The Roadmap for Housing Energy Affordability Implementation

Board of Commissioners, Vermont Housing Finance Agency
Community Development Board, Vermont Dept. of Economic, Housing and Community Development
Board of Directors, Vermont Housing and Conservation Board

Thursday October 13, 2011 1:00 PM – 3:00 PM
(Lunch is available for Board members from 12:00 PM to 1:00 PM)

Central Vermont Chamber of Commerce Building, Berlin VT

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AGENDA

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Central Vermont Chamber of Commerce Building, Berlin VT
(For those who cannot attend in person, we are using GoToMeeting: https://www1.gotomeeting.com/join/561518497; use your microphone and speakers (VoIP) - a headset is recommended. Or, call in using your telephone: Dial +1 (213) 289-0012; Access Code: 561-518-497; Audio PIN: Shown after joining the meeting; Meeting ID: 561-518-497. Please allow 10-15 minutes time in advance of the start of the meeting. Maximum 15 participants.)

Tony Klein, State Representative from East Montpelier and Middlesex, has been invited to come and speak to the Boards on State energy policy and goals, shortly before the 1:00 start time of the meeting.

I. Overview of MacArthur Funding and the Development of the Roadmap for Housing Energy Affordability and the Mechanical System Optimization Guide

Joe Erdelyi; introduction to the Roadmap committee members and the authors of the Roadmap and the Guide; why this initiative was undertaken

II. Roadmap Presentation

Andy Shapiro; presentation and questions and answers

III. Building Science 101

Roadmap Committee; general overview of building science issues for multifamily housing; envelope and advanced mechanical; presentations, then questions and answers

BREAK

IV. Codes, and Requirements of Funders

Roadmap Committee; Codes prior to 10/1/2011; RBES and CBES; Efficiency Vermont, VFEP, and requirements of other energy improvement funders; Enterprise Green Communities and LEED; Vermont's Green Building and Design Standards; Screening and Analysis tools (payback, modeling)

V. The Proposed Roadmap Implementation

Roadmap Committee:
What the proposed standards are
Comparison to Codes and to Requirements of Funders
Vermont Multifamily Air Sealing Protocol ("VMASP") and Vermont Multifamily Mechanical Design Protocol ("VMMDP")
Comparison to Recently Done Projects
Cost versus Savings
Questions and Answers from the Boards and the Public

Support Materials :

A Roadmap for Housing Energy Affordability (hyperlink to VHCB website)

Mechanical System Optimization Guide (hyperlink to VHCB website)

Vermont Multifamily Energy Design Standards (table, Excel)

Comparison of Vermont Building Standards and Codes (table, Excel)

Multifamily Energy Design Standards Q&As (Word document)

Vermont Multifamily Air Sealing Protocol (Word document)

Vermont Multifamily Mechanical Design Protocol (Word document)

Housing Vermont Memorandum of 9/16/2011; Comments on Proposed Standards

**Materials for Andy Shapiro Presentation (PowerPoint)*

**Comparison of Vermont Building Standards and Codes (PowerPoint)*

Note: Materials can be found at http://www.vhfa.org/about/events/calendar.php. The items marked with an asterisk (*) are not currently available but will be available for the meeting on the 13th, and staff will endeavor to make them available after the meeting also.

September 29, 2011

Multifamily Energy Design Standards Questions and Answers, V2

1. What is the rationale behind recommending essentially one standard across building types when the "Roadmap" provides guidance on retrofit packages by building type?

   The Roadmap recommendations, while specifying separate standards by building type, are not so dissimilar as to require different standards for funding requirements. Further, by providing a single, consistent standard the guideline will be easier to implement allowing developers to focus on the processes needed for successful implementation. Additionally, multiple standards would create too much confusion particularly at initial phases where focus should be given to instituting best building practices.

   The committee was charged with recommending an implementable baseline standard for multifamily buildings. While the Roadmap provides a path to best building science, our recommended standard is a balance of best achievable practice and creating energy efficient, affordable housing.

2. Why do small buildings (New Construction) have a separate standard?

   While recognizing local community desires and needs for small buildings, construction of new small buildings should recognize the inherent higher energy use those buildings entail. In order for small buildings to maintain affordability within VT's portfolio, they need to be designed to use much less energy per square foot than larger buildings.

3. How does the recommended standard line up with other standards or the direction in which other standards are moving?

   The Funding standard is based on what needs to be implemented to ensure portfolio energy affordability; it typically exceeds code minimums. Efficiency Vermont's updated multifamily program balances what is technically possible with what passes State wide cost effectiveness rating, also typically exceeding code minimums.

   In addition to slightly more robust target numbers (e.g. R60 vs. R49), the Funding Standard also specifically requires the incorporation and utilization of two process related documents, the VMASP and the VMMDP (see question 7 below).

   Both the EVT MF program and the proposed Funding Standard require marginally better energy efficiency standards than the 2011 RBES Standard, as described in the table. (*Comparison Of Vermont Building Standards and Codes*---attached)

4. Where does the recommended standard get the buildings to with regard to achieving operational cost performance?

Generally, bigger buildings will perform better than smaller buildings due to the single standard for all building sizes. The final assessment on how buildings perform will largely depend on the actual air sealing performance (which is why there is a process document to meet this aspect of the standard).

Overview of Roadmap Case Study Buildings Using Proposed Funding Standard	
Building	**Performance level achieved with proposed standard**
87 Pleasant	Near term
Small Duplex	Not quite near term
Salmon Run	Near term
Pleasant Street	Near term
Willard Mill	Near term
Middlebury South Village	Near term plus
Stone Hill	Close to long term

5. What is the potential range of capital development cost increase to implement these standards?

Cost per unit is highly dependent on building type, starting position (baseline) and number of units. Roadmap cost estimates represent a full "honest" cost analysis of energy only costs on rehabilitation projects already under development. Costs represent full upgrades from existing conditions and are inclusive of costs typically incorporated in current projects.

- New Construction, double loaded corridors $8,000 - $11,000
- Rehabilitation: $22,000 - $35,000

6. What are the expected challenges (other than cost) which the committee expects may arise in the implementation of these standards?

Broadly, prioritizing energy affordability and incorporating the new protocols and processes into existing development systems are the two main areas of potential challenge. (i.e. Incorporating "buy in" across the development community). There are no technical barriers to designing, building, or implementing the standards; products and systems exist widely today to meet these requirements, with these caveats:

- Sourcing R-5 windows
- Integration with Historic Preservation standards

7. What is the rationale behind developing a VMASP and VMMDP as part of the standard?

Some energy requirements are best described by numbers or values (R-30); others are best implemented through a collaboration process. The recommended protocols require the use of specific processes (for mechanical systems & air sealing), to ensure a rigorous and collaborative design procedure occurs.

As part of the Roadmap process, it became clear that both advanced mechanical system design and high performing air sealing systems were critical to achieving our goals. Successful implementation of air sealing and mechanical systems requires in depth and comprehensive design and construction

8. How has the committee addressed the questions of on-site renewable generation?

   Renewable energy sources on site are encouraged, but not required on projects due to:
   - Site specific nature of systems makes them not applicable to all projects.
   - Renewables are not tried and true for all building types (unlike insulation and air sealing); as such they are not required.
   - Ensure that all efficiency measures are implemented before renewable.

9. Why is there not a separate standard for natural gas territory vs. fuel oil territory?

   While current costs of natural gas are lower than oil and propane, it is impossible to guarantee future costs. The most comprehensive approach for all-fuels is to set energy standards leading to MMBtu maximums per unit.

10. What recommendations does the committee have with regard to how incentive funding may be applied?

    As a general rule the committee views air sealing, better shell measures and renewables in that order as candidates for bonus funding. Air sealing provides the largest benefit for the investment. One option could be to require increased air sealing together with bonus incentive funding in another building measure incentive area. Developers would have the option of choosing between 3 different sets of measures for the bonus incentive:
    - Windows
    - Solar domestic hot water
    - Biomass

Comparison of Vermont Building Standards and Codes
September 7, 2011

	Glazing U-Factor	Max Glazing Area	Flat Ceiling R-Value (1)	Slope Ceiling R-Value	Wood Frame Wall R-Value	Mass Wall R-Value	Floor R-Value	Basement Wall R-Value	Slab Edge R-Value and Depth	Heated Slab R-Value	Air Inflitration Performance Testing	Minimum Heating System Efficiencies: Gas boiler < 300,000 MMBtu	Gas boiler > 300,000 MMBtu	Oil boiler < 300,000 MMBtu	Oil boiler > 300,000 MMBtu	Kitchen Ventilation Required
2005 RBES	<= .40	< 15%	38	30	19	19	30	10	10	n/a	n/a	80% AFUE	80% TE	80% AFUE	83% TE	n/a
IECC 2009	<= .35	n/a	49	49 (30)	20 or 13+5ci	19 or 15ci	30	19 or 15ci	10, 4ft	+R-5, perimiter	7 ACH 50p	80% AFUE	80% TE	80% AFUE	83% TE	n/a
Proposed 2011 RBES (2)	<= .32	< 20%	49	49 (30)	20 or 13+5ci	20 or 15ci	30	20 or 15ci	15, 4ft	15	5 ACH 50p					n/a
EPA / ENERGY STAR V3							*(IECC 2009)*					.85% AFUE		85% AFUE		Exterior vent
Roadmap Near Term	0.2-0.3	n/a	55-60	n/a	19-27	n/a	40	16	10	n/a	.9-5 ACH 50	n/a	n/a	83% - 86%	n/a	n/a
Roadmap Long Term	0.14-0.2	n/a	60-80	n/a	27-40	n/a	50	16	10	n/a	.4-1.2 ACH 50	n/a	n/a	83% - 86%	n/a	n/a
Existing EVT MF	<= .35	n/a	38	30	19	19	30	10	10	10	.4-.6cfm50/sqft	90% AFUE	90% TE	85% AFUE	85% TE	n/a
DRAFT EVT MF T1 (3)	<= .30	n/a	55	49 (30)	25	n/a	30	20 or 15ci	5	15	4 ACH 50p	94% AFUE	n/a	85% AFUE	n/a	n/a
DRAFT EVT MF T2 (4)	<= .30	n/a	60	49 (30)	28	n/a	30	20 or 15ci	5	15	3 ACH 50p	95% AFUE	n/a	91% AFUE	n/a	Exterior vent
Proposed VHCB, VHFA, DHCA Funding Standard (5)																
Rehab, all bldgs	U-.30		60		25			15 ci	15		3 ACH 50p	95% AFUE		91% AFUE		n/a
NC >5 units	U-.30		60		30			15 ci	15		3 ACH 50p	95% AFUE		91% AFUE		n/a
NC <4 units	0.2		60		40			20 ci	15		3 ACH 50p	95% AFUE		91% AFUE		n/a

(1) Attic Notes for 2011 RBES

Attic hatches and doors insulated to surrounding surfaces

402.2.1 Ceilings with attic spaces. R-38 shall be deemed to satisfy the requirement for R-49 wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the U-factor alternative approach in Section 402.1.2, 402.1.3 and the total UA alternativein Section 402.1.4.

(2) ENERGY STAR V3 references ASHRAE 62.1, which includes make up air provision.

(3) Additional EVT MF Tier 1 requirements include

- Staged multiple boiler control w/ reset
- Programmable thermostat or boiler based setback controls
- Efficient heat loop pump & demand control
- Energy Star exhaust only
- DHW conservation

(4) Additional EVT MF Tier 2 DRAFT measures may include:

- 70% HRV
- Drain water heat recovery
- EnergyStar certification
- Pellet boiler
- Increased pipe insulation
- Increased AC SEER levels

(5) Proposed Funding Requirements include:

- Complaince w/ VMASP (VT MF Air Sealing Protocol
- Compliance w. VMDP (VT MF Mechanical Design Protocol)
- Bonus funding for biomass, solar, and heat recovery
- Moderate rehab discouraged.
- Alternative load based design:
  - <20MMBtu/unit
  - Demonstrate operating budget w/ $6.25/gal fuel oil cost

Vermont Multi-Family Air Sealing Protocol:

Purpose:

Energy loss through air exchange can account for 40% of the space heating cost for buildings. Unlike other building thermal enclosure measures, such as under slab insulation, air sealing requires a near perfect installation to be effective. This not unlike many other non energy systems in buildings, electrical systems or fire rated assemblies are not allowed to be 95% effective. Air tightness must elevated to the same status.

As operational assumptions are directly tied to energy costs and air leakage can account for such a high degree of heat loss. Understanding how a project mitigates those risks is essential in evaluating the long term financial performance of the project.

Forecasting performance:

High performance air sealing requires good coordination between design and execution, which with practice can produce consistent reliable results. The best predictor for future air sealing performance is a firm's ability to deliver equivalent performance in the past. Please provide three examples of past projects that have achieved a leakage rate of (3) air changes per hour at 50 Pascal.

Or

Please provide the name of the firm or individual whom you plan to contract with whom can provide a list of three projects that has achieved an air tightness of (3) air changes per hour at 50 Pascal.

Means and Methods

Provide a written narrative or schematic drawing showing the design and location of the air barrier. The air barrier design must close such that it can be traced in sectional view from start to start. Please describe each separate system that makes up the complete air barrier and how they connect. Please describe how Penetrations and openings will be sealed.

Materials

Please provide the material choices for each of air barrier systems selected and the transitions between those systems. If planning a winter build, please indicate if material selection is compatible with low temperatures.

Verification

Please provide a plan for air tightness verification, the plan must include a least two stages:

1. Progress testing or inspection, where if faults are found, they can be easily remedied.
2. A final close out test, which values will be entered in as the record air tightness.

If the project is enrolled in and will comply with Energy Star 3.0, the visual inspections and testing for that program can be utilized.

Vermont Multi-family Air Sealing Protocol

Air Sealing Project Form:

Project Name: _______________________ Project Location: ______________________________
Project Sqft: _________________________ Project Volume: ______________________________

Air leakage goal: _____________ACH @50Pa *which is*: ___________________CFM @50Pa

Past Projects verified to perform at or below 3 ACH at 50 Pa		
Project Name:	Air tightness	Verifier
Blake Commons	3.2 ACH @ 50 pa	EVT

Means and Methods:

Please describe air barrier design

The slab on grade project will utilize an exterior sheathing air barrier, starting at the top of concrete wall and ending at the top of wall plate. At which point we will transition the air barrier to the gypsum attic floor through the top plate, the transition will occur at the top plate, with both the exterior sheeting and drywall ceiling being completely caulked to the top plate. The air barrier will continue along the ceiling, down the other exterior wall and return through the concrete slab.

All penetrations or opening will be sealed using low expansion foam or caulk

Materials:

Please describe materials for each air barrier system	
System:	**Material**
Walls	Liquid applied air barrier at sheathing seams, Tremco Exoair 220 or equal
Transitions	Acoustic sealant Auralex StopGap or equal
Ceiling	5/8" gypsum wall board with taped joints, penetrations sealed
Wall openings	Low expansion foam "Touch and Seal" or equal

Verification Plan:

A progress test and inspection will be conducted upon completion of the drywall ceiling, window installation and air barrier application. If deficiencies found, they will be corrected.

Record testing will be conducted by Efficiency Vermont through their home performance with Energy Star program.

Vermont Multifamily Mechanical Design Protocol Project Requirements			
Task		**Responsibility**	**Completed**
1.	Owner Project Requirements (OPR)	Completed by owner before funding application or design team procurement.	
2.	Design Team Procurement	Base "Design Team Procurement" on understanding of, and experience with, high performance building. Include OPR in RFP for design team and their work contracts.	
3.	Basis of Design	Completed by design team, with input from Owner. Owner approves Basis of Design.	
4.	Sequence of Operation	Completed by design team. Included in final documentation to building owner and operator.	
5.	Training Requirements documentation	Completed by design team. Resources for all training outlined included in project budgets	
6.	Meet or Exceed Minimum Equipment Efficiencies	Design team meets or exceeds minimum requirements, which are included in OPR, RFP, and design team contract.	

1. Owner Project Requirements (OPR):

A comprehensive document outlining the project requirements, typically referred to as the Owner's Project Requirements (OPR) will be developed for each project. The OPR ensures that the development team, owners, design team, contractors, funders and even building occupants understand the expectations for the building.

The OPR will be developed as part of the initial funding documentation and used to review the project throughout the design, construction and turnover process to increase the likelihood that the constructed building reflects the original vision of the project.

Owner Project Requirements: Minimum documentation expectation	
Event	**Deliverable**
Funding Application	Include in housing funding applications to VHCB, VHFA, and State of VT DHCA)
Design RFP	Include OPR in the RFP and require that the team works with the owner to refine, and ultimately meet the OPR.
Design Contract	Reference OPR in the design contract, and require that the team works with the owner to refine, and ultimately meet the OPR.
Construction Contracts	Include the OPR in the Bid Specifications
Project Documentation	Provide OPR in electronic format to the building operator and reference in maintenance contracts

Sample OPR language is provided in the MSOG, Appendix C; this is not a comprehensive OPR, but rather a starting place for the development of a project specific OPR. The OPR should state:

1. Owner and User requirements – including occupancy information, number of units, accessibility needs and the expected lifetime of equipment and components.
2. Energy Performance Requirements – state the PUM cost goal, require design, construction and ultimate building performance are in accordance with the RHEA and MSOG and identify other energy efficiency requirements such as use of ENERGYSTAR appliances.
3. Indoor Environmental Conditions – including temperature requirements in units and common areas, elevator turnaround time, time delay for hot water in winter, VOC limitations during construction and maintenance, etc.
4. Building Occupant and O&M Personnel Requirements – identify whether the project will be maintained by owner personnel or contracted maintenance, indicate acceptable frequency of in unit maintenance, address access requirements - particularly for equipment located in units. Include training expectations from design team to building operation personnel at turn over and end of warranty period.

5. Project sustainability goals – this may relate to achieving a specific recognition such as LEED certification, or it could define specific areas such as LEED prerequisites and credits that are to be addressed in a project that may not be pursuing certification. Address requirements for construction waste recycling, on site recycling and composting facilities, site septic and other environmental requirements.

2. Base "Design Team Procurement" on understanding of, and experience with, high performance building.

Event	Deliverable
Selection Criteria	Select design team members based on criteria that include demonstrated ability, understanding and commitment to achieving the proposed budget and energy goals as well as the cost of design services.
Design Firm RFP & Contract	To ensure that project teams have read and understand the OPR, RHEA and MSOG, include language in design firm RFPs and contracts that prioritize integrated mechanical design. Examples below.

Example Selection Criteria for high performance building design team:	
Criteria	**Points**
Team's demonstrated understanding of the design and construction approaches necessary to achieve the OPR, including the building energy performance goals and the approaches outlined in RHEA and MSOG.	30
Team's demonstrated ability to design high performance buildings that are constructed within budget	25
Team's success in delivering energy performance coupled with building indoor environmental quality on prior projects	25
Proposed pricing, including the reasonable allocation of design resources among team members	20

Design Firm RFP	
The following RFP requirements will facilitate review of proposals relative to the Selection Criteria outlined above:	
1.	The team shall describe how they will approach the development of a design that is in full compliance with the OPR and address the recommendations of the RHEA and MSOG documents. The response shall include information from the architect and mechanical engineers at a minimum and other team members' input should be included where relevant. The response shall include a clear statement of the design process and timeline that will be used to ensure fully integrated design, including but not limited to: a. Development of the Basis of Design b. Building modeling and or load calculations

	c. Interactive review of building components and design approaches, method for prioritizing and selecting the final building components and design approaches. *In reviewing proposals for scoring relative to item 1 above, look for integration of the responses as an indicator of a team with better communication which will more likely result in the collaboration required to meet the energy performance goals. Also look for a timeline that includes early modeling*
2.	The team shall provide at least one and not more than three examples of recently completed projects (in the past 5 years) that were designed to meet specified project energy goals, completed within budget and achieved energy performance consistent with the goals. Information required includes: a. Project name and facility type b. Project team including owner, architect, engineers, general contractor, mechanical subcontractor c. Gross conditioned square footage and unconditioned area (separate) d. Building construction budget, actual construction cost, total design costs and other soft costs e. Overview of the design and construction timeline including design start, DD complete, CD complete, construction start, construction complete, occupancy f. Project energy goal(s) – numeric, modeled energy use for the building, measures used to achieve the building energy goals g. Project energy and indoor environmental quality performance – provide information on the actual performance of the building and describe the team's role, if any in post occupancy monitoring, addressing issues relative to energy, shell performance or comfort h. Discussion of actual building performance relative to goals
3.	Provide proposed pricing by design phase, including the breakdown of fees by subconsultant and a list of deliverables at the conclusion of each phase. Subconsultant selection opportunity: architects could include the average fee for the mechanical design in their proposal. Once selected, the architect could then present the mechanical proposals including fees and responses to the selection criteria questions for review and selection in collaboration with the owner. The architect's fee would then be adjusted to reflect the difference between the initial average fee and specific fee for the selected mechanical engineer.
4.	Certify in writing that team members have read the OPR, RHEA and MSOG and that the proposal is based on developing a design that will satisfy the OPR and will use approaches that are consistent with RHEA and MSOG. (Include similar language in contracts.)
Design Firm Contract	
1.	Include critical energy and other performance goals as part of the design contract language, including OPR and reference to MSOG.
2.	If the engineer is subcontracted to the architect, include a statement in the architect's contract that this energy performance target is a collaborative target required of all team members.

<table>
<tr><td>3.</td><td>Require energy performance milestones and deliverables and tie payment to completion of these milestones. Milestones may include:
Design charrette in which the team discusses and refines the project requirements, establishes responsibilities and communication protocols for addressing interactive effects and brainstorms on strategies. Complete by SD
Building modeling - early completion (where included) and HVAC load calculations for review against building envelope tradeoffs. First iteration by 50% DD and final iteration submitted as part of 100% DD documents. Includes submission of Mechanical Modeling/Load Calculation forms in MSOG Appx. B
BoD - Complete a draft BoD at 100% SD and a full BoD at 100% DD. The BoD should be updated to reflect changes in approach through bid documents</td></tr>
<tr><td>4.</td><td>Operations, Maintenance, and Training – For all mechanical equipment, provide an O&M schedule including
Routine maintenance requirements
Training procedures necessary for staff to complete routine maintenance
Training plan for project operations staff to operate equipment</td></tr>
</table>

3. Basis of Design (BoD) Documentation

The BoD describes the building systems, outlines all design assumptions and specifically addresses how the system design will meet the OPR. The BoD will evolve as the design is developed. The BoD document is made for the life of the facility and should be included in the project contract documents.

Basis of Design Documentation	
Event	**Deliverable**
RFP & Contract	State that BoD is required
100% SD	Design team submits draft BoD for review
100% DD	Design team updates and resubmits BoD. If the project includes commissioning, the CxA should be included in the BoD review
Design and Construction	BoD should be updated to reflect any major changes in design approach based on pricing, alternates or other changes
Turn Over	Provide the BoD to the building operator

The following should be included in the BoD:

- General Project Information
  - Type of building
  - Location
  - Square footage
  - Number of stories
  - Types of occupancy
- Primary design assumptions:
  - Design conditions
  - Interior conditions for various types of rooms
  - Space use
  - Occupancy density
  - Ventilation rates
- Standards and Codes – Reference the specific applicable codes (version), regulation, guidelines and other references that will be used for the project. The BoD should include as a minimum:
  - Specific applicable code, including the version referenced for the design
    - Building codes
    - Fire and Life safety codes
    - Plumbing codes
    - Energy codes
  - Standards (Example: ASHRAE Ventilation Standard 62.2-2010)
  - Guidelines
- Narrative descriptions
  - Description of performance criteria for building envelope, HVAC systems, lighting, domestic hot water, on-site power, etc. and specifically indicate

how these systems and the design approaches satisfy the project requirements articulated by the Owner. A well written BoD should include:

- Lighting types, design foot-candles, lighting design LPD, types of lighting (interior/exterior), lighting controls
- HVAC design loads, diversity factors, zoning
- Number of Boilers, boiler redundancy, type of boilers, operating efficiency
- Pumping systems: Number of pumps, arrangement (primary / secondary), variable flow, diversity factors, full load and part efficiency, fluid design temperature difference
- Type of airside distribution, airside and ventilation, loads, coils, delivery temperatures, economizers, exhaust systems, energy recovery systems, fan power , fan efficiency (performance metrics)
- Domestic How Water system type (direct/indirect), full load capacity, full and part load efficiency, design entering/storage/delivery temperatures, DHW recirculation sizing
- Control and operational concepts for each system
- Operations and maintenance requirements to be included in the specifications

The owner should review the discipline specific Basis of Design documents, provide comments and sign off on the agreed upon approach at each phase of design review.

Additionally, Design and Operating Assumptions will be documented to demonstrate to all team members the interactive assumptions responsible for the building performance (Modeling / Sizing Inputs and Outputs). Example:

PART I: Modeling / Sizing Inputs	
Parameter	**Modeled Value or Range**
General Parameters	[Example information provided]
Building Location	Burlington, VT
Building Type Classification	Multifamily, Mixed Use Commercial, etc.
Building Code Applied	VT Res Guildeline 2005
Weather Data Source / Type	NOAA TMY3, BTV
Building Dimensions	
Number of Floors Above Grade	*2*
Number of Floors Below Grade	*1*
Floor to Ceiling Height	*8ft*
Roof Configuration	*Gabled, 25 degree pitch*
Perimeter	*200 ft*
Surface Area	*4000 sq-ft*
Envelope	
Infiltration rate	*0.1 ACH*
Exterior Wall Assembly R-Value, Insulation Type	*R-40, x" continuous polyiso + x" Batt*
Attic Floor Assembly R-Value, Insulation Type	*R-50 x" continuous polyiso + x" Batt*
First Conditioned Floor is Above (Slab, Garage, Other)	*Garage open to ambient conditions.*
Slab Insulation (Below, above, slab edge, etc)	*X" continuous R-14 below + 3" polyiso slab edge*
Below Grade Wall Insulation	*R-3, continuous polyeurethane, x"*

Window & Door Tabulation	*Include types, assembly R values, shading coeff, orientation and quantity in separate table.*
Other Envelope Features	*Address other features such as fixed exterior shading or shading by trees. Particularly important for cooling calcs.*
Building Occupants	
Occupancy Schedule	*Weekdays 5pm to 7am 100%* *Weekdays 7am - 3 PM 55%* *Weekdays 3PM - 5PM 75%* *Weekends & holidays 100%*
Occupied Temperature Setpoint (winter, summer)	*70/75F*
Unoccupied Temperature Setpoint (winter, summer)	*70/75F (no setback)*
Total # of Units in Building	*12*
Average # of Occupants per Unit	*3*
Total Bedrooms in Building	*20*
Occupant types for DHW calculations	*Senior, Family, Single Parent, Income Levels, Working, etc.*
Central Heating Plant Equipment	
Equipment Type	*Condensing Boiler*
Fuel Source	*Oil*
Equipment Efficiency	*91% Efficient*
Cooling Equipment	
Equipment Type	
Chilled Delivery Mode	
Equipment Efficiency (EER/COP)	
Number of Units	
DHW HP heating system	
ERV heating/cooling system	
Terminal Equipment	
Terminal Equipment Type	*Baseboard*
Capacity Rating	*800 BTU/hr/sq-ft*
Ventilation	
Ventilation rate dwelling	
Ventilation rate common areas	
Building Loads & Schedules	
Lighting Power Density - common areas	
Common area lighting schedule	
LPD dwelling units	
Dwelling unit lighting schedule	
Laundry loads & frequency	
Cooking	
Miscellaneous plug loads	

PART II: Modeling / Sizing Outputs		
Energy Use	**Value**	**Units**
Total Annual Space Heating Input Energy		MMBTU
Total Annual Space Cooling Input Energy [3]		Ton-Hrs
Total Annual Building Electrcal Energy		kWh/yr
Total Annual DHW Input Energy		
DHW Thermal Storage		
Peak Space Heating Load		MBTU/hr

Peak Heating Load from Ventilation		MBTU/hr
Space Heating Thermal Storage		
Boiler size and quantity		
Boiler and Thermal Storage peak hour capacity		MBTU/hr
Peak Space Cooling Load [3]		MBTU/hr
Energy Intensity		MBTU/sq-ft/yr
PUM Electrical Coss (current $ value) [1]		$/unit/month
PUM Fuel Costs (current $ Value) [2]		$/unit/month
PUM Electrical Costs (Yr. 15 @ 5% Esc) [2]		$/unit/month
PUM Fuel Costs (Yr. 15 @ 5% Esc)		$/unit/month
[1] Per housing unit monthly expenses. Includes common areas.		
[2] To calculate year 15 rough costs for 5% multiply current dollar fuel costs by 2.08, this is a rough approximation and does not include inflation.		
[3] For buildings with cooling model and report loads for ERV and for HRV to allow for comparison.		

4. Sequence of Operations documentation

Design team shall supply a written sequence of operation (SOP) for entire heating, ventilation, and air conditioning system and each individual piece of equipment. SOP shall define the manner and method by which all equipment operates.

SOP shall include start up and shut down procedures, and operations at different operating conditions including:

- Night / Day
- Seasonal (winter/summer)
- Occupied / Unoccupied
- Fully / Partially loaded system

5. Training Requirements Documentation

System orientation and training should be required for all building operators, and is recommended for owner's facility management/project managers; particularly as new technologies are introduced. For new buildings and major renovation projects, training typically occurs at the end of project construction. Operators often do not assume full responsibility for the system until the system warranty period expires one year later. It is recommended that additional training be provided as the end of warranty period approaches to ensure the operating staff has the opportunity to apply what they've learned shortly after the training is completed.

Training Documentation	
Event	**Deliverable**
OPR	Include training requirements, timing (at project completion and end of warranty period), specify in house or third party O&M, O&M provider input on training
RFP & Contract	Explicit language regarding training documentation requirements
Design Review	Ensure specifications address training
Construction	Review formal training plan, ensure O&M staff are available for and attend training
Post Occupancy	Schedule training at close of warranty period

Example Training Schedule:

Appendix I: Training Requirements

Spec Section	Equipment / System	Total Hours	Type of Training	Timing [1]	Verified in Spec	Trainer	Trainer Organization	Verified Training Provided
Miscellaneous Equipment								
142424	Hydraulic Elevators	4	System shut down, elevator recall, emergency proceedures, demonstrate elevator operation upon loss of power and any required reset upon restoration of power	TO				
213250	Fire Suppression	2	Overview of system, maintenance requirements and testing, location of tamper and flow switches and system valves	TO				
Plumbing								
224100	Plumbing Piping	1	Review routing, access, placement of cleanouts, venting, roof drain locations - Building walk through with plans, review insulation levels	TO, 10 month post oc				
224400	Plumbing Fixtures	1	Review parts inventory, review equipment list	TO, 10				
	Well water system	1	location of well, pumps, valves, shut down proceedure	TO, 10				
	Septic system	1	tank location(s), maintenance requirements, mowing requirements	TO, 10 month post oc				
	Domestic Hot Water Heater	1	Equipment startup, trouble shooting and shut down proceedures, review preventive maintenance requirements as documented on the PM matrix, review spare parts	TO, 10 month post oc				
	Domestic Hot Water Pumps	1	Equipment startup, trouble shooting and shut down proceedures, controls, expected operation, potential problems with operation, review preventive maintenance requirements as documented on the PM matrix, review spare parts	TO, 10 month post oc				

6. Minimum Equipment Efficiencies

Installed mechanical equipment shall meet the minimum efficiencies listed below:

Minimum Equipment Efficiencies	
System	**AFUE**
Natural Gas Hot Water Boiler	95% AFUE
Oil Hot Water Boiler	91% AFUE
Wood Pellet Boiler	85%
Ventilation, small, in-unit HRV's	60%%
Ventilation, central HRV's	50%
Boilers installed with outdoor reset control and boiler temperature set back.	
Indirect-fired hot water storage tank	

7. Glossary

BoD	Basis of Design
DD	Design Development
MSOG	Mechanical System Optimization Guide
OPR	Owner Project Requirements
PUM	Per unit per month cost of heat and domestic hot water
RHEA	Roadmap to Housing Energy Affordability
RFP	Request for Proposal
SD	Schematic Design

HOUSINGVERMONT
Building possibilities.

To:	Joe Erdelyi/VHFA & Craig Peltier/VHCB
From:	Kathy Beyer/HV
Cc:	Trevor Parsons/HV
Date:	September 16, 2011
RE:	Energy standards

Joe & Craig,

Trevor spent some time with me last week reviewing the proposed multifamily energy design standards and I would like to provide some input from Housing Vermont's perspective. I would like to comment on three areas: the proposed standards, the possible divergence from the Efficiency Vermont multifamily standards, and quality of life issues.

Proposed standards:
Attached is an analysis of recent building completed or under construction by HVT, in comparison to the proposed standards. We note the following by category:

New construction, over 4 units: In new construction buildings where the ceiling/attic insulation is blown cellulose, it is affordable and cost effective to get to the R60 level. However, when the building has a flat roof assembly (such as Avenue Apartments), and rigid foam insulation, the delta from an R50 to an R60 may not be cost effective. We recommend a baseline standard of R50.

You can also see from our recently completed Johnson building, and the under construction Vergennes building, that these buildings do not meet the R30 wall standard or the R15 slab standard. The Johnson building is very, very tight. I would caution using either the R30 wall standard or the R15 slab standard as a baseline.

New construction, 4 units and under: The attached analysis compares the standard to the duplexes recently completed at Hickory Street in Rutland. We understand the policy, from an energy perspective, is to increase the standard for smaller buildings. However, there are other policy issues to be considered---such as quality of life and the character of the neighborhood. At the proposed baseline level, very few of the buildings could be built.

Rehab: The proposed standards recognize the difficulty of getting to an R25 wall due to historic preservation issues. However, the standards assume that we will be able to get to an R60 ceiling/attic. For almost all historic rehabs, this will be blown insulation in the attic. Getting to an R60 will be completely dependent on the amount of attic space in the existing building. The same is true for slab edge insulation, which can sometimes be limited by expensive hardscape or other unexpected limitations. We ask that there be latitude around rehab prescriptive measures to acknowledge existing conditions.

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Efficiency Vermont draft MF checklist:
As currently proposed, the Efficiency Vermont multifamily standards would not match the proposed standards to be used by the Funders. This divergence in standards could present problems as we seek every dollar necessary to implement these new standards. If EVT managed funding must meet the cost effectiveness screening based on the State Screening Tool, we ask that the base standard be in harmony with the EVT MF checklist. We presume the proposed draft MF Checklist does pass the State Screening Tool. If we have divergent standards between funders, we may find ourselves ineligible for incentive funds managed by EVT.

Quality of life, housing choices:
The efforts of putting together the Roadmap and these proposed standards are to be commended. Aptly named, we now have a roadmap which helps us understand where we have been, and where we need to go if the inflation in energy pricing continues.

As I am sure VHFA, VHCB and VCDP also understand, there are hundreds of choices to be made in the construction or renovation of a building. Making the decision to upgrade the energy efficiency package, could conversely result in some other decisions. Adoption of the fairly high standard for buildings that are 4 units are less, could mean we can't build these smaller buildings. Yet from a quality of life perspective, a duplex or triplex building is one of the most desirable units for our renters. The smaller buildings create more of a sense of home, and can be used to create a streetscape that is in scale with the neighborhood.

The increased capital costs related to the energy upgrades may have the consequence of building fewer affordable units across the state. Or a decision to invest in the energy upgrades could make it very difficult to also invest in more sustainable products for our buildings---such as wood flooring, or non-vinyl siding.

Another quality of life issue is ventilation. As we tighten up our buildings, we also need to properly ventilate our buildings. This is an area where additional research is needed, as we struggle to find the right ventilation approach. Maintenance costs, electricity costs, noise are all problems that impact our residents and our operating budgets. From HV's perspective, we really should be very careful about tightening up our buildings if there is not a good ventilation solution.

We have made great progress over the last two years in upgrading our building envelopes and incorporating solar domestic hot water in just about every project. Several of our new buildings will go through their first full heating season this year: Johnson, Hickory Street, and Cedar's Edge. Analyzing the actual fuel usage in these buildings should be an ongoing part of the discussion about our future direction.

Thanks for the opportunity to comment on the proposed standards.

Envelope comparision between current practice and proposed standards.

Bulding B, Duplex
Hickory Street, Rutland

Component	Existing R-value	Proposed R-value
Basement / slab	R-10 - 2" of XPS foam	R-20 - 4 inches of XPS foam
Walls	R-25* - 2 x 6 walls, dense pack cellulose, 1" of XPS foam	R-40 - 2x6 walls, dense pack cellulose, + 4" of XPS foam
Windows	R-3.3, double glased, low e, argon filled	R-5.0 - triple glased, low e, gas filled.
Attic / Roof	R-50, loose fill cellulose	R-60, loose fill cellulose

Senior Building, 10 Units
Johnson Community Housing, Johnson

Component	Existing R-value	Proposed R-value
Basement / slab	R-10 - 2" of XPS foam	R-15 - 3 inches of XPS foam
Walls	R-28* - 2 x 6 walls, 4.5 inches 2 part spray foam	R-30 - 2x6 walls, 4.5 inches 2 part foam, + 1/2" XPS foam
Windows	R-3.3, double glased, low e, argon filled	R-3.3, double glased, low e, argon filled
Attic / Roof	R-60, loose fill cellulose	R-60, loose fill cellulose

Vergennes Senior
Vergennes

Component	Existing R-value	Proposed R-value
Basement / slab	R-10 - 2" of XPS foam	R-15 - 3 inches of XPS foam
Walls	R-34* - 2 x 6 walls, 4.5 inches SF + 1" Poly-iso	R-30 - 2x6 walls, 4.5 inches 2 part foam, + 1/2" XPS foam
Windows	R-3.3, double glased, low e, argon filled	R-3.3, double glased, low e, argon filled
Attic / Roof	R-60, loose fill cellulose	R-60, loose fill cellulose

* Note: The list R-value is the cavity only insulation value, when we account for wood the clear wall R value of both Hickory Street and Johnson are about equal at approximately R-22. Vergennes Clear wall R-value is 29.

Vermont Multifamily Energy Design Standards-Draft - September 2011, v2

Base Standard for All Building Types (Except small 4 unit or less new construction)

	Ceiling / Attic R [1]	Wall R[1]	Window[2] R-value / U-Value	Foundation R-Value, Continuous	Slab Edge R	Air Sealing: VMASP [4]	Advanced Mechanical			
							Mechanical [5]	Solar	Biomass	ASHP
Rehabilitation	60	25 [3]	R 3.3 / U.30	15	15	<3ACH 50	VMMDP	*Not Required*	*Not Required*	None
New Construction	60	30	R 3.3 / U.30	15	15	<3ACH 50	VMMDP	*Not Required*	*Not Required*	None
Potential Future Incentive Level		30	R 5 / U.20	15	15	<2ACH 50	HRV required	50%+ of load	75%+ of load	COP <3

Base Standard for Small Buildings, New Construction (4 units and less):

	Ceiling / Attic R[1]	Wall R[1]	Window[2] R-value / U-Value	Foundation R-Value, Continuous	Slab Edge R	Air Sealing: VMASP [4]	Advanced Mechanical			
							Mechanical [5]	Solar	Biomass	ASHP
New Construction	60	40	R5/U.20	20	15	<2 ACH50	VMMDP	*Not Required*	*Not Required*	None

Alternative Load Based Design Standard:

Projects which can not meet the energy specifications detailed in the tables will be eligible for incentives with building energy modeling demonstrating annual energy load is equal to or less than:

Required:	< 20 MMBTU / Unit

Projects not meeting the base standard or Alternative Load Based Design will be considered Moderate Rehabilitation Projects

Moderate Rehabilitation Discouraged:

Where required for portfolio reasons moderate rehabilitation projects will be underwritten from an energy perspective on a case by case basis. During pre-application feasibility a blower door guided energy audit is required to determine all possible energy upgrades that can be accomplished within the parameters of project scope and budget. In addition all moderate rehabilitation upgrades shall include an operating budget based on $6.25/gal. fuel oil equivalent input price.

Notes

[1] R-value is represented by cavity + continuous, and does not include structural or finish materials (studs, sheet rock, siding, etc.)

[2] Expect window requirements to be reviewed in 2012

[3] R-20 Exemption may be made for Historic buildings where siding can not be replaced or cavity depth can not be increased

[4] VMASP: Vermont Multifamily Air Sealing Protocol

[5] VMMDP: Vermont Multifamily Mechanical Design Protocol