services. Each installation should determine whether AWS is secure enough given their security needs and cybersecurity directives.

### USER SATISFACTION

- No disruption of building occupants

### COST-EFFECTIVENESS

- Drive-by costs to scan, analyze, and report \$200,000 each for Camp Lejeune (4.2M ft<sup>2</sup>) and Scott AFB (4.6M ft<sup>2</sup>); hand-held costs \$920,000 and \$840,000, respectively.
- Cost is less than handheld methods when scanning 1M+ ft<sup>2</sup> of building space, with simple payback in 10 years.
- Recommended ECM measures potentially save Camp Lejeune \$1.7M with investment less than 1M, and 9-year payback.
- Recommended ECM measures potentially save Scott AFB over \$4M with investment of 2M and 7-year payback.