Appendix I
Class 1 Buildings
Energy Analysis Requirements

I. DEFINITIONS

SEED Building: The building as designed for construction.

Proposed Baseline Building: The building as planned by the Owner and the Design team before final decisions are made regarding which Energy Conservation Measures (ECMs) will be included in the SEED Building. The Proposed Baseline Building shall include ECMs that do not require cost effectiveness analysis. The Proposed Baseline Building is used to benchmark the cost effectiveness of ECMs that do require analysis.

Code Building: A hypothetical building design based on the SEED Building. The Code Building shall incorporate the standard design features of typical buildings of the same usage and just meet the prescriptive requirements of the Oregon Energy Code according to guidelines presented in this document. The Code building is used to benchmark the SEED Buildings' relative energy efficiency performance.

Energy Code: Chapter 13 of the current State of Oregon Structural Specialty Code.

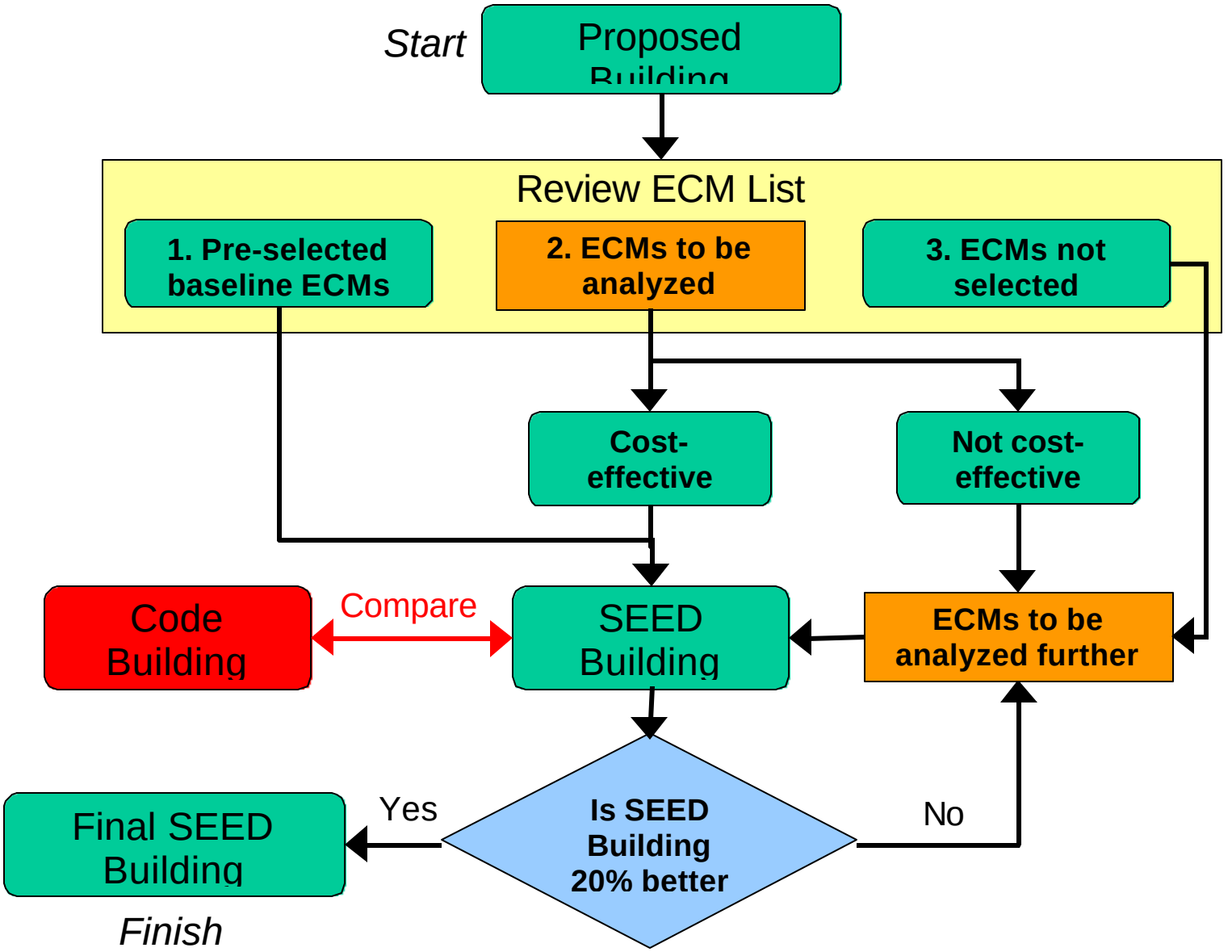
Baseline ECMs: ECMs that are beyond code requirements and will be included in the building without analysis required. These measures represent typical design practice of the Design Team and / or measures that are commonly found to be cost effective and don't warrant individual ECM analysis.

II. GOALS

1. To ensure that all cost effective ECMs are included in the SEED Building.

2. To ensure that the SEED Building uses 20% less energy than the Code Building.

III. OVERVIEW OF ANALYSIS APPROACH



IV. RECOMMENDED MODELING APPROACH

1. Preliminary energy analysis

The Energy Analyst completes the preliminary energy analysis before the ECM review meeting. The preliminary energy analysis includes the Proposed Building analysis, the Code Building Analysis, individual ECM analysis, and preliminary interactive package analysis:

a. Complete the model of the Proposed Baseline Building using the approved modeling program. The Proposed Baseline Building model includes Baseline ECMs not requiring analysis.

b. Review the Proposed Baseline Building model end-use energy breakdown and total energy use. Compare the results to average energy use index for that type of building.

c. Analyze energy use of ECMs individually using the Proposed Baseline model as the benchmark to determine energy savings. All manual calculations shall be fully documented (Page I-9).

d. Complete cost estimates (Page I-10) and ECM cost-effectiveness analysis (Appendix J). ECMs are considered cost effective when the net present value (NPV) of savings is positive and the benefit-to-cost ratio (BCR) is greater than one (1.0).

e. Rank the cost-effective measures based on their NPV. If ECMs are mutually exclusive, select the ECM with the higher NPV savings unless there are overriding aesthetic, functional, reliability, maintenance, or programmatic reasons to select an ECM that has a lower NPV. An ECM with a lower NPV also could be selected if the higher NPV alternative is not as cost-effective when analyzed in an ECM package.

f. Complete an interactive building model containing a package of all ECMs with a BCR greater than 1 and determine the package BCR and NPV. A second interactive model may be necessary only if there are two or more ECMs that are mutually exclusive (e.g., two different kinds of heat recovery systems). In that case, select the ECM package with the highest BCR.

g. Create a Code building model following the Guidelines located in Appendix L.

h. Determine the percent energy savings of the SEED Building using the Code Building as the benchmark. If the SEED Building does not meet the requirement of using 20% less energy than the Code Building do the following:

i. Select an alternative ECM package with a BCR greater than 1 that meets the minimum

20% better than code requirement.

(a) Add to the SEED Building model one ECM (or a group of similarly ranked ECMs) with the highest BCR of the ECMs not yet in the package. Repeat this procedure until the SEED Building meets the 20% requirement, the benefit to cost ratio of the selected package is less than one, or all reasonable analyzed measures have been added.

(b) If the SEED Building still does not meet the 20% better than code requirement, re-evaluate the ECM identification list for inclusion of ECMs not originally selected for analysis. This will require consultation with the design team, the Owner, and the Department of Energy. Include these ECMs in the SEED Building Model as necessary to meet the 20% better than code requirement.

2. Final energy analysis

The Energy Analyst completes the final energy analysis after the ECM review meeting. The final energy analysis includes the final ECM package analysis:

a. Adjust individual ECM, Proposed Baseline Building analysis, or Code Building analysis, if required, based on feedback and changes at the ECM review meeting.

b. Eliminate ECMs determined to be inappropriate or impractical at the ECM review meeting. Document reasons for their elimination.

c. Complete the analysis of the final selected interactive package to include in the SEED Building.

d. Refine cost estimates for ECMs to be included in the SEED Building. Make any other necessary adjustments to the ECM cost-effectiveness analysis.

V. BUILDING MODELING GUIDELINES

Hourly building modeling is required for all Class 1 buildings except for the following building types which may use simplified hourly building modeling, bin modeling, or the procedures for Class 2 buildings (see Section 3):

a. Heated-only warehouses of any size;

b. Theaters and assembly buildings smaller than 35,000 square feet;

c. Office buildings smaller than 35,000 square feet;

d. Other Class 1 Buildings for which a simplified hourly Building Model or other calculation is appropriate as approved by the Oregon Department of Energy.

1. Hourly building modeling

Hourly building modeling shall use a computer-based simulation program for the analysis of energy consumption in buildings (a program such as, but not limited to, DOE-2, BLAST, or Energy Plus). The simulation program shall include calculation methodologies for the building components being modeled.

2. Simulation Program

The simulation program shall be approved by the Oregon Department of Energy and shall, at a minimum, have the ability to model the following:

a. a minimum of 8,760 hours per year;

b. hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat set points, and HVAC system operation, defined separately for each day of the week and holidays;

c. thermal mass effects;

d. 10 or more thermal zones;

e. part-load performance curves for mechanical equipment;

f. capacity and efficiency correction curves for mechanical heating and cooling equipment;

g. HVAC system controls.

h. perform design load calculations to determine required HVAC equipment capacities and air and water flow rates in accordance with generally accepted engineering standards and handbooks

i. perform simulation using hourly values of climate data, such as temperature and humidity for the city in which the building is to be located

3. Detailed Modeling Protocol

A detailed modeling protocol shall be used to demonstrate that the SEED Building meets the requirement of using 20% less energy than the Code Building. This protocol is described in Appendix L. The summary table below provides an example of the type of outcomes that might result from following the detailed protocol.

Summary of SEED Building Modeling Parameters for Demonstrating Performance in Excess of Code

Parameter	SEED Building	Code Building
Envelope		
Opaque Construction Materials	As designed.	Code minimum pre-defined light frame construction.
Fenestration Thermal Performance	As designed.	Code minimum based on climate zone and window wall ratio.
Shading Devices	As planned, including fins, overhangs, setback, and automatically controlled shades.	None. Windows flush with outside wall.
Window Area	As designed.	The lesser of the as designed area or 40% in Zone 1 or 33% in Zone 2.
Skylight Area	As designed.	The lesser of the as designed area or 6% of roof area.
Building Orientation	As designed.	Same as proposed or average of (4) 90^0 rotations if approved by ODOE.
Lighting		
Lighting Power Density	As designed.	Per Code, Table 13G
Lighting Schedules	As determined by Owner and design team.	Same as proposed with adjustments allowed for lighting controls beyond code requirements.
HVAC		
HVAC Zones.	As designed.	Same as proposed.
System Type	As designed.	Derived from system "map" based on building size, usage, and heating source.
Heating Source	As designed.	Based on proposed heating source.
Cooling Source	As designed.	Packaged DX or water cooled chiller dependant on building size.
Ventilation Rate	Code required/ as designed.	Same as proposed with limited exception for demand controlled ventilation.
Thermostat Setpoints	As designed.	Same as proposed.

Fan Schedules	"On" when space is occupied. Cycled during unoccupied.	Same as proposed.
Fan Power	As designed.	As allowed by code, Section 1318.4.2.
Pumping Energy	As designed.	Per rules in performance rating method (from ASHRAE)
Economizers	As designed.	As required by code.
Motor Efficiencies	As designed.	As required by code Table 13T
Equipment Capacity	As designed.	Based on sizing runs. Oversized 15% for cooling and 25% for heating.
Equipment Efficiencies	As designed.	Minimum code requirements, Tables 13L through 13R.
System Airflow	As designed.	Based on supply-air-to-room-air temperature difference of 20°F
Building Usage Schedules	As planned for the building. Determined by Owner and design team.	Same as proposed.
Domestic Hot Water System	As designed.	Equipment type same as proposed. Efficiencies per code, Table 13I.
Other Non-Regulated Loads including Plug Loads and Process Equipment	As designed	Same as proposed.
Building Electric Transformers	As designed	Same as proposed unless authorized by ODOE.
Utility Rates	Actual rates in effect at start of construction, or default rates provided by Oregon Department of Energy.	Same as proposed.
Weather Data	Climate data from location of proposed building.	Same as proposed.

The inputs for the Proposed Baseline, ECM runs, SEED building and the Code Building shall be submitted in a table format in the Energy Analysis report, (See Appendix H, Section II Report Appendices, Tables A-1, A-2).

Guidelines for Manual Calculations

Where no *simulation program* is available that adequately models a design, material, or device, the Oregon Department of Energy may approve manual calculations to demonstrate savings. Manual calculations shall include documentation of the calculations performed and theoretical and/or empirical information supporting the accuracy of the method. Documentation should provide sufficient detail to reflect all aspects of the ECM energy use impact. The following guidelines shall be followed:

a. Manual calculation methods may be used for:

   i. The initial analysis to screen ECMs for potential elimination. Simple methods may include assumed percentages of baseline energy use as determined by computer model or standard engineering formulas applied to appropriate hourly bin analysis.

   ii. Simple ECMs that interact in a very limited way with the building thermal characteristics. Examples are motor efficiency changes, lighting in unconditioned spaces, exterior lighting, steam trap monitoring, and other ancillary devices.

   iii. Reduction of preliminary data to values for input into the building model. Examples are generation of U-values for finned or underground surfaces, pool and other process loads, domestic hot water loads, and determination of lighting load.

   iv. Post-processing of data from the hourly building model reports to simulate measures that cannot be accurately simulated within the building model. Examples include complex central plant storage or heat recovery strategies that cannot be simulated directly with the model.

b. Manual calculations must be fully documented:

   i. State all assumptions and basis for calculations.

   ii. Show units of all values and intermediate steps of all calculations in algebraic format.

   iii. Provide references for all empirically-derived weighting factors, formulas, or input values.

   iv. Computerized spreadsheets, programmable calculators, and analyst-developed computer programs may be used to replicate simple manual calculations as long as full formula references and documentation is included. Documentation includes a fully developed sample problem showing all input, derivation, and output. Copies of program code, program listings, or spreadsheet formula listings are not acceptable documentation.

VI. COST ESTIMATING

For purposes of the analysis, the incremental cost of the measure is the incremental cost of the ECM (i.e., the cost of the system with the energy-saving features minus the cost of the Proposed Baseline system):

1. Cost estimates for recommended ECMs shall be documented in the report. The level of detail shall be appropriate to the measure. A typical cost estimate shall include material or equipment description, size, quantity, and unit of measurement.

2. The estimates shall include contingencies, overhead and profit, special design and construction supervision costs, where applicable.

3. Values for cost estimates can come from any of the following sources: recent bids, vendors, contractors, or published cost databases such as *Means*.

4. Energy Analysts may prepare a simpler budget when analyzing single ECMs before the ECM review meeting. Once the measure is put into the recommended package, more detailed description and cost estimates may be developed, and the total cost may change. If there is a significant change in cost, the individual cost effectiveness of the ECM may be need to be verified.

5. At the agency's option, the cost of compliance with OAR 330-130 may be included as part of the ECM package cost. These costs may include analysis, meeting attendance, information submittal, and related administrative costs.