Appendix H
Class 1 Buildings
Energy Analysis Report Format

I. ENERGY ANALYSIS REPORT FORMAT

The Energy Analyst completes the *Energy Analysis Report* according to the following outline. The report includes previously submitted data, such as the building description and building design criteria. Present the data in a bound report in the order described and with all tables shown. Include the energy model electronic input/output files in an attached sleeve within the report.

Section 1. Executive Summary

a. Provide a brief description of the facility and the analysis process. Include for the Code Building, the Proposed Baseline Building, and the SEED Building the following information; the energy use, energy cost, energy-use index (EUI), and energy-cost index (ECI). The EUI is Btu per conditioned square foot per year. The ECI is dollars per conditioned square foot per year.

b. Include a table of analyzed package results (Table 1-1). This table shows ECM costs, annual cost savings, annual million Btu (MMBtu) savings, Net Present Value savings (NPV), Net Present Cost Savings (NPC), benefit-to-cost ratio (BCR), and percent energy savings as compared to the Code Building.

Table 1-1 – ECM Package Analysis Summary

Recommended Package

Incremental Investment Cost	Annual Dollar Savings	Annual MMBtu Savings	NPV Savings	NPC Savings	Benefit-To-Cost Ratio	% Energy Use Below Code Bldg.

Instructions for Table 1-1: Summarize package results from Tables 3-1. Percent below code is based on the Code Building. All other values are as compared to the Proposed Baseline Building.

c. Provide brief description of recommended ECMs and ECM package.

d. Describe other results.

e. Include a list of all considered ECMs grouped by status: recommended package, individually cost effective, individually not cost effective, or included in baseline.

Section 2. Proposed Baseline Building

a. Provide detailed building descriptions. Include the following:
   - **Building Operating Characteristics**. Discuss building operation, function, site, and occupancy schedule,
   - **Building Envelope Characteristics**. Discuss construction and thermal properties of all exterior envelope components. Include window thermal performance, frame materials, window to wall ratios, and building and window shading surfaces.
   - **Lighting and Lighting Controls**. Discuss target footcandle levels, lighting power densities, lamp and fixture types, operating schedules, lighting controls (i.e. sweep, occupancy sensors, daylight dimming, etc.)
   - **Exterior lighting and controls**. Discuss lamp and fixture type, operating schedules, and controls.
   - **HVAC Systems**. Describe type and characteristics of the HVAC systems in the building and the areas served by each system. Include capacities of heating and cooling units, efficiencies of units, list fan/pump motor sizes, ventilation quantities, supply and exhaust air volumes, etc. Describe boilers, chillers, cooling towers, heating and chilled water loops, heat exchangers, and other central plant equipment.
   - **HVAC Controls**. Describe HVAC controls system and controls strategies. Include temperature set points, operating schedules, etc.
   - **Domestic Hot Water**. Discuss hot water using equipment. Describe capacities, efficiencies, fixture flow rates, circulation pumps and schedules.
   - **Miscellaneous and Process Equipment**. Discuss other energy using equipment including miscellaneous plug loads, kitchen equipment, laundry equipment, computer room equipment, process loads, etc.

b. List each Baseline ECM, (Table 2-1). Baseline ECMs are those ECMs that are included in the Proposed Baseline Building without the need for detailed cost effectiveness analysis.

Table 2-1 Baseline ECMs	
ECM No.	ECM Name
Instructions for Table 2-1: List Baseline ECMs.	

c. **Provide detailed descriptions of baseline ECMs**. The description should contain the level of detail necessary to serve as a performance specification for the design team

so they can design an ECM that achieves the projected savings and specific enough for ODOE, the commissioning agent, or other performance verification provider to verify in the construction documents. An example is a daylight dimming system. The required information would include areas where this ECM would be implemented, identification of controlled fixtures, fixture control strategy, required foot-candle levels, and any architectural features related to this measure such as lightshelves, overhangs, blinds or shades, window configuration, and glazing visible light transmittance.

d. Describe building energy analysis. Discuss energy analysis program used, modeling assumptions, and parameters.

e. Discuss utility rates.

f. Discuss modeling results. Include comparison to similar building types or comparison to utility bills if modeling an existing building.

g. Include a table of annual Proposed Baseline energy use and cost by category (Table 2-2). Indicate the energy rates used and determine the energy-use index (EUI) and energy-cost index (ECI).

Table 2-2 – Proposed Baseline Building Energy Use Summary

Energy Use Category	MMBtu per Year			% of Total MMBtu	Annual Energy Cost	% of Total Cost
	Electricity	Natural Gas*	Total			
Heating						
Cooling						
Fans/Pumps						
Lighting						
Dom. Hot Water						
Equip. & Misc.						
Total				100%		100%

Gross conditioned** Floor area in square feet	Energy Use Index (EUI) Btu per square foot per year	Energy Cost Index (ECI) $ per square foot per year

Electricity cost per kWh***:	Natural gas cost per therm***:

Table 2-2 Instructions. Using the results from the baseline energy model, list the energy use by fuel type and total cost for each end use category. Calculate and show the energy-use index (Btu per gross conditioned square foot) and energy-cost index $ per gross conditioned square foot).

*Substitute oil or other fuel for natural gas, if appropriate.
**The gross conditioned floor area is the heated or cooled part of the building measured to the outside of the walls.
*** If utility rate include seasonal charges, block charges, demand charges, etc, use average annual rate.

Section 3. Preliminary ECM Analysis

Section 3 of the *Energy Analysis Report* is based on individual analysis of ECMs and of the recommended ECM package before the ECM review meeting. ECM content and results may change as a result of the ECM review meeting. Refer to Section 5 of the *Energy Analysis Report Format* for final results and descriptions.

a. Provide detailed descriptions of cost-effective ECMs and discuss implementation and feasibility considerations. Describe ECM components, and how the measure saves energy. Schematic level drawings are encouraged. The description should contain the level of detail necessary to serve as a performance specification for the design team so they can design an ECM that achieves the projected savings and specific enough for ODOE, the commissioning agent, or other performance verification provider to verify in the construction documents.. Describe the areas affected by each ECM. An example would be a dedicated ventilation system with heat recovery. The description would include the specifics of the system including suggested location, areas served, airflow, heating source and efficiency, heat recovery technology and efficiency, control strategies, and effect on remaining other systems.

b. Describe analyzed ECMs determined not to be cost-effective. Less detail is required for the descriptions of these ECMs

c. Provide a table that shows ECM results based on preliminary analysis (Table 3-1). Include the first-year energy savings and costs for the analyzed ECMs.

- The Energy Analyst calculates savings using the building model. Savings are calculated using the Proposed Baseline as the benchmark. Savings are expressed in MMBtu for all fuel types to allow comparison of fuels.
- The first-year energy cost savings is the annual energy savings based on current energy rates.
- The incremental investment cost is the increase in ECM cost compared with the Proposed baseline. It is the budget cost increase required for ECM implementation.
- Enter the benefit to cost ratio (BCR) that summarizes individual Analyzed ECM results based on life-cycle cost analysis. The BCR is the PV of the savings (benefit) divided by the PV of the costs. The BCR must be greater than one (1.0) for a measure to be considered cost effective. **Worksheets (available in Appendix J of the Guidelines) showing the life cycle cost analysis must be included in the Energy Analysis Report Appendix.**
- Create an interactive model that includes all analyzed ECMs with a BCR greater than 1.
- If the package BCR is less than 1.0 and the Recommended SEED building is 20% better than code, the analyst can do the following. Remove individual ECMs that have a BCR less than 1.5 until the point that the Package BCR is better than 1, provided the Recommended SEED building is still 20% better than code.

Table 3-1 Preliminary ECM Savings Analysis							
ECM No	ECM Name	MMBtu Saved per Year			Annual ($) Savings	Incremental Investment Cost ($)	Benefit to Cost Ratio
		Electricity	Natural Gas*	Total			
Individually Cost-Effective ECMs							
Interactive Package (Recommended SEED Bldg)							
% Savings							N/A
Other Analyzed ECMs (not cost-effective)							

Table 3-1 Instructions. The values in Table 3-1 represent first-year results shown on the *Preliminary ECM Cost-Effectiveness Analysis* worksheets (Appendix J of the Guidelines). Items are as follows:

- MMBtu Saved from the Annual Energy Savings section: Enter for each fuel and the total.
- Annual $ Saved: Total Annual Savings (Energy + Maintenance).
- Incremental Investment Cost: Cost from the ECM Incremental Capital Cost section.
- The Benefit to Cost Ratio represents the results of the Preliminary ECM Cost-Effectiveness
- Percent Savings based on comparison to baseline use from Table 2-2.

*Substitute oil or other fuel for natural gas, if appropriate.

Section 4. Code Building

a. Provide a description of the differences between the Recommended SEED Building (Interactive Package) and the Code Building.

b. List ECMs removed from the Recommended SEED Building to create the Code Building. Include both baseline and analyzed ECMs.

c. Discuss other changes made to the Recommended SEED Building model as a result of the rules in Appendix L-Building Modeling Guidelines

d. Include a table of annual Code Building energy use and cost by category (Table 4-1). Indicate the energy rates used and determine the energy-use index (EUI) and energy-cost index (ECI).

Table 4-1 – Code Building Energy Use Summary

Energy Use Category	MMBtu per Year			% of Total MMBtu	Annual Energy Cost	% of Total Cost
	Electricity	Natural Gas*	Total			
Heating						
Cooling						
Fans/Pumps						
Lighting						
Dom. Hot Water						
Equip. & Misc.						
Total				100%		100%

Gross conditioned** floor area in square feet	Energy Use Index (EUI) Btu per square foot per year	Energy Cost Index (ECI) $ per square foot per year

Electricity cost per kWh:	Natural gas cost per therm:

Table 4-1 Instructions. Using the results from the Code energy model, list the energy use by fuel type and total cost for each end use category. Calculate and show the energy-use index (Btu per gross conditioned square foot) and energy-cost index ($ per gross conditioned square foot).

*Substitute oil or other fuel for natural gas, if appropriate.

**The gross conditioned floor area is the heated or cooled part of the building measured to the outside of the walls.

e. Compare Code Building Energy Use to Recommended SEED Building.

Table 4-2– Recommended SEED Building Savings Compared to Code Building					
	ECMs Included in Package (by number)	Energy Use MMBtu		Energy Savings MMBtu	% Energy Savings
		Electricity	Natural Gas*		
Code Building	N/A			N/A	N/A
SEED Building					

Table 4-2 Instructions. The values in Table 4-2 represent the first-year energy savings. Items are as follows:

- Recommended SEED Energy Use and Code Building from Tables 3-1 and 4-1.
- Energy savings and % energy savings are calculated values.

Section 5. Final ECM Package Analysis (completed after ECM review meeting)

Section 5 of the *Energy Analysis Report* describes any differences between the recommended ECM package and the final SEED package from Section 3.

a. Discuss the recommended ECM package at the ECM review meeting. **Document agency comments and any reasons for eliminating cost-effective ECMs or including non-cost-effective ECMs. Document any changes to ECMs or baseline assumptions.**

b. Update any changes to the previous Sections of the report based on feedback received at the ECM review meeting, Revise Table 3-1 to show the final ECM Package (SEED Building) results and Table 4-2 to show percentage better than code building, if this has changed.

c. Describe the recommended ECM package and discuss implementation and feasibility considerations.

d. Include a table of annual SEED Building energy use and cost by category (Table 5-1). Indicate the energy rates used and determine the energy-use index (EUI) and energy-cost index (ECI).

Table 5-1 – SEED Building Energy Use Summary

Energy Use Category	MMBtu per Year			% of Total MMBtu	Annual Energy Cost	% of Total Cost
	Electricity	Natural Gas*	Total			
Heating						
Cooling						
Fans/Pumps						
Lighting						
Dom. Hot Water						
Equip. & Misc.						
Total				100%		100%

Gross conditioned** floor area in square feet	Energy Use Index (EUI) Btu per square foot per year	Energy Cost Index (ECI) $ per square foot per year

Electricity cost per kWh:	Natural gas cost per therm:

Table 5-1 Instructions. Using the results from the SEED energy model, list the energy use by fuel type and total cost for each end use category. Calculate and show the energy-use index (Btu per gross conditioned square foot) and energy-cost index $ per gross conditioned square foot).

f. Discuss any other results determined during the analysis. Present the financial impact of other items reviewed that are not ECMs.

II. REPORT APPENDICES

The Energy Analyst includes the following appendices in the *Energy Analysis Report*.

1. Baseline-model HVAC zone map.

2. Model inputs for the Code Building, the Proposed Baseline Building, all ECM runs, and the SEED Building. **Electronic copies of inputs and the complete output reports are required**.

3. Provide a table that lists the modeling inputs and values that have been changed for each building model. (See Tables A-1 and A-2 on following page)

4. Summary output report(s) for the Code Building, the Proposed Baseline Building, all ECM runs, and the SEED Building including:
   - A breakdown of energy usage by at least the following components: lights, internal equipment loads, service water heating equipment, space heating equipment, space cooling and heat rejection equipment, fans, and other HVAC equipment (such as pumps).
   - The amount of time any loads are not met by the HVAC system for both the SEED building design and baseline building design
   - An explanation of any warning messages noted in the simulation program output.

5. Manual savings calculations if any. This can include simple savings calculations and other calculations used to develop input parameters for the model (such as lighting power densities, DHW usage, equipment efficiencies, custom equipment part load curves, etc.)

6. ECM calculations, estimates, and justification for eliminated ECMs, including *Cost Effectiveness Analysis* worksheets for all eliminated ECMs.

7. Cost estimates for all ECMs analyzed.

8. *Cost-Effectiveness Analysis* worksheets (See Appendix J)
   - Individual ECMs analyzed
   - ECM packages

9. Current energy rate schedules. Where energy is received from a state-operated central plant, cite the rate source used.

10. Meeting minutes:
    - Scoping meeting
    - ECM review meeting including an updated ECM checklist showing Recommended ECMs.

11. Miscellaneous information: equipment catalog sheets, equipment rated performance., i.e. ARI, ANSI, NFRC , etc.

12. Energy Systems Performance Verification Plan (See Appendix E for plan details)

13. Building Metering Plan (See Appendix F for metering requirements)

Table A-1 - Tracking Sheet of Model Input Variables		
Proposed Baseline Building Input	**Analyzed ECMs Input**	**Comments**
		ECM #1
		ECM #2
		ECM #3
		ECM #4
		ECM #5
		ECM Package (SEED Building) Describe differences in inputs from above included ECMs due to interactive effects
Table A-1 Instructions. List all input changes between the proposed baseline building and each ECM, see Example Table		

Table A-2 - Comparison Table of Code Building Inputs Vs. SEED Building Inputs		
SEED Building Input	**Code Building Input**	**Comments**
Table A-2 Instructions. List all input changes between the SEED Building and Code Building, see Example Table		

Example Table

SEED Building Input	Code Building Input	Comments
"TILT-UP-L" = LAYERS MATERIAL = ("Conc HW 140lb 12in (CC07)", **"R-13-MET-STUD"**,"GypBd 1/2in (GP01)") ..	"TILT-UP-L" = LAYERS MATERIAL= ("Conc HW 140lb 12in (CC07)", **"R-13-Met-Stud-Derate"**, "GypBd 1/2in (GP01)") ..	ECM 1- Improved Envelope. De-rates wall thermal resistance to just meet requirements of 90.1.
"FLAT ROOF-L" = LAYERS MATERIAL = ("Blt-Up Roof 3/8in (BR01)", "Plywd 3/4in (PW05)", "Polyurethane **3in (IN46)**", "Steel Siding (AS01)") ..	"FLAT ROOF-L" = LAYERS MATERIAL = ("Blt-Up Roof 3/8in (BR01)", "Plywd 3/4in (PW05)", "Polyurethane **2in (IN45)**", **"Polyurethane 1/2in (IN41)"**, "Steel Siding (AS01)") ..	ECM 1- Improved Envelope. De-rates wall thermal resistance to just meet requirements of 90.1.
"Metal ROOF-L" = LAYERS MATERIAL =("Steel Siding (AS01)", "Polyurethane 3in (IN46)", "Steel Siding (AS01)")..	"Metal ROOF-L" = LAYERS MATERIAL =("Steel Siding(AS01)", "Polyurethane 2in IN45)", "Polyurethane 1/2in (IN41)", "Steel Siding (AS01)") ..	ECM 1- Improved Envelope. De-rates wall thermal resistance to just meet requirements of 90.1.
"Win-1-Fixed" = GLASS-TYPE TYPE = SHADING-COEF SHADING-COEF = **0.39** GLASS-CONDUCT = **0.45** VIS-TRANS = **0.7** .. "Win-3-Fixed" = GLASS-TYPE TYPE = SHADING-COEF SHADING-COEF = **0.29** GLASS-CONDUCT = **0.48** VIS-TRANS = **0.36** ..	"Win-1-Fixed" = GLASS-TYPE TYPE = SHADING-COEF SHADING-COEF = **0.45** GLASS-CONDUCT = **0.68** VIS-TRANS = **0.7** .. "Win-3-Fixed" = GLASS-TYPE TYPE = SHADING-COEF SHADING-COEF = **0.45** GLASS-CONDUCT = **0.68** VIS-TRANS = **0.36**	ECM 5- Improved Windows. Increases window shading coefficient and glass conductance to just meet 90.1 requirements for SHGC and U-value.

"AHU-5-OSA-WD" = DAY-SCHEDULE-PD TYPE = FRAC/DESIGN VALUES = (0, &D, &D, &D, &D, &D, &D, **0.56**, &D, &D, &D, &D, &D, &D, &D, &D, &D, &D, &D, &D, &D, &D, 0) ..	"AHU-5-OSA-WD" = DAY-SCHEDULE-PD TYPE = FRAC/DESIGN VALUES = (0, &D, &D, &D, &D, &D, &D, **0.5**, &D, &D, &D, &D, &D, &D, &D, &D, &D, &D, &D, &D, &D, &D, 0) ..	ECB requirements changes total system airflow. Therfore, OSA fraction must also be changed to maintain equivalent OSA CFM. (Note that the same strategy is uses for all other AHU's, but % varies. See input comparison file for details.)
"Bldg Shade 1" = BUILDING-SHADE X = 162 Y = 152 Z = 16.5 HEIGHT = 9 WIDTH = 2.5 ..	*No building shades are input.*	ECB requirements are for no fenestration shades in baseline. (Note that additional building shades are input in proposed building. See input comparison file for details.)
LIGHTING-W/AREA = **(0.88)**	LIGHTING-W/AREA = **(1.5)**	ECM 2 - Reduced Lighting Power Density Uses average of 1.5 Watts/sqft for baseline as allowed by 90.1. Proposed building inputs Watts/sqft as designed on a space by space basis. See input comparison file or attached lighting spreadsheet for details of space input in proposed building.