Evaluating Sealed Attics for ZNE Homes

Jonathan Slack, Residential Building Systems
Lawrence Berkeley National Laboratory

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photo by Roy Kaltschmidt

Project Overview

- ZNE homes support AB32's GHG reduction goals
- Technical background to support changes to Title 24 and make ZNE easier for production builders
- Moving ducts into conditioned space at lower cost
- Project Team: LBNL, De Young Properties, and Johns Manville

Sealed Attic Innovation

Batt insulation vs. spray foam:

- Spray foam roof deck sealing effective, but expensive and therefore a barrier to adoption. Spray foam concerns include sensitivity to "good" installation and off-gassing of chemicals.
- Can batt insulation produce similar energy savings at significantly lower cost?
- Measure moisture dynamics in attic; is there a threat to roof deck or attic framing?

Benefits of moving HVAC into conditioned space:

- Significant energy savings; 10-15% in new construction, 25 – 50% in retrofits.
- Residential peak load reduction supports grid reliability.
- Occupant comfort with rapid cool down

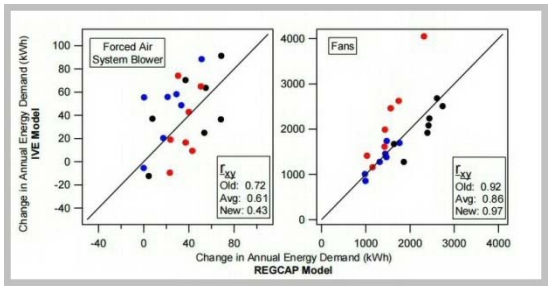
Technical Tasks

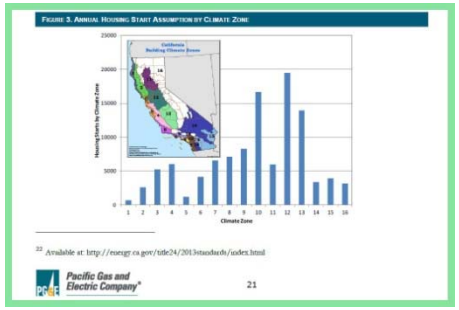
Field monitoring the homes of the future

- Fresno home to exceed Title 24 by 30%
- Clovis home to be Zero Net Energy
- 122 monitored points in each house
  - temp, RH, SC, WMC, heat flux, HVAC power, solar irradiance, wind, weather

Simulation of Attic and HVAC system performance

- Determine optimal specifications for all 16 CA climate zones
  - Roof deck insulation, air tightness, roofing materials, thermal mass
- Refine REGCAP simulations using field data



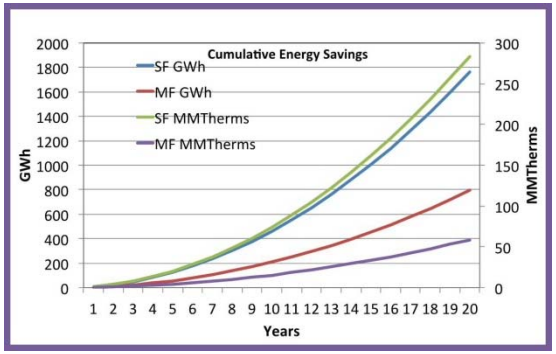


Literature review

- Compilation of existing literature exploring alternative attic construction
- Summarize performance, construction specs, cost estimates, etc.
- Analyze as guide to simulation and field study tasks

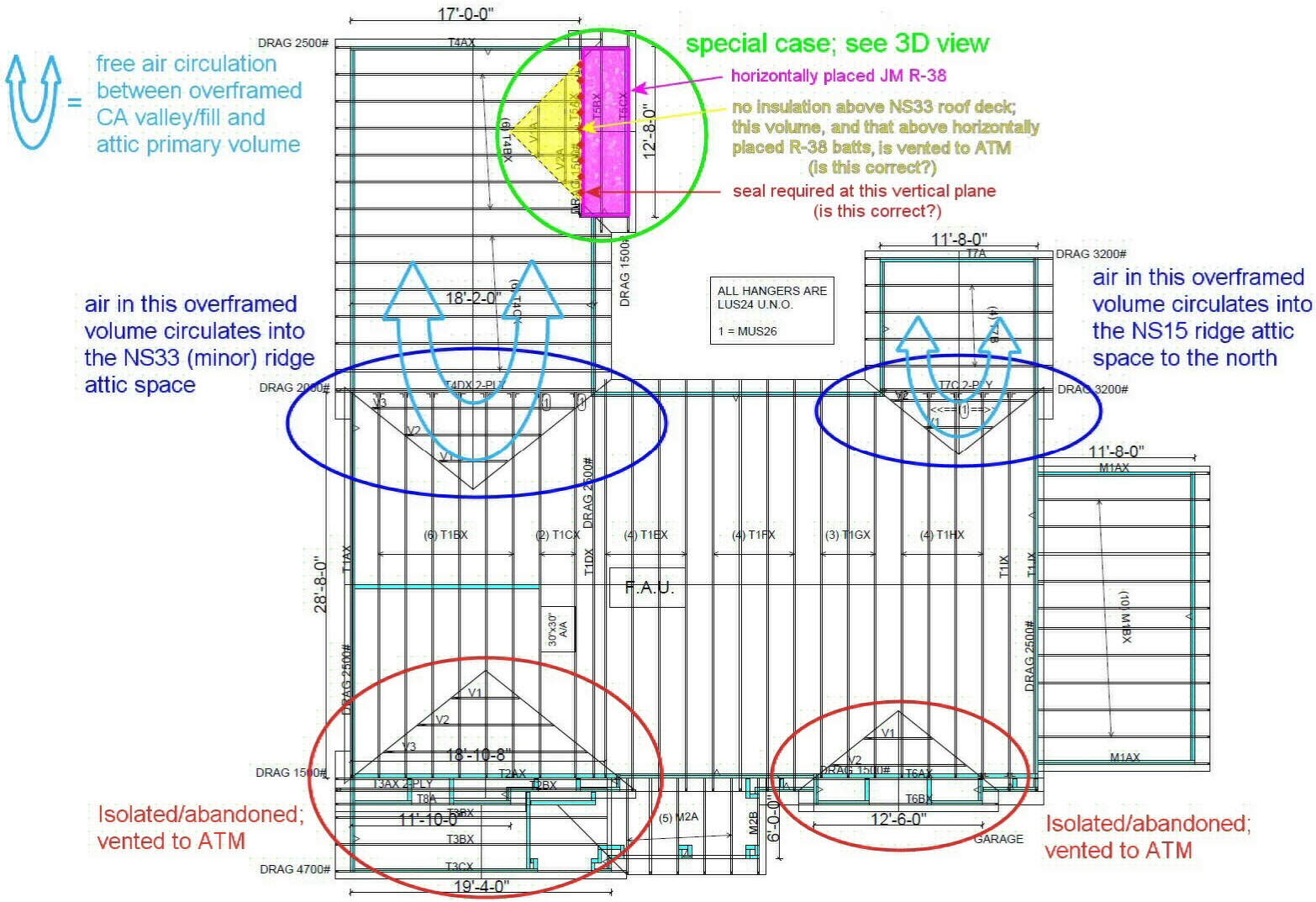
Evaluation of project benefits

- New construction: Drop HERS score from 50 to 40, help reach ZNE
  - 8.2 GWh/yr, 1.35 MMtherms/yr, $40 M cumulatively by 2025, 15 yr payback
- Retrofit potential: 30%$^{+}$ savings, 373K homes/yr, jobs program
  - 1,500 GWh/yr, 320 MMtherms/yr, $530 M/yr, 5% drop in residential peak



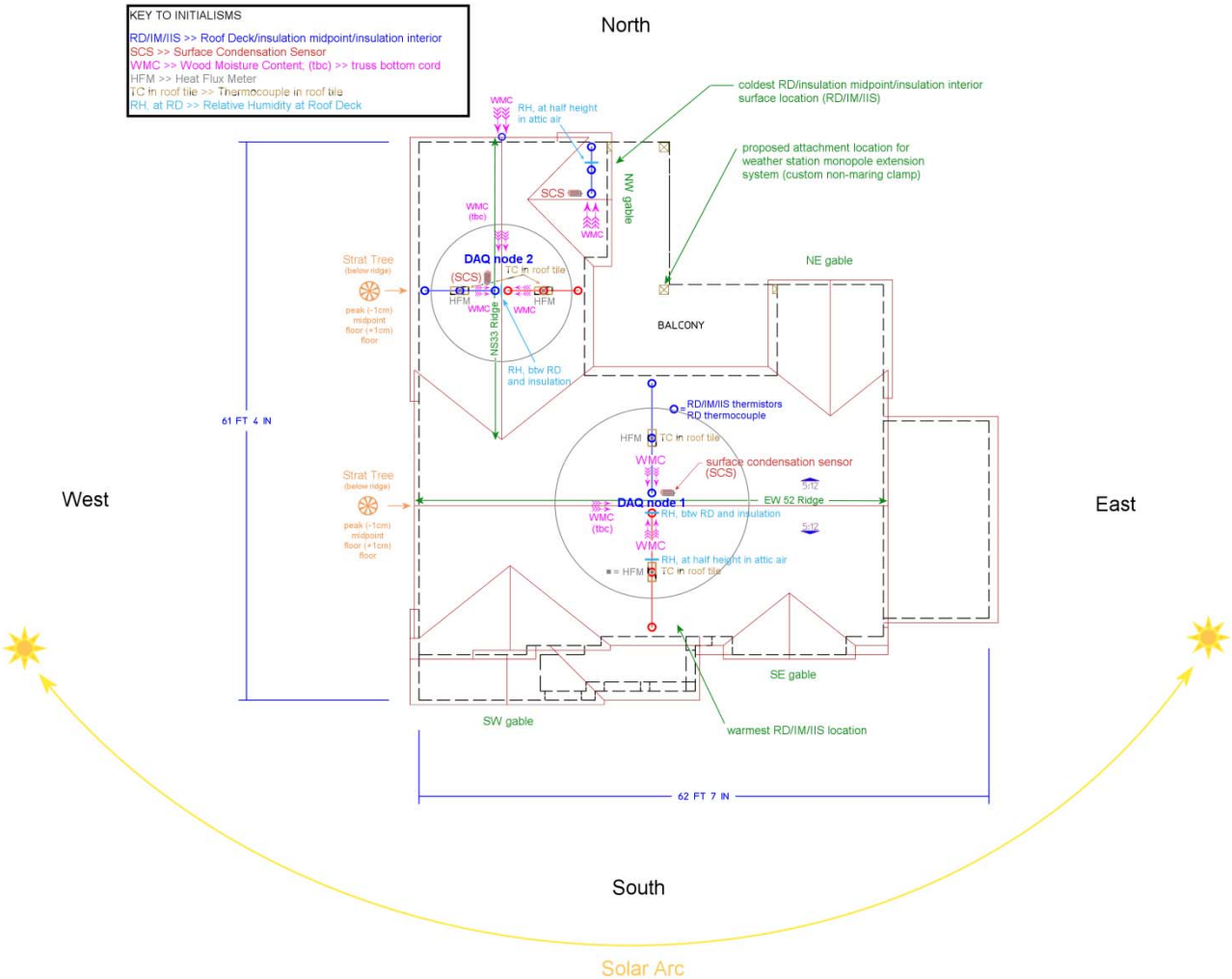
Field Testing: Sensors and Data Acquisition

Evaluate roof/attic design, solar path, vulnerable locations, air circulation…



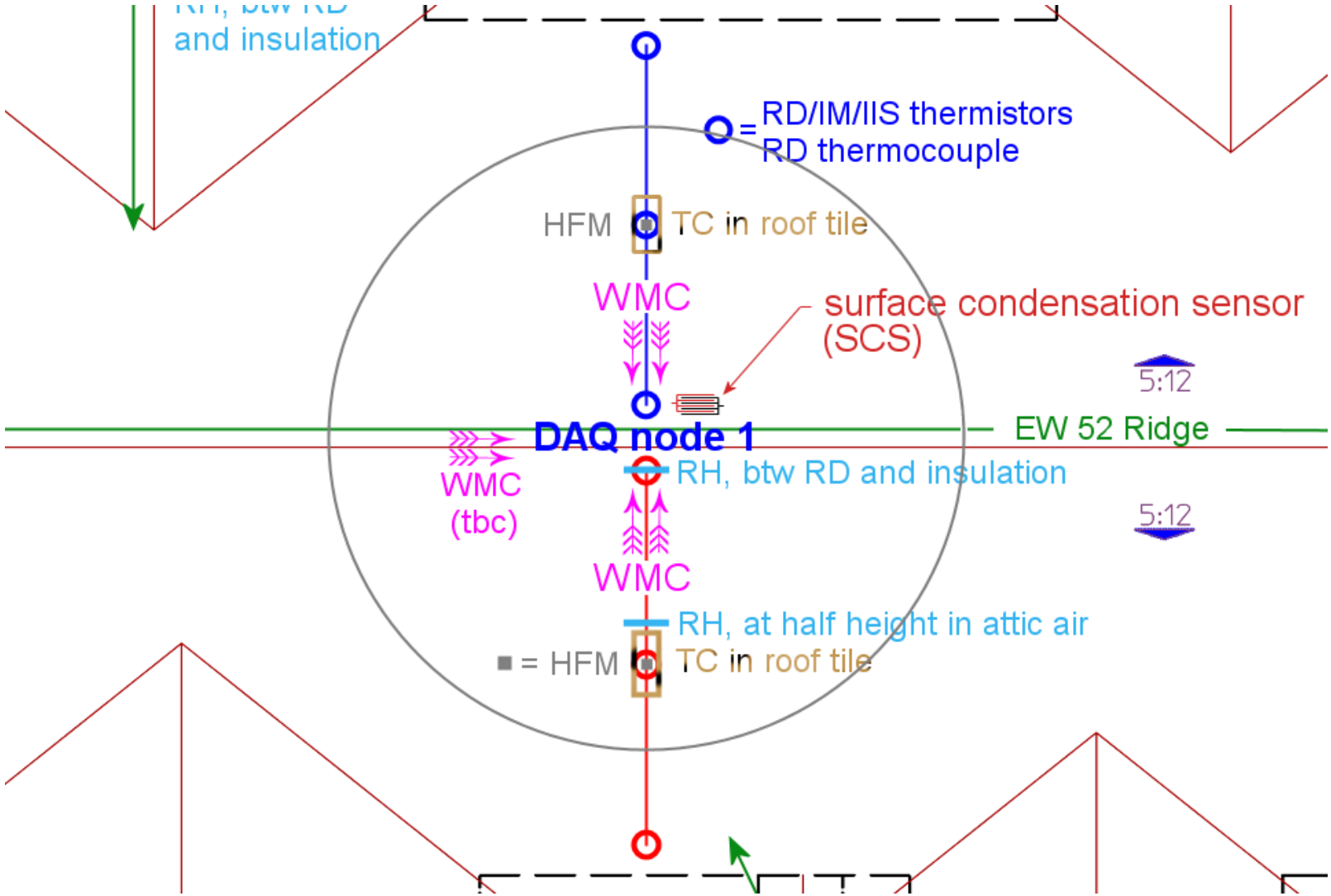
Field Testing: Sensors and Data Acquisition

Map out strategic sensor distribution and positioning…



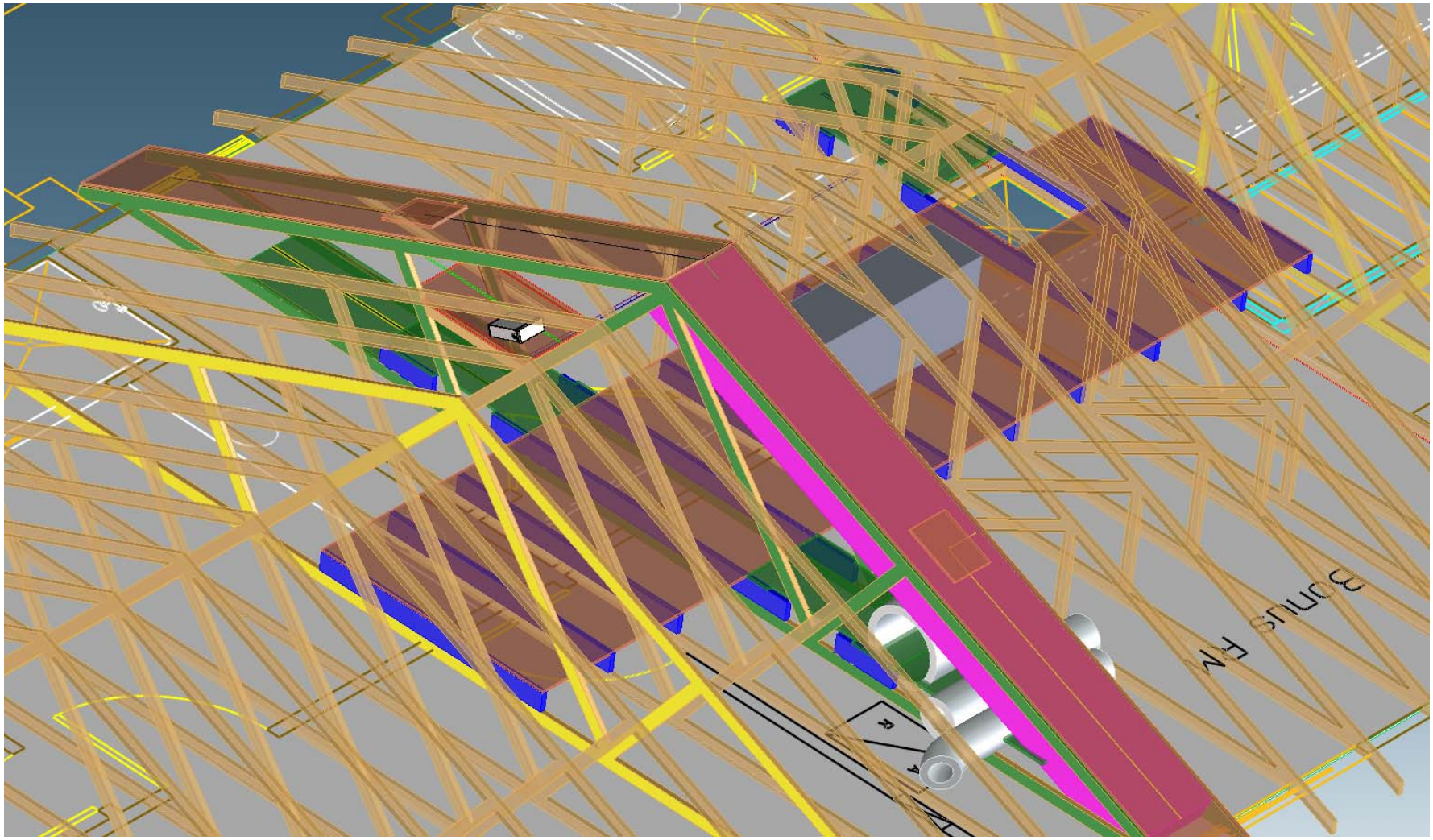
Field Testing: Sensors and Data Acquisition

Select and/or design sensors and plan out integration methods…



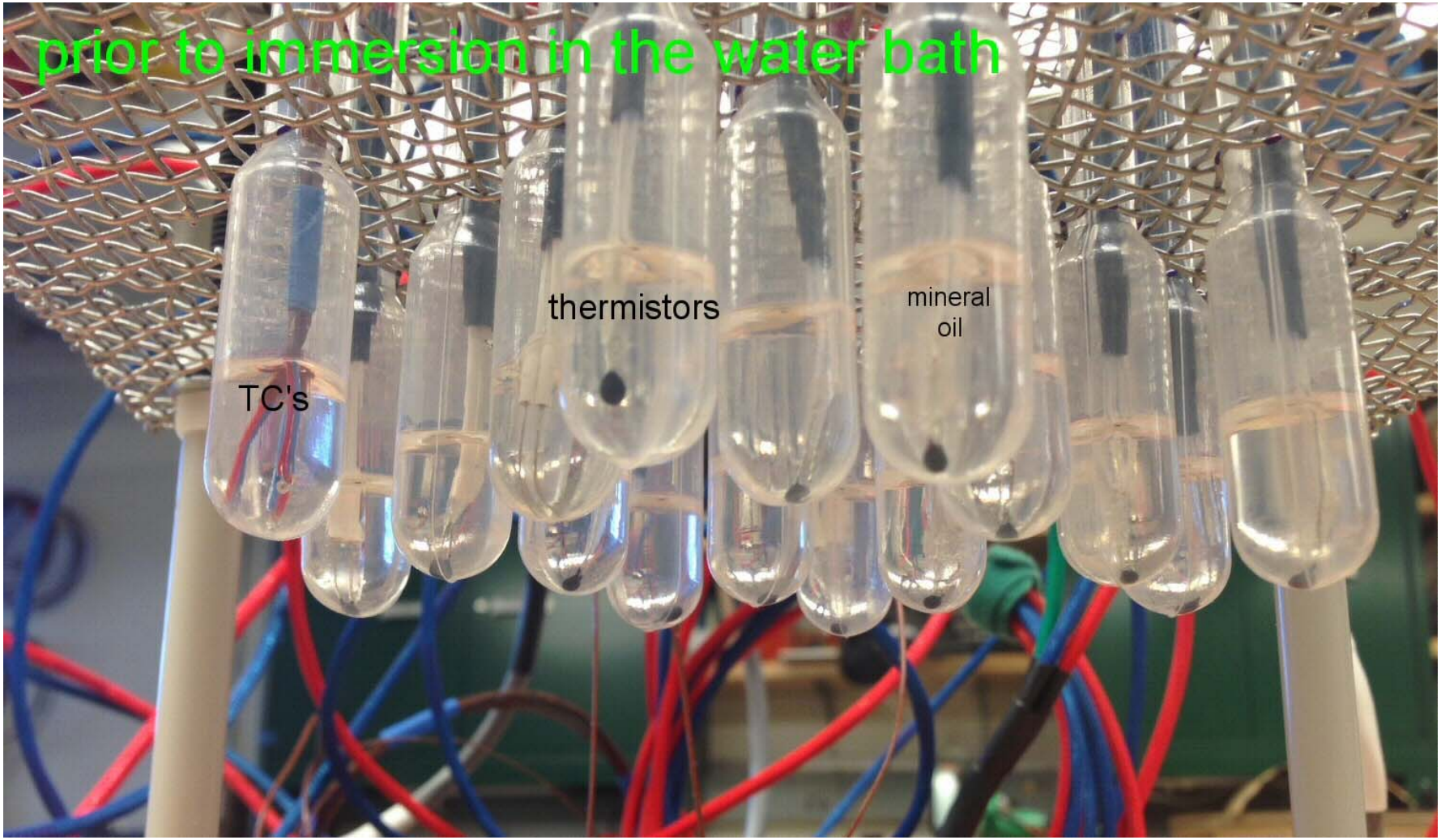
Field Testing: Sensors and Data Acquisition

Model space, identify possible conflicts, duct runs, wiring options…



Field Testing: Sensors and Data Acquisition

Calibrate thermistors and thermocouples individually…

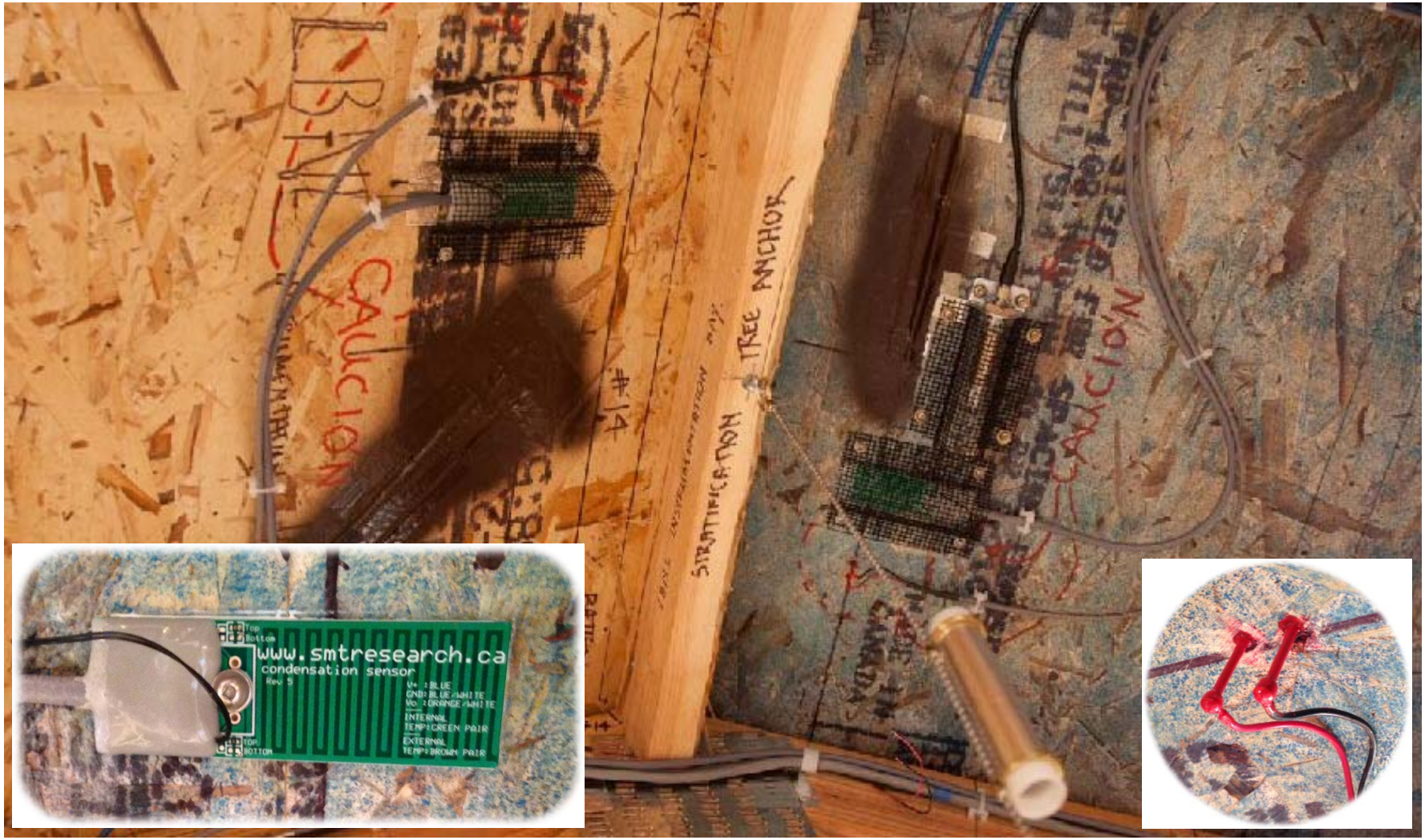


Field Testing: Sensors and Data Acquisition

Sensor installation … Hukseflux HFS

Field Testing: Sensors and Data Acquisition

Sensor installation … SCS, WMC, RH, Therm, TC, Strat tree



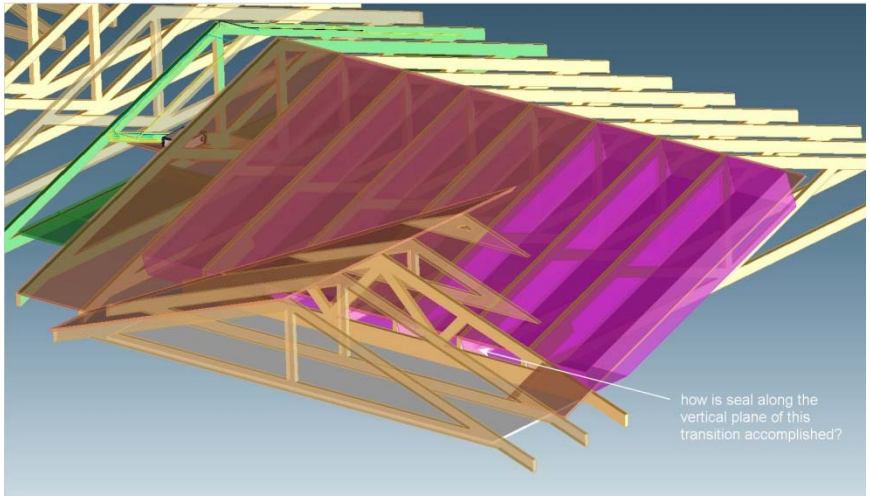
Field Testing: Sensors and Data Acquisition

Sensor installation … roof tiles thermally monitored at surface and underside

IRC Requirements (Table R806.4):

- In inland CA climates – no exterior roof deck insulation required if a tile roof is used
- May need this extra insulation in other location for non-tile roofs

Predicted and Discovered Challenges



CAD modeling helps predict:

- How to handle complex gable structures
- Geometric sealing challenges
- HVAC and insulation interference
- DAQ node locations and sensor wiring runs
- Sensor placements, esp. relative to roof battens

Real-Time Challenges:

- Communicating modified construction to subcontractors and their teams
- Engagement of subcontractors with objectives
- Need to check that work has been completed as intended
- Time with code officials to explain adaptations and seek their buy-in

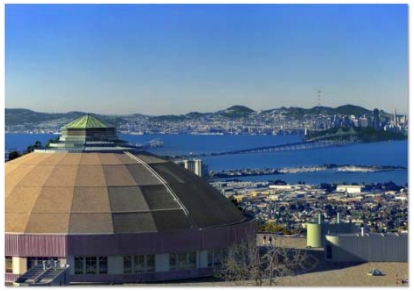
Project Team

Iain Walker
Ronnen Levinson
Jonathan Slack
Brennan Less
Anna Liao
Stephen Czarnecki
Woody Delp
Darryl Dickerhoff

Brandon De Young

Broken Drum Insulation
DuctTesters
BIRA Energy

Francis (JR) Babineau

Elam Leed

Todd Bridgeford