New Energy Auditing Standards for New York

Energy Audit Levels 1, 2 and 3

Jim Kelsey, P.E., BEAP
President, kW Engineering
kW & Jim

Commercial & Industrial
50% business = private
50% business = IOUs
Consulting Engineering
Building Data Science

• 30 years in practice
• Chair ASHRAE Audits Standard
• Founding Board Member CA EE Industry Council
Acknowledgments

Many thanks to the members of SPC 211 who’s work on Std 211-2018 has helped raise the bar for energy audits and from whom I’ve learned so much.

• Barry Abramson  
• Chris Balbach  
• Michael Bobker  
• David Eldridge  
• Fred Goldner  
• Ellis Guiles  
• Adam Hinge  
• Glenn Hourahan  
• Bruce Hunn  
• Dennis Landsberg  
• John Lee  
• Paul Mathew  
• Ron Nelson  
• Tom Paxson  
• Xiaohui Zhou  
• Stan Harbuck  
• Supriya Goel  
• Ben O’Donnell
1st Edition emphasized:

- Levels of Effort
  - I, II, III
- Forms
  - Audit forms
  - Site use

Became de facto standard
But way too much “leeway”
Victims of our own success

Level 1

Level 2

Level 3
3 Levels, What’s the difference?

1. **Scoping**
   - How do you compare to peers?
   - Potential?
   - Qualitative

2. **Site specific**
   - Savings
   - Costs
   - Economics

3. **Design Development**
   - Risk mitigation,
   - Best cost/impact estimates
   - Life-cycle costing

Oh, an audit
Scopes build
Why write a standard?

- Leeway $\rightarrow$ “apples and oranges” bidding
- Cities with mandatory ordinances found difficult to enforce – wrote their own
- Efficiency from consistent reporting
Detail
Accuracy
Rigor
Confidence
Risk

Cost of Service
Cost of Saved Energy
Levelized Cost of Energy ($/MWh)

Coal w/ Carbon Capture

Biomass

Combustion Turbines

Hydro

Combined Cycle

Solar PV

Wind

Geothermal

Energy Efficiency

Competing Costs

EE is a diffuse resource
Who's qualified?

Engineers?  
PEs?  
Contractors?

Most people reply, in effect, “me.”
Who’s qualified?

qualified energy auditor: an energy solutions professional who assesses building systems and site conditions; analyzes and evaluates equipment and energy usage; and recommends strategies to optimize building resource utilization. Experience must include completion of five commercial (non-residential) building energy audits within the past three years or a cumulative completion of ten or more commercial building energy audits. The auditor must be one of the following:

a) A person who holds a certification from a credentialing program approved by the U.S. Department of Energy Better Buildings Workforce Guidelines for Building Energy Auditors or Energy Managers.
b) A licensed Professional Engineer or a Licensed Contractor specifically approved to conduct energy audits by the authority having jurisdiction (AHJ).
c) A person approved as qualified by the authority having jurisdiction (AHJ).

Informative Note: For a current listing of certifications that meet the requirements of the DOE’s Better Building Workforce Guidelines see the DOE’s website at [URL omitted]. Only credentialing programs that specifically certify Building Energy Auditors or Energy Managers are applicable.

goodbuildingssolutioncenter.energy.gov/workforce/participating-certifying-organizations
Value of an Audit

Many share an implicit assumption…
Not goals

Best Practices
Consistency of Measures [ which is ≠ Quality ]
Overly prescriptive methods or recommendations
“Virtual” or “Remote” audits
Prescriptive actions for owners

Standard 211 Sets the bar for the minimum required procedures and reporting requirements that can be called “ASHRAE Level X”
Level “0”

Billing data
Metered and “delivered”
Fuel cost breakdown
Energy Use Intensity (EUI)
Energy Cost Index (ECI)
Benchmarking
Benchmark

Source: bpd.lbl.gov
# EUI / ECI

## Existing Building EUI/ECI

<table>
<thead>
<tr>
<th>Building Name</th>
<th>Acme Rocket Skates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Conditioned Square Feet</td>
<td>94,241</td>
</tr>
<tr>
<td>$EUI_{BLD}$ (kBtu/sf/yr)</td>
<td>147.6</td>
</tr>
<tr>
<td>$EUI_{SITE}$ (kBtu/sf/yr)</td>
<td>77.4</td>
</tr>
<tr>
<td>Site ECI (energy cost index or $/sf/yr)</td>
<td>$ 3.21</td>
</tr>
</tbody>
</table>

*E UI: Energy Use Intensity

Which begs the question…
Energy Efficient?
But do simple EUI’s encourage the right behavior? What is green?
Level 1

Purpose: To assess the potential at a given sites with a brief, low-cost, qualitative study

Changes

- Qualitative only
- Did not make lower qualifications “bar”
## Level 1 Audit - Recommended Energy Efficiency Measure Summary

<table>
<thead>
<tr>
<th>Low-Cost and No-Cost Recommendations</th>
<th>Modified System</th>
<th>Impact on Occupant Comfort or IEQ</th>
<th>Other Non-Energy Impacts</th>
<th>Cost</th>
<th>Savings Impact</th>
<th>Typical ROI</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add VFD to Chilled Water Pumps</td>
<td>Ventilation</td>
<td>None</td>
<td>None</td>
<td>low</td>
<td>high</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Convert manual radiator valves to thermostatic models</td>
<td>Space Heating</td>
<td>Improved occupant comfort</td>
<td>None</td>
<td>medium</td>
<td>high</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>Demand Controlled Ventilation</td>
<td>Ventilation</td>
<td>e.g., None</td>
<td>None</td>
<td>medium</td>
<td>low</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>Repair Steam Leaks</td>
<td>Space Heating</td>
<td>Improved occupant comfort</td>
<td>Increase equipment longevity</td>
<td>low</td>
<td>high</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Replace Boiler</td>
<td>Space Heating</td>
<td>Setpoint maintenance improvement</td>
<td>Reduced maintenance costs</td>
<td>high</td>
<td>medium</td>
<td>low</td>
<td>medium</td>
</tr>
<tr>
<td>Cost</td>
<td>Savings Impact</td>
<td>Typical ROI</td>
<td>Priority</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>-------------</td>
<td>----------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>medium</td>
<td>high</td>
<td>high</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Level 2

What didn’t change

All the basics;
  site-specific cost savings,
  energy savings,
  project costs,
  Simple economic reporting (Payback, ROI)

Avoided any responsibility for IAQ/IEQ or hazardous conditions

“if you see something, say something”
Level 2

Changes

- Quality Assurance / Quality Control
- Distributed Energy Resource Evaluation
- Reporting Form Standardization

Calculations

Have to use the same methods consistently, for energy disaggregation, savings, and demand savings calcs
## Basis of “energy balance”

### Simplified Example

<table>
<thead>
<tr>
<th>Base Case</th>
<th>Proposed Case</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 fixtures</td>
<td>100 fixtures</td>
<td>3 kW</td>
</tr>
<tr>
<td>90 W each</td>
<td>60 W each</td>
<td>9,000 kWh</td>
</tr>
<tr>
<td>9 kW</td>
<td>6 kW</td>
<td></td>
</tr>
<tr>
<td>2,000 hrs</td>
<td>1,500 hrs</td>
<td></td>
</tr>
<tr>
<td>18,000 kWh</td>
<td>9,000 kWh</td>
<td></td>
</tr>
</tbody>
</table>
## Level 2 QA/QC

### Level 2 Audit - QA/QC

#### Projected EEM Savings Levels QA/QC

<table>
<thead>
<tr>
<th>End Use Category*</th>
<th>Electricity (kWh)</th>
<th>Natural Gas (therms)</th>
<th>Purchased Steam (lbs District Steam)</th>
<th>Total Energy [kBtu]</th>
<th>% Electricity Savings</th>
<th>% Natural Gas Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Distribution (fans)</td>
<td>9,000</td>
<td></td>
<td></td>
<td>30,708</td>
<td>38%</td>
<td>0%</td>
</tr>
<tr>
<td>Space Heating</td>
<td>11,000</td>
<td>8,000</td>
<td>40,000</td>
<td>885,292</td>
<td>22%</td>
<td>53%</td>
</tr>
<tr>
<td>Lighting</td>
<td>25,000</td>
<td></td>
<td></td>
<td>85,300</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>Space Heating</td>
<td>(200)</td>
<td></td>
<td></td>
<td>(20,000)</td>
<td>0%</td>
<td>-1%</td>
</tr>
<tr>
<td>Air Distribution (fans)</td>
<td>9,000</td>
<td></td>
<td></td>
<td>30,708</td>
<td>38%</td>
<td>0%</td>
</tr>
<tr>
<td>Space Heating</td>
<td>11,000</td>
<td></td>
<td>40,000</td>
<td>85,292</td>
<td>22%</td>
<td>0%</td>
</tr>
<tr>
<td>Refrigeration</td>
<td>510,000</td>
<td></td>
<td></td>
<td>1,740,120</td>
<td>102%</td>
<td>0%</td>
</tr>
<tr>
<td>Space Cooling</td>
<td>20,000</td>
<td></td>
<td></td>
<td>68,240</td>
<td>2%</td>
<td>0%</td>
</tr>
</tbody>
</table>

#### Low-Cost and No-Cost Recommendations

- Air Distribution (fans)
- Space Heating
- Lighting
- Space Heating
- Refrigeration
- Space Cooling

#### Potential Capital Recommendations

- Digital PRV Upgrade
- Replace Roof
- TRV Installation
- Steam Trap Replacements
- Replace Roof
- Digital PRV Upgrade
- Spray Foam Insulation Duct
- Replace AC-2 with new Heat Pump
- BMS Installation
- Chiller Plant Upgrade
- Re-enable Static Pressure Reset
- Hallway LED Lighting Upgrade
- Modify Low Limit DAT Setting
- Replace UH thermostats
- Weatherstripping
- Change Chiller Operation Schedule
- Enable Heat Timer Night Setbacks
- Test LC-NC EEM 1

#### Total Savings (QA-QC)

- Total Savings (QA-QC): 604,000
- Total Savings (EEM Summary): 604,000
- Total Historical Use: 1,000,000
Level 2 Distributed Energy

Qualitative Assessment only

Requires

- One Distributed Energy Resource (e.g. cogen)
- One Renewable Energy Resource (e.g. Solar PV)
- Include an estimate of the system size, configuration, savings, cost, and simple payback
# Reporting Forms

## Level 2 Audit - Building Envelope Characteristics

<table>
<thead>
<tr>
<th>Description</th>
<th>Area (sq ft)</th>
<th>Insulation Level (R-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total exposed above grade wall area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below grade wall area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cool Roof (Y/N)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cool Roof: Yes = White, not asphalt shingle; No = Other, including all asphalt shingles**

<table>
<thead>
<tr>
<th>Description</th>
<th>Area (sq ft)</th>
<th>Insulation Level (R-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fenestration Seal Condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall Enclosure Tightness Assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description of Exterior doors**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Cool Roof: Yes = White, not asphalt shingle; No = Other, including all asphalt shingles*

Glazing area, approx % of exposed wall area [10, 25, 50, 75, 90, 100]*

Above grade wall common area with other conditioned buildings (ft²)

## General Building Shape*

### Construction Properties (check all that apply)

<table>
<thead>
<tr>
<th>Roof Construction*</th>
<th>Floor Construction*</th>
<th>Wall Construction(s)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Built up with metal deck</td>
<td>□ Concrete (above unconditioned space)</td>
<td>□ Brick/stone on steel frame</td>
</tr>
<tr>
<td>□ Built up with concrete deck</td>
<td>□ Slab on grade</td>
<td>□ Brick/stone on masonry</td>
</tr>
<tr>
<td>□ Built up with wood deck</td>
<td>□ Steel joist</td>
<td>□ Brick/stone on wood frame</td>
</tr>
<tr>
<td>□ Metal surfacing</td>
<td>□ Wood frame</td>
<td>□ Metal panel / Curtain wall</td>
</tr>
<tr>
<td>□ Shingles/Shakes</td>
<td>□ Other</td>
<td>□ Sliding on steel frame</td>
</tr>
<tr>
<td>□ Other</td>
<td></td>
<td>□ Sliding on wood frame</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fenestration Frame Type(s)*</th>
<th>Fenestration glass type(s)*</th>
<th>Foundation Type*</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Metal</td>
<td>□ Single pane</td>
<td>□ Slab on Grade</td>
</tr>
<tr>
<td>□ Metal with thermal breaks</td>
<td>□ Double pane</td>
<td>□ Crawlspace</td>
</tr>
<tr>
<td>□ Wood/ Vinyl/ Fiber glass</td>
<td>□ Double pane with low e</td>
<td>□ Basement</td>
</tr>
<tr>
<td>□ Exterior Glass Doors***</td>
<td>□ Triple pane</td>
<td>□ Unknown</td>
</tr>
<tr>
<td>□ Other</td>
<td>□ Triple pane with low e</td>
<td>□ Other</td>
</tr>
<tr>
<td></td>
<td>□ Other</td>
<td></td>
</tr>
</tbody>
</table>
# Level 2 Audit - HVAC System

## HVAC Properties (check all that apply)

<table>
<thead>
<tr>
<th>Zone Controls</th>
<th>Central Plant Controls</th>
<th>Heat Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Digital (DDC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumatic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programmable tstats</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual tstats</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Outside Air*

- Temperature Economizer
- Enthalpy Economizer
- No Functioning Economizer
- Dedicated OA System
- | Enthalpy |
- | Sensible (Temp Only) |

## Exhaust Fans

- No Mechanical Exhaust (natural only, i.e. windows, doors or gravity shafts)
- Exhaust Fans Only
- Supply and Exhaust Fans

## Cooling Distribution Equipment Type*

- Air Handler Unit (AHU)
- Constant Volume
- VAV
- Hydronic to zone equipment (e.g. fan coil units, packaged terminal units or radiators)
- Refrigerant to zone equipment (e.g. fan coil units, packaged terminal units or radiators)
- Hydronic AHU
- DX AHU
- Other
- None (i.e. electrically driven PTAC, baseboards)

## Heating Distribution Equipment Type*

- Air Handler Unit (AHU)
- Constant Volume
- VAV
- Hydronic to zone equipment (e.g. fan coil units, packaged terminal units or radiators)
- Steam to zone equipment (e.g. fan coil units, packaged terminal units or radiators)
- None (i.e. electrically driven PTAC, baseboards)
- Other

## Cooling Source*

- No cooling
- DX cooling
- Central plant
- Chiller
- District chilled water
- Water-side Economizer
- Other (specify) ______________
- | Electricity |
- | Gas Absorption |
- | Gas |
- | Steam Absorption |
- | Oil (specify grade) |
- | Steam Turbine |
- | Other |

## Chiller Input*

- Reciprocating
- Scroll/Screw
- Centrifugal
- Air
- Water
- Ground
- Indirect Evaporative
- Direct Evaporative

## Compressor*

- | Air |
- | Water |
- | Ground |
- | Indirect Evaporative |
- | Direct Evaporative |
- | Electricity |
- | Gas |
- | Oil |
- | Steam |
- | Water |
- | Other |

## Condenser*

- Air
- Water
- Ground
- Indirect Evaporative
- Direct Evaporative
- Electricity
- Gas
- Oil
- Steam
- Water
Level 3 Requirements

Reducing risk through project development

• Schematic diagram for the EEMs

• Analyze either
  • measured data; or
  • building energy modeling; or
  • engineering calculations

• Envelope measures must use building energy modeling

• Costs must be:
  • quotes from vendors willing to do the work; or
  • based on actual previous project costs for similar projects

• Life-cycle cost analysis is required for all measures

• A simplified risk assessment approach based on the impact of “key assumptions”
Where does your audit end up?
<table>
<thead>
<tr>
<th>Email Address</th>
<th>Number of Emails</th>
</tr>
</thead>
<tbody>
<tr>
<td>!NYSERDA</td>
<td>1</td>
</tr>
<tr>
<td>momegan</td>
<td>14</td>
</tr>
<tr>
<td>ASHRAE</td>
<td>14</td>
</tr>
<tr>
<td>BidSync</td>
<td>6</td>
</tr>
<tr>
<td>Bills</td>
<td>6</td>
</tr>
<tr>
<td>BLDG SIM</td>
<td>6</td>
</tr>
<tr>
<td>CA CEC CPUC</td>
<td>156</td>
</tr>
<tr>
<td>CEM</td>
<td>2</td>
</tr>
<tr>
<td>Cycling</td>
<td>2</td>
</tr>
</tbody>
</table>

Or here?
BuildingSync Schema: What is it

“A standard language for commercial building energy audit data that software developers can use to exchange data between audit tools.”

∴ It’s language, not a tool
No more data dead ends!

Energy Audit Report Forms

- EEM 1
- EEM 2
- EEM 3

City’s database

Asset Score (online)

OpenStudio
EnergyPlus
211 – What we didn’t spec

Tried to limit burden & increase options for owners

EE for $ cost savings is over-rated

Many users (most?) implement measures for “non-energy-saving benefits”

(aka for any other good reasons – not our biz!)

If the standard makes it hard to get your customer what they want, we’re doing something wrong
Trends

- CO₂
- HFC phase outs
- Emphasis on building value

Emphasis on whole buildings

M&V 2.0

Emphasis on kW = f(t)
Next Steps

Green book ➔ users guide (in progress)

Forms are online, expect changes

Alternate focus on CO2 / GHG (?)

Enhanced focus on demand, DERs
How we’re advancing EE in CA
Normalized Metered Energy Consumption

Baseline  | Install  | 1st Performance Period

→ Open source methods, transparent savings estimates
Emphasis on actions that result in savings, not “bean counting”
NYSERDA REM Pilot

ACME 1063 PATTERSON Electric Meter kW Demand System Now vs New York, NY Temp

Weather New York, NY Temp (°F)

ACME 1063 PATTERSON Electric Meter kW Demand System Now
Now’s your chance
## “Virtual” Audits?

### POTENTIAL

- Lower cost
- “Scale”

### DRAWBACKS

- Recommendations are often vague – leave customers wanting
- No standard – omitted from ASHRAE process
- Disaggregation ≠ Recommendation
- “Generic” recommendations

---

“We’re still telling people they are doing simultaneous heating and cooling”

- Swapnil Shah, CEO, FirstFuel