



The Parker Ranch installation in Hawaii

Combustion Appliance Zone Best Practices

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What is TAP?

DOE's Technical Assistance Program (TAP) supports the Energy Efficiency and Conservation Block Grant Program (EECBG), the State Energy Program (SEP) and the Better Buildings grantees by providing state, local, and tribal officials the tools and resources needed to implement successful and sustainable clean energy programs.



TAP offers:

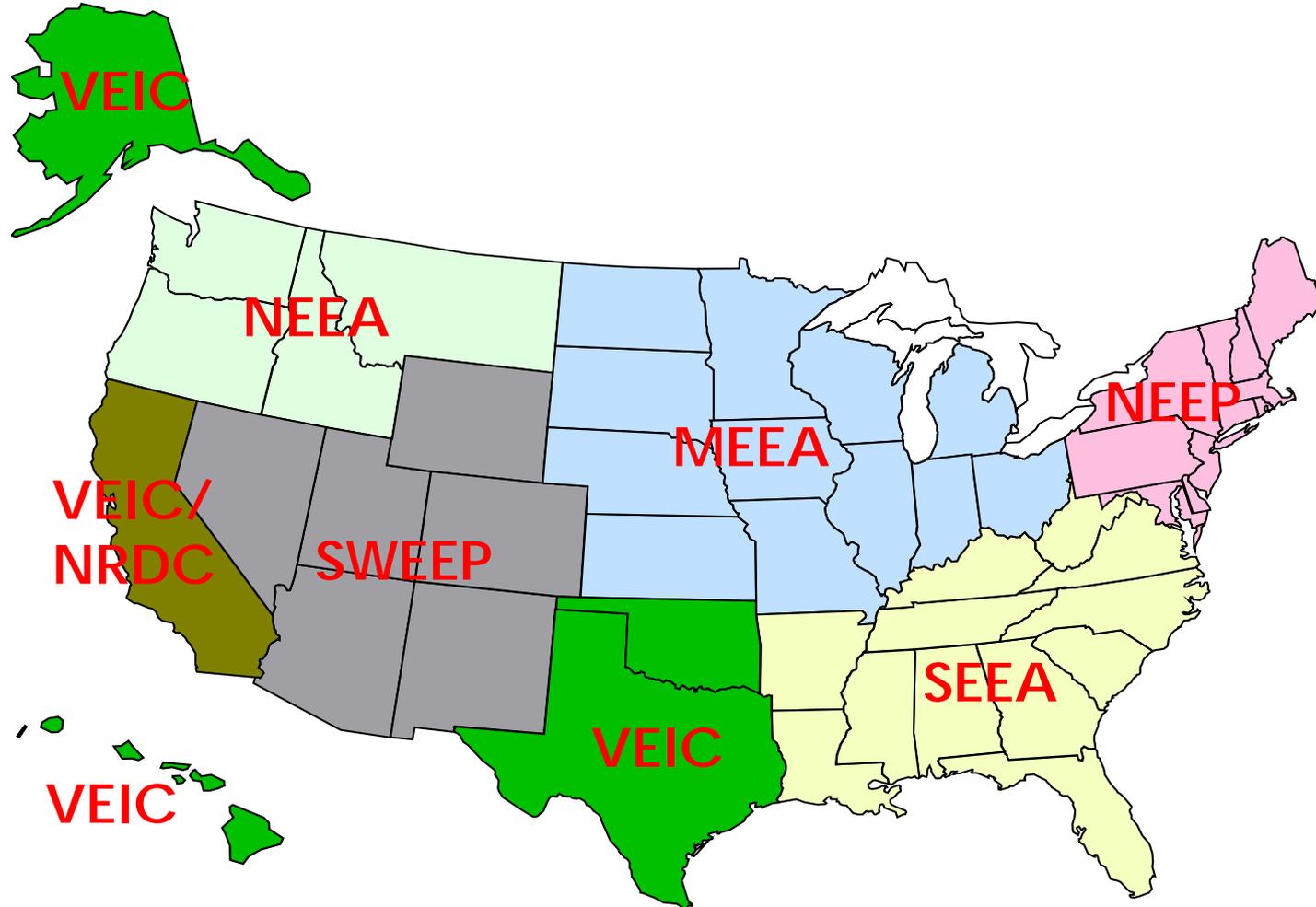
- One-on-one assistance
- Extensive online resource library, including:
 - Webinars
 - Events calendar
 - TAP Blog
 - Best practices and project resources
- Facilitation of peer exchange

On topics including:

- Energy efficiency and renewable energy technologies
- Program design and implementation
- Financing
- Performance contracting
- State and local capacity building

| | |
|--|---|
| State and Local Capacity Building | <ul style="list-style-type: none">• Trainings• Workshops• Peer-to-peer matching |
| Technical | <ul style="list-style-type: none">• Renewable energy siting and development• Review of technical specs for RFPs• Strategic planning, energy management, and conservation strategies• Green building technologies• Building codes |
| Program Design and Implementation | <ul style="list-style-type: none">• Policy and program development• Coordinating rate-payer funded dollars with ARRA projects and programs• Sustainable community and building design• State and regional EE and RE assessments and planning• EE and RE portfolio program design elements |
| Financial | Program design support and guidance on financing mechanisms such as: <ul style="list-style-type: none">• Revolving loan funds (RLFs)• Property-assessed clean energy (PACE)• Loan loss reserves and enhanced credit mechanisms |
| Performance Contracting | <ul style="list-style-type: none">• Designing and implementing a performance contract• Leveraging private investment• Reducing institutional barriers• Tracking and comparing programs |

Who We Are: Team 4



ACEEE, NRDC: National Support

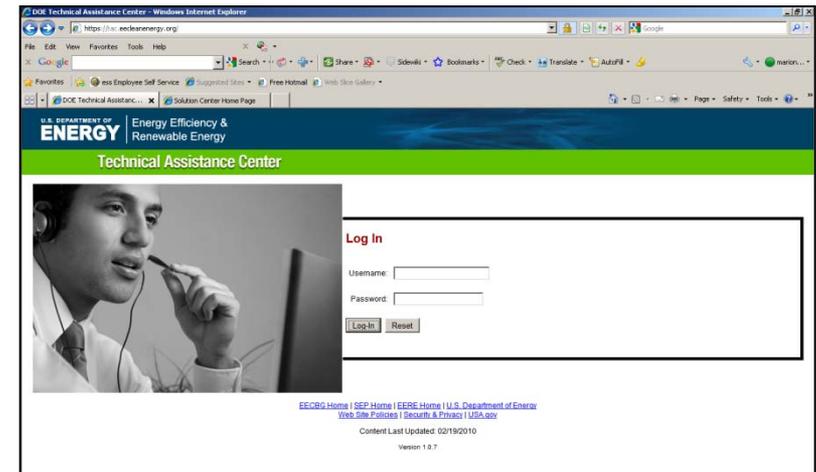


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2) Submit a request via the [Technical Assistance Center](#)



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- Questions and discussion after presentation
 - Have your questions ready
- To ask a question/make a comment
 - If you want facilitator to read your question – Type your question in “questions” box, specify speaker to address
 - If you want to speak – use “Raise hand” function and type question in “questions” box, when you are recognized you will be un-muted

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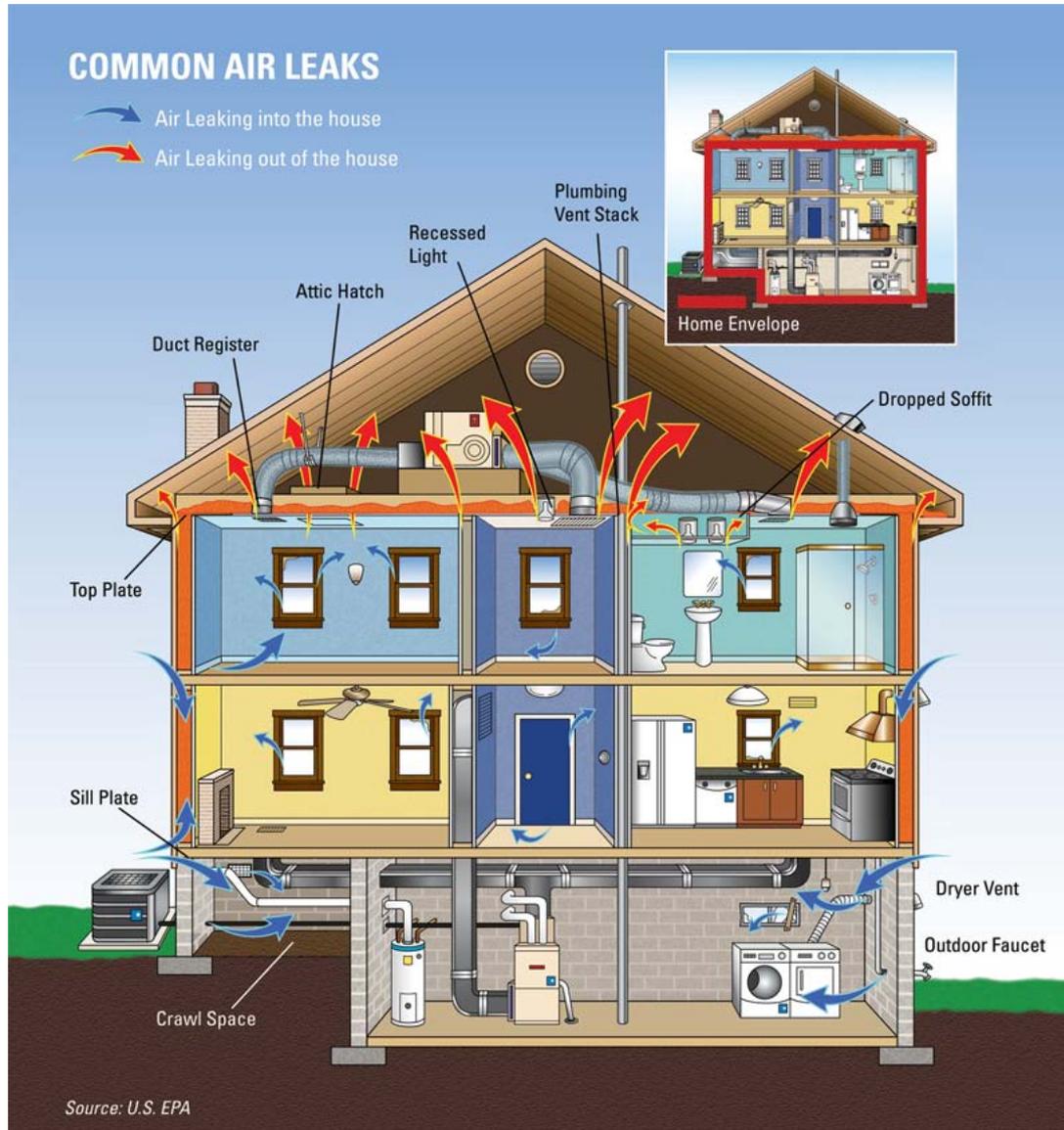


"As our new company logo, I'm not quite sure it's sending out the right message."

- Key Definitions
- What is Combustion Safety Testing and why it is important
- Tests - Carbon Monoxide, Spillage, Draft and Combustion Appliance Zone
- National Standards
- Implementing Combustion Safety Testing in programs
- Resources

- **Combustion Appliance Zone (CAZ)** - A contiguous air volume within a building that contains a combustion appliance; the zone may include, but is not limited to, a mechanical closet, mechanical room, or the main body of a house, as applicable
- **Back draft** - Spillage of combustion by-products into the home (after running the appliance for one minute). Instead of venting out through the chimney or flue, the combustion by-products spill into the home.
- **Draft** - A pressure difference that causes combustion gases or air to move through a vent connector, flue, chimney, or combustion chamber.
- **Spillage, Spill** - Combustion gases emerging from an appliance or venting system into the combustion appliance zone during burner operation.

- **Atmospheric Venting System:** Negative vent pressure that uses standard chimney to remove combustion by-products from the home.
- **Sealed Combustion Venting System:** Uses either a concentric or a two-pipe vent. (A concentric vent is one in which there is a small pipe inside a larger pipe.) One pipe is designated to bring in combustion air, and the other is designated for removal of combustion by-products out of the home. No combustion air comes from inside the home.



- By-products for combustion can be dangerous. These include:
 - Carbon Monoxide (CO)
 - Carbon Dioxide (CO₂)
 - Moisture
 - Oxides of Nitrogen (NO_x)
 - Sulfur Dioxide (SO₂)
 - Particulates
 - Water vapor

What is Combustion Safety and Testing?

- Combustion Appliance Testing: Tests combustion appliances while operating for:
 - Carbon Monoxide
 - Draft
 - Spillage
- Combustion Appliance Zone (CAZ) Testing
 - Testing pressure to determine potential of an appliance backdrafting into the home

- Ensure all combustion appliances in home are operating safely
 - Drafting properly
 - Not spilling exhaust into the CAZ
 - Not producing significant levels of carbon monoxide
- Energy efficiency improvements often have a direct impact on the building shell, which impacts the safe operation of combustion equipment.
- Routinely sealing up buildings without looking at the combustion equipment risk sooner or later will result in harming someone with flue gas.

How to do Combustion Safety Testing

- Inspect and clean heat exchanger
- Measure flue gases for CO
- Clean gas burner
- Test cook stove for CO
- Inspect water heaters
- Test the safety controls
 - Gas valve
 - High-limit switch
- Test worst-case scenarios



- For all combustion appliances, CO shall be measured at steady-state operating conditions.
- Measurements shall be taken of undiluted flue gases.
- With the exception of unvented gas or propane cooking appliances, test CO in all combustion appliances under worst-case conditions and normal draft conditions.

- Complete spillage and draft tests for all natural and induced draft space heating systems and water heaters.
- First test spillage and draft under worst-case
- Conditions and then repeated for natural conditions if the appliance fails under worst-case.
- Acceptable Appliance Spillage Periods
 - Vented appliances, regardless of type, that spill flue gases for more than 60 seconds after startup, fail the spillage test.

Combustion Safety Test Action Levels

| CO Test Result (CO measurements for undiluted flue gases at steady state) | And/ Or | Spillage and Draft Test Results | Retrofit Action |
|--|------------|---------------------------------------|--|
| 0 – 25 ppm | <i>And</i> | Passes | Proceed with work |
| 26 – 100 ppm | <i>And</i> | Passes | Recommend that the CO problem be fixed |
| 26 – 100 ppm | <i>And</i> | Fails at worst case only | Recommend a service call for the appliance and/or repairs to the home to correct the problem |
| 100 - 400 ppm | <i>Or</i> | Fails under natural conditions | Stop Work: Work may not proceed until the system is serviced and the problem is corrected |
| > 400 ppm | <i>And</i> | Passes | Stop Work: Work may not proceed until the system is serviced and the problem is corrected |
| > 400 ppm | <i>And</i> | Fails under any condition | Emergency: Shut off fuel to the appliance and have the homeowner to call for service immediately |

- Determines the largest combustion appliance zone depressurization due to the combined effects of:
 - Door position
 - Exhaust
 - Appliance operation
 - Air handler fan operation
- Measure a base pressure with all fans off and doors open
- The worst-case depressurization is the pressure difference between worst-case and the base pressure.
- Refer to BPI Combustion Safety Test Procedure for Vented Appliances

- Building Performance Institute, Inc (BPI)
 - Nationwide technical standards
- Residential Energy Services Network (RESNET)
 - accreditation of building performance auditors and HERS raters.
- Most federal energy-related program guidance refer to or are based on BPI standards
 - EPA's Healthy Indoor Environments Protocols for Home Energy Upgrades
 - EPA's Home Performance with Energy Star
 - DOE's Workforce Guidelines for Home Energy Upgrades

- Technical Standards require blower door tests to verify healthy ventilation when -
 - Air sealing 15% or more of building shell
 - Sealing ducts outside thermal envelope
- Combustion appliance safety inspection is required whenever changes are being made to the building envelope and/or heating system, including.
 - Carbon monoxide test
 - Draft measurement
 - Spillage evaluation
 - Worst-case depressurization of the combustion appliance zone
 -

- RESNET Interim Guidelines for Combustion Appliance Testing and Writing Work Scope
 - Followed by RESNET-accredited raters and auditors
- 3 types of assessments
 - Home Energy Survey (Does not include CAZ)
 - Building Performance Audit (Includes CAZ)
 - Comprehensive HERS Rating (Includes CAZ)
- CAZ procedures include
 - Gas test leak procedures
 - Worst case depressurization test procedures
 - CO test procedures

- Who conducts CAZ testing?
 - RESNET /BPI credentials in the organization/company
- When is testing conducted?
 - Program scopes vary based on cost & time limitations
 - RESNET & BPI have achieved market penetration and most follow those guidelines
 - Auditor/contractor responsibilities vary from program to program
 - Auditor?
 - Is it a BPI-certified auditor?
 - Is the auditor performing blower door-assisted air-sealing?
 - Retrofit contractor?
 - Before and after building shell is altered
 - Maybe customer didn't have an audit prior to hiring the retrofit contractor

- Who is responsible for addressing the results?
 - Program, contractor, homeowner?
- Who pays for testing?
 - Private sector cost \$150-\$300 per test



- Many low income programs - HUD's HOME program, HUD's Rehab and Repair Home Loans, HUD's Community Development Block Grants, Weatherization Assistance Program, Neighborhood Stabilization Program – ELIMINATE HEALTH & SAFETY HAZARDS
- Energy efficiency loan programs, PACE, micro loans
- Other state and local programs
 - Integrate combustion safety into any applicable program

- WEATHERIZATION PROGRAM NOTICE 11-6 - WEATHERIZATION HEALTH AND SAFETY GUIDANCE
 - Combustion safety testing is required when combustion appliances are present. Inspect venting of combustion appliances and confirm adequate clearances. Test naturally drafting appliances for draft and spillage under worst case conditions before and after air tightening. Inspect cooking burners for operability and flame quality.
 - Completed at the time of initial energy audit and at the final inspection

- Require participating auditors/raters be trained in CAZ testing
- Require that all jobs have CAZ testing and ventilation testing performed before and after retrofit
- Require that all paperwork include key data points (air flow, combustion testing results, etc)
- Program account manager reviews 100% of CAZ data elements to identify red flags
- Perform on-site QA inspection on 5% of jobs

- Basic package requires CAZ testing AFTER air sealing by a BPI certified individual. No audit is required.
- Advanced package requires pre-assessment and post-assessment by a BPI certified individual. As part of the assessments, CAZ testing is mandatory.

- Complete the energy audit
- Provide homeowner with home improvement recommendations and retrofit contractor choices
- Contractor performs combustion safety testing before and after performing insulation and/or air-sealing
- This model involves 3 blower door tests



- Contractors typically don't itemize combustion safety testing and instead roll it into the final bid
- Some insulation/air-sealing contractors subcontract safety testing out to specialists (BPI certified)
- Some perform testing in-house
- Some give it for free if the customer commits to a certain amount of work (example: \$2500+ gets free testing)
- Integrating combustion safety testing into government-funded programs drives the private sector to train staff and perform the testing

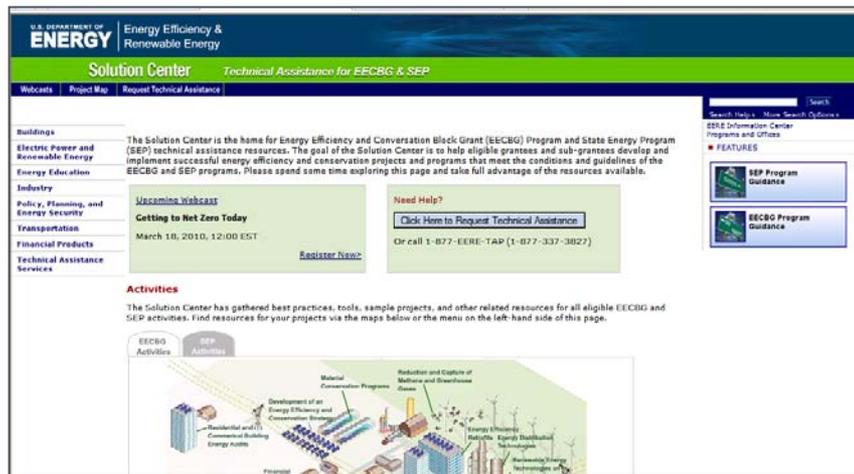
- Marketing benefits to homeowners
 - Health and safety
 - Headaches, dizziness, nausea, DEATH
 - Identify performance issues with combustion appliances.
 - Repairs can lead to improved performance and efficiencies
 - Ensure that weatherization will not create an unhealthy indoor environment



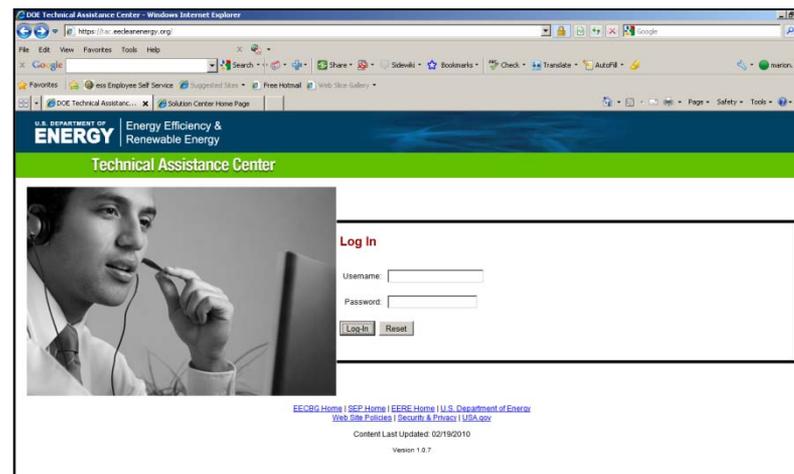
- BPI Standards
 - [Http://www.bpi.org/standards_approved.aspx](http://www.bpi.org/standards_approved.aspx)
- ASTM E1998-02(2007) “Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances”
 - www.astm.org
- Weatherization TA Program Field Guides and Standards
 - www.waptac.org/Technical-Tools/Field-Standards-and-Guides.aspx
- DOE’s Workforce Guidelines for Home Energy Upgrades
 - www1.eere.energy.gov/wip/pdfs/workforce_guidelines_home_energy_upgrades.pdf
- EPA’s Healthy Indoor Environment Protocols for Home Energy Upgrades
 - www.epa.gov/iaq/homes/retrofits.html

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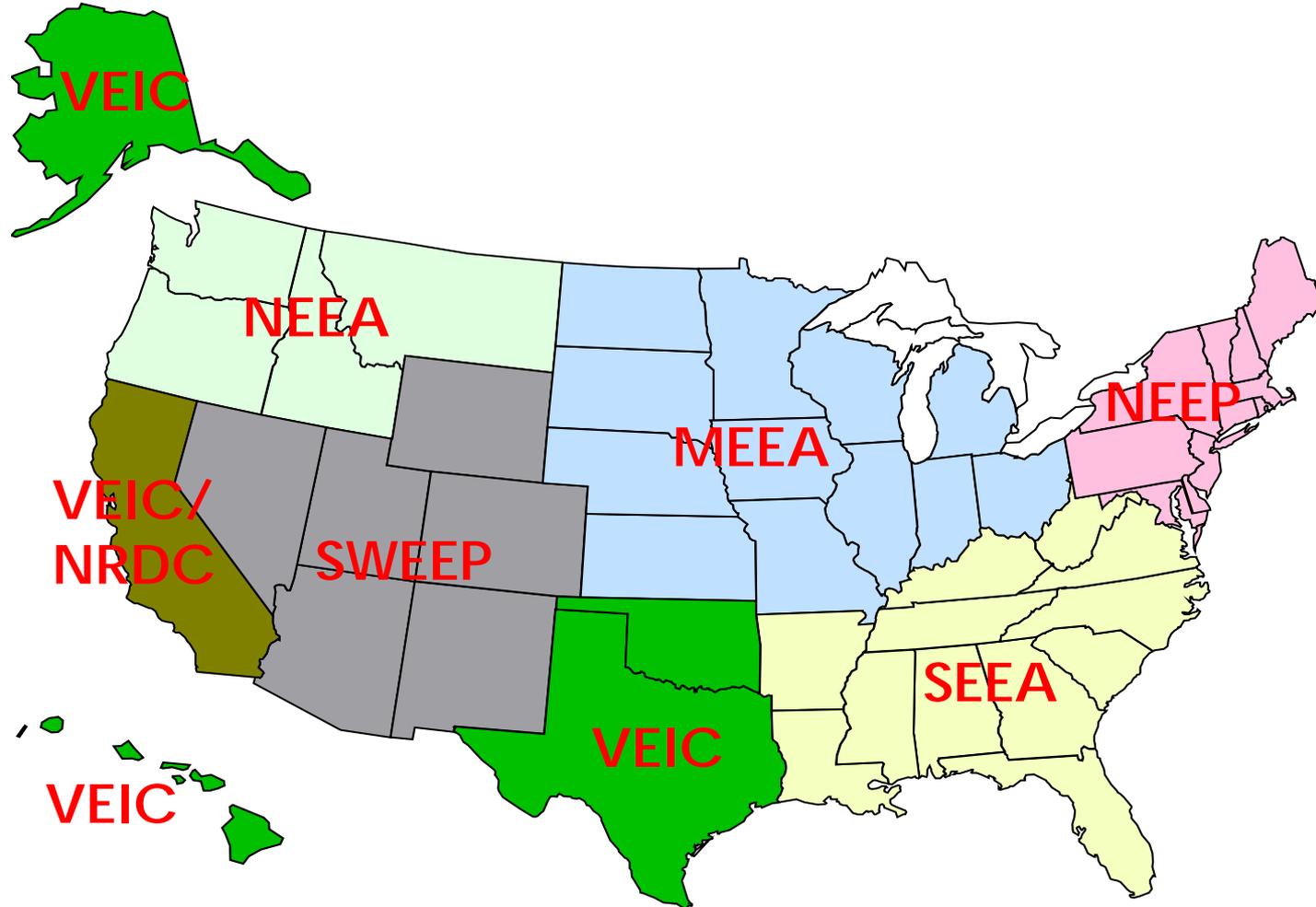


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Who We Are: Team 4



ACEEE, NRDC: National Support



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Host: Peter Flippen, ICF International

Date: April 14, 2011

Time: 2:00-3:00 EDT

Title: **Exterior Solid-State Lighting Solutions for Municipal**

Host: Chad Bulman, Midwest Energy Efficiency Alliance

Date: April 19, 2011

Time: 2:00-3:00 EDT

Title: **Engaging Financial Institution Partners**

Host: Mark Zimring, Lawrence Berkeley National Laboratory

Date: April 25, 2011

Time: 2:00 – 3:30 PM EDT

Title: **Energy Conservation Modeling for Weatherization**

Host: Ed Pierce, Oak Ridge National Laboratory

Date: April 27, 2011

Time: 3:00 - 4:15 PM EDT

Title: **Interactions between Energy Efficiency Program Funded under Recovery Act and Utility Customer-funded Energy Efficiency Programs**

Host: Chuck Goldman, Lawrence Berkeley National Laboratory

Date: April 28, 2011

Time: 2:00-3:30 PM EDT

Title: **Residential Retrofit Program Design Guide Overview**

Host: Vermont Energy Investment Corp.

Date: May 3, 2011

Time: 2:00 - 3:00 PM EDT

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