FLORIDA SOLAR ENERGY CENTER®
Creating Energy Independence

Interim Report on ISO TC 163 Working Group 3

FSEC-CR-1799-09

Annual Progress Report
April 2, 2009

Submitted to

U.S Department of Energy
Building America Program

Contract No. DE-FC26-06NT42767

Author

Philip Fairey

1679 Clearlake Road
Cocoa, Florida 32922, USA
(321) 638-1000
www.floridaenergycenter.org

A Research Institute of the University of Central Florida

Interim Report on ISO TC163 Working Group 3

Philip Fairey
Florida Solar Energy Center

April 2, 2009

Abstract

This report covers the initial year efforts of the International Standards Organization (ISO) to develop international standards for rating the energy performance of buildings. The author of this report is a participant in this effort. This report summarizes the activities of the ISO Working Group charged with development of these standards and makes recommendations to the sponsors for future U.S. involvement in this ISO effort.

Keywords: International Standards Organization, ISO, building energy ratings, building energy efficiency, building energy performance, rating systems

Background

In December 2007, the author was nominated by ANSI to serve as the U.S. representative on the International Standards Organization (ISO) Technical Committee 163 (TC163), *Thermal Performance and Energy Use in the Built Environment*, Work Group 3 (WG3) on *Energy Performance of Buildings*. The author's participation on this working group is being supported by the U.S. DOE's EERE Office of Building Technologies, Building America Program. The membership roster of the ISO TC163 WG3 is included in Appendix A.

Membership on this ISO Working Group gives the U.S. a seat at the table in the development of international standards that will likely be used for the purposes of characterizing the relative efficiency of buildings and the characterization of efficiency improvements that can reduce carbon emissions.

ISO TC163 WG3 Activity Summary

To date, ISO TC163 WG3 has met three times. Its first meeting was held in Delft, Netherlands in February 2008, its second meeting was in Nanjing, China in April 2008 and its third meeting was in Delft, Netherlands in October 2008.

At its first meeting, TC163 WG3 put forth the initial conceptual framework for its activities. This framework consisted primarily of a group of definitions that the convener felt were important to the activities of the WG and a significant number of European Standards that had been previously developed in response to the European Union's Energy Performance of

Buildings Directive (EPBD), which were thought to contain much of the needed technical basis for an ISO Standard on building performance.

In conjunction with the first meeting of TC163 WG3, an ad hoc joint meeting was held between experts from TC163 and experts from TC205, *Building Environment Design*. One result from the joint ad hoc meeting of these two TCs was a recommendation to the Technical Management Board (TMB) of ISO that 2 new sub committees (SCs): one under TC163 (SC 4) entitled *Calculation of Building Energy Efficiency* and one under TC205 (SC 1) entitled *Calculation of System Efficiency* be developed.

At its second meeting in Nanjing, TC163 WG3 made some significant progress in defining the needs of an ISO standard as it may differ from the existing European standards. A list of six "hot topics" was drawn up by the convener as a result of these discussions. This list was distributed for comment and for discussion at the following WG3 meeting. The author submitted two additional "hot topics" to the WG3 convener, which were added to the list for discussion at the third meeting of the WG. The full list of eight "hot topics" was vetted with U.S. experts through widespread distribution by RESNET as well as through an ad hoc meeting held at the ACEEE Summer Study in August 2008. The list of "hot topics" and responses from U.S. experts is attached at Appendix B.

The third meeting of TC163 WG3 addressed the list of "hot topics" that were developed as a result of the second meeting of the WG. The results of the WG3 deliberations were as follows:

- Hot topic 1. *Can we prescribe an ISO choice on how to aggregate to one energy performance indicator?* The general consensus was to prescribe uniform conversion factors for an **ISO Weighted Energy Us**e with a prescribed universal conversion factor of 2.5 from electrical site energy use to primary energy use.
- Hot topic 2. *Can we prescribe one common ISO numerical expression of the energy performance?* The general consensus was to ISO weighted total energy use and ISO weighted energy use per square meter of conditioned floor area. It was also decided that an informative annex would be created to address a **reference building approach** that would provide a relative measure of the building energy use compared with a reference building. The author was charged with submitting a preliminary draft of such an approach, based on U.S. methodologies, for residential buildings. A copy of the submitted preliminary draft is attached at Appendix C.
- Hot topic 3. *Do the given procedures to define the boundaries of the building cover all needs?* There are three areas with boundaries in between: (1) building energy needs, (2) energy delivered to the technical building systems on site (and energy exported from the site), (3) conversion of energy outside the site (electricity, heat, cold). Area (3) brings us back to the conversion factors, hot item 1 above. The output of renewable energy systems at the site should be recorded separately, if possible.
- Hot topic 4. *Do we include (or allow to include) the energy use of household appliances?* WG3 decided to add the energy use for household appliances, assuming that this will not create a conflict with the EPBD in Europe. Standard values will be introduced. These standard values may be replaced by specific lower values if the long term presence of specific less energy consuming appliances can be guaranteed.

- Hot topic 5. *Do we include (or allow to include) measured energy use as basis for energy performance rating?* Following considerable discussion, WG3 decided that the calculated energy performance rating will be the basis for the ISO rating aimed at international comparison of energy performance of buildings (with standardized operating conditions). While it may be allowed nationally, measured energy will not to be required in the "ISO rating" as the *prime* metric for the EP of buildings. On the other hand, measured energy is to be encouraged as a *secondary* (supporting) metric, supported by clear harmonized procedures, as a very important tool to detect the effect of specific user behavior and/or the actual functioning of building and its systems.
- Hot topic 6. *Can we define uniform operating conditions (as function of building use, climate, etc…) at this level?* The establishment of a set of uniform operating conditions to be assumed in the calculation of the weighted energy use was considered by WG3 to be very important for the international comparison of energy performance of buildings (i.e. "uniform operating assumptions").
- Hot topic 7. *Will all calculated energy ratings be required to use ISO13790:2008 as the standard for building simulation and modeling?* ISO 13790:2008 provides a level playing field with regard to the definition of boundaries (building, systems, which details to be included, classification, etc.), input data and conditions, applicable for both simplified methods and detailed simulation tools. It **does not** provide specifications or performance specifications if detailed simulation tools are used. This is a gap in ISO (and CEN) standards. The current CEN software validation standard covers only a small part of the energy calculation (dynamic thermal balance in a single room). This subject has been identified as a possible new work item within TC 163. Existing validation procedures and requirements in ASHRAE or elsewhere allow too wide a band width in calculation results (for some important components of the calculation on the order of even 50%), which makes these procedures / requirements not suited for use in the context of building regulations where reproducibility is very important.
- Hot topic 8. *Will provisions to prevent manipulation of reference building calculations be included in the Standard?* The minutes of the meeting state that this item was covered in hot topic 3. However, this is not the entire case and results of efforts to create a reference building methodology (hot topic 2) will determine much of the answer to this topic.

Recent ISO Actions

In March 2009, the ISO Technical Management Board (TMB) passed Resolution 5/2009 (attached at Appendix D) creating a Joint Working Group (JWG) between TC163 and TC205 and requiring that all matters of building energy rating systems that is of interest to both TCs be conducted through this new JWG. To date, TC205 has not appointed a co-convener for this working group. It is anticipated that this new matter will become much clearer following the May 4-8, 2009 meeting of TC163 in Zurich, Switzerland. On March 2, 2009, the author was nominated by ANSI as a member of this JWG.

Recommendations

It is highly recommended that the U.S. DOE's EERE Building Technologies Program continue to support U.S. participation in these efforts to develop ISO standards on energy rating of buildings. Without a seat at the table, the U.S. will have little influence on the outcome of such deliberations. To date, U.S. positions have been carefully considered and often supported by the membership of ISO TC163 WG3.

There are two items of considerable impact in this regard. First, the concept of reference buildings, while it is extremely important in U.S. activities, had not been duly considered in international deliberations on building energy rating systems until it was pressed by U.S. representation. This item is now clearly on the agenda of the international experts and is being pursued as an effective means of rating the relative energy use in all classes of buildings.

And second, with reference to "hot topic" number 7, there is clearly more work and influence that needs to be brought to bear by U.S. interests on verification of detailed software used to calculate energy ratings. The U.S. has consistently relied on ASHRAE Standard 140, *Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs*, for verification of software tools in use in the U.S. for code compliance, federal tax credit and energy rating purposes. ISO Standard 13790:2008 does not contain software verification tests of similar rigor or comprehension. Rather, it specifies a series of algorithms that are to be used for seasonal or annual calculation of building energy loads and largely leaves detailed hourly analysis insufficiently addressed.

While, the practice of specifying all of the explicit algorithms and boundary conditions that are to be used for calculation of building energy loads may have some merit in producing "reproducible" results, it does not mean that such result are accurate for the specific set of circumstances of the building being evaluated. For example, ISO 13790:2008 specifies the effective sky temperature that is to be used in calculation of radiation heat transfer from the exterior surfaces of buildings. It specifies only two conditions. On the other hand, the effective sky temperature for radiation heat transfer from buildings is a strong function of both the hourly conditions and local climate condition (moisture content of the air and cloud cover). As such, while specifying a single annual effective sky temperature for seasonal or annual building load calculations may lead to consistent results; it will also almost always lead to less accurate results.

Acknowledgements

This work is sponsored, in large part, by the US Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy, Building Technologies Program under cooperative agreement number DE-FC26-06NT42767. We appreciate the support and encouragement of our program managers, Mr. George James, Mr. Ed Pollock and Mr. William Haslebacher. This support does not constitute DOE endorsement of the views expressed in this paper.

Appendix A
Members of ISO TC163 WG3

Country	Name	Email	Class
Members:			
THE NETHERLANDS (convenor)	Mr Dick (H.A.L.)van DIJK	dick.vandijk@tno.nl	P
	Mr Jaap HOGELING	j.hogeling@isso.nl	P
AUSTRIA	Mr Thomas BEDNAR	thomas.bednar@tuwien.ac.at	C
BELGIUM	Mr Dirk van ORSHOVEN	dirk.van.orshoven@bbri.be	C
CANADA	Mr. Robert MARSHALL	marshallRbrt@aol.com; bob.marshall@jacqueswhitford.com;	P
	Mr Laverne DALGLEISH	Ldalgleish@bpc.ca	P
EGYPT	Mr Essam E KHALIL	khalile1@asme.org	P
FRANCE	Mr. Gilles VERLINDEN	gilles.verlinden@afnor.org	C
GERMANY	Mr Hans ERHORN	hans.erhorn@ibp.fraunhofer.de	P
	Mr Franz-Josef KASPER	franz-josef.kasper@saint-gobain.com	P
	Mr Martin H. SPITZNER	spitzner@fiw-muenchen.de	P
JAPAN	Mr Shuichi HOKOI	hokoi@archi.kyoto-u.ac.jp	P
	Mr Takao SAWACHI	sawachi-t92ta@nilim.go.jp	P
	Mr Akihiro NAGATA	ngt@tmu.ac.jp	P
	Mr Mitsuhiro ADAGAWA	adagawa@cc.kogakuin.ac.jp	P
	Mrs Kanako NISHINO, Mr Tatsuo FUJII	Isotc163@iibh.org	P
	Prof Hiroshi YOSHINO	yoshino@sabine.pln.archi.tohoku.ac.jp	P
PR CHINA	Prof Yi JIANG	jiangyi@tsinghua.edu.cn	P
	Mrs Xiu YANG	yangxiu00@mails.tsinghua.edu.cn	P
	Mr Shengyuan ZHANG	zhang-sy07@mails.tsinghua.edu.cn	P
REPUBLIC OF KOREA	Mr Seung-Eon LEE	Selee2@kict.re.kr	P
	Mr Won-Hang LEE	wbcolor@korea.com	P

SOUTH AFRICA	Mr Sanj LUTCHMAN	lutchmas@sabs.co.za	C
SWEDEN	Mrs Åsa WAHLSTRÖM	asa.wahlstrom@cit.chalmers.se	P
UNITED KINGDOM	Mr Brian ANDERSON	andersonb@bre.co.uk	P
USA	Mr Philip FAIREY	pfairey@fsec.ucf.edu	P
	Mr Steve BADEN	sbaden@natresnet.org	P
	Mr Damian LJUNGQUIST	damian@jdlbs.com	P
Copy to:			
TC 163 Secretariat	Mr Rikard SILVERFUR	rikard.silverfur@sis.se	C
TC 163/SC 2 Secretariat	Mr Thor Endre LEXOW	tel@standard.no	C
Convenor of CEN/BT/TF 173	Mr Jaap HOGELING	j.hogeling@isso.nl	C
Convenor of ISO TC 163/SC 2/WG 10	Mr Claude-Alain ROULET	claude.roulet@apples.ch	C
NEN, Secretariat of CEN/BT/TF 173	Mr Arie de JONG	Arie.deJong@nen.nl	C
Class: P = participating member; C = corresponding member, candidate member or included in mailing list ("copy to")			

Appendix B
Development of ISO Standard on Energy Performance of Buildings

Philip Fairey
Florida Solar Energy Center
pfairey@fsec.ucf.edu

Background

ISO TC163 WG3 is at the start of a 3-year process of developing an international standard on energy performance ratings for all building types. The effort is in part a result and expansion of the European Union's "Energy Performance of Buildings Directive" (EPBD). The Work Group has met three times and at their April 2008 meeting in Nanjing, China, developed a set of "hot discussion items" issues for further discussion. The Work Group Convenor, Mr. Dick van Dijk of the Netherlands, has specifically requested that "national positions" on these hot discussion items be put forth for the next Work Group meeting on October 27-28, 2008 in Delft, Netherlands. The U.S. representative for the ISO Work Group is Philip Fairey.

Hot Discussion Items

1. Can ISO prescribe a single choice for the aggregation of all energy uses?
   Four energy metric approaches have been proposed: 1) primary energy use rating; 2) emitted mass of CO_2 rating; 3) energy policy factor rating; and 4) electricity equivalent rating.

2. Can ISO prescribe one common numerical expression of energy performance?
   Three expressions have been proposed: 1) energy per unit area; 2) energy use per unit area times a shape factor; 3) an index referenced to minimum code requirements.

3. What are the boundaries of the building to be used for rating purposes?
   What constitutes a building? Can parts of a building be rated? Are energy uses external to the building included (e.g. parking lot lighting)? How are district heating and cooling system efficiencies to be handled as a function of distance? How are solar systems to be handled?

4. Will household appliances be included in residential ratings?
   Present proposal includes space heating, cooling, hot water, vent fans and lighting. EU position is that appliances are not related to the building but rather to users. However, appliances can have major impact on heating and cooling loads and the efficiency of appliances is becoming more and more important as we move toward very high performance buildings.

5. Do ratings include (or allow inclusion of) measured energy use ratings?
   There are two perspectives on the issue: 1) measured energy use is the quickest and easiest metric to obtain and is therefore the least expensive and intrusive means of obtaining a building rating and 2) it is not possible to realistically compare building energy use across building types and countries on a level field unless operating assumptions are standardized. No acceptable means of adjusting measured energy use to a standard set of operating assumptions is available.

6. Can a set of uniform operating conditions as a function of climate and building type and space use be defined?
   Very closely related to item # 5. A set of uniform operating conditions would greatly facilitate international comparisons of building energy performance ratings. However, life styles may be so different across developed and developing countries that a set of uniform standard operating conditions is not possible to achieve.

7. Will all calculated energy ratings be required to use ISO 13790-2007 as the standard for building simulation and modeling?
   ISO 13790-2007 requires that specific standard calculations and algorithms be used for all elements of energy simulations. It contains three basic options: 1) a monthly heat balance method, 2) an hourly heat balance method, and 3) provisions for dynamic simulation (with validation through Standard EN 15265). In the U.S., ANSI/ASHRAE Standard 140-2007, "Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs" and additional software test suites developed specifically for residential energy rating systems, tax credit qualification and code compliance are used for these purposes. What will be the degree to which U.S. would be willing to sign on to the developing international standard for building energy ratings if the ISO software validation and testing requirements are not expanded to include current U.S. practice and standards?

8. Will provisions to prevent manipulation of reference building calculations be included in the Standard?
   Codes and Standards provisions in the U.S. generally call for code compliance and residential ratings performance-based software tools to be configured such that the standard reference building against which the real buildings is compared is automatically generated by the software tool with no possibility of user intervention. This requires that a very specific software "rule set" for the configuration of the standard reference building be included in the standard. This rule set needs to describe in considerable detail exactly how the standard reference building is to be configured with respect to the real building. Should similar provision be included in any forthcoming ISO standards for building energy ratings?

Ernest Orlando Lawrence
Berkeley National Laboratory
Environmental Energy Technologies Division
Bldg: 90   Room: 3026   Ext: 5238
Fax: 5454   MDLevine@lbl.gov

MEMORANDUM

August 18, 2008

TO: Phil Fairey

FROM: Mark D. Levine

RE: Hot Discussion Items re. Development of an ISO Standard

Cc: David Goldstein

It was a very interesting discussion today. I thought it would be useful for me to respond in writing to your hot discussion items.

1. Can ISO prescribe a single choice for aggregation of all energy uses?

   Of the four choices given, my first preference in primary energy use; my second choice is emitted CO_2. I'm not sure what an energy policy rating factor is. I find the electricity equivalent rating (as proposed by Prof. Jiang Yi) to be very interesting and well worthy of scrutiny. However, I think the general approach – providing a surrogate for exergy – is probably too complex a concept for widespread use at this time.

   My strongest feelings relate to what should not be used. Any use of site energy needs to be scrupulously avoided. Site energy, in which energy use in fuels is added to electricity converted at 4314 Btu/kWh, is in my view a meaningless term. Use of site energy is highly misleading; because it is so widespread in its application, it has made virtually impossible the task of comparing the energy efficiency or energy use of buildings. Also, site energy as a metric for energy use will almost certainly retard the development of policies for energy efficiency in buildings. As an example, when the federal government evaluated Building Energy Performance Standards (BEPS), the Edison Electric Institute strong favored the use of site energy for the mandatory energy budgets for residential space conditioning. Had site energy been used as the basis for the budgets, all non-electric heating would have been banned! At the time, electric resistance heating was in widespread use; it would have replaced natural gas heating.

   I am providing an attachment: a briefing on site energy that I gave at a meeting on energy data for buildings that took place in Helskinki shortly after the ACEEE conference.

   In short, let's make certain that site energy does not show up anywhere in the rating, even if it's not the final rating. The term should be banished.

2. Can ISO prescribe one common numerical expression of energy performance?

I doubt that there is one common numerical expression of energy performance. Here are my comments on the terms listed.

4. Energy (primary energy equivalent) per unit area gives useful statistical information. It should be used, but is primarily useful for statistical purposes.

2) Energy use per unit area times a shape factor does not seem justified in my view, but I could be educated. My main objection is that shape factor is just one of many variables that affect energy use in a building. Why not fraction of window area? Specialized uses within buildings which are energy-consuming? These are other factors should be used to assess energy performance of individual buildings compared to some expected value. But ISO should specify the expected value to be compared against.

3) An index referenced to minimum code requirements is interesting but I think it creates some problems. In different places, different minimum code requirements will prevail. Some will be relatively stringent; others, not at all. So it seems that energy use in one location will be compared with an orange and in another location with an apple. This is unsatisfactory.

I believe I do understand the intent of this comparison. However, if the minimum standard and the energy performance are both expressed in the same units (primary energy and/or electricity in kWh and fossil fuel in GJ) for the same end-uses, then anyone can find out the minimum code requirements for her location and make the comparison. ISO's job is to make certain that the basic data are available for such a comparison.

5. What are the boundaries of the building to be used for rating purposes?

If a building is multi-use, then the fraction associated with each use should be specified. This allows the possibility of specifying parts and adding the results in some way. Parking lot lights should be included as a separate term, not mixed in with building energy use *per se.* I leave the last two questions – district heating and cooling and solar systems to people who have more expertise than I on the topic.

6. Will household appliances be included in residential ratings?

Appliances should be treated separately as they can easily change whereas the building shell, space heating, cooling, hot water, and vent fans are not often changed and are seen as part of the house. I'm not sure why lighting is covered.

The issue of internal loads does become important for very efficient houses. It makes sense to take account of the appliances in a general way, so as to obtain an estimate of internal loads. But I would only include them in an approximate way; internal loads will always be an estimate – better a rough estimate than none.

5. <u>Do ratings include (or allow inclusion of) measured energy use ratings?</u>

It's important to have both measured and simulated energy use. ("Simulated" does not necessarily using a complex simulation tool; for many residences, a number obtained from a spreadsheet or look-up table may be sufficient.)

1. You note that "(n)o acceptable means of adjusting measured energy use to a standard set of operating assumptions is available." Then one or more standards should be chosen. I say one or more: it's not necessary to have one universal standard. If there were three or four to choose from, it might be possible to get general agreement that one of them corresponds roughly to the operating conditions in a country or region. However, to enable full comparisons it will be necessary to run buildings using all three or four sets of operating conditions. Ways should be sought to minimize the burden that this puts on the analyst—e.g., detailed reporting of results from just one set of operating conditions and single numbers (or a few numbers) from the others.

6. <u>Can a set of uniform operating conditions as a function of climate and building type and space use be defined?</u>

See above. I doubt very much that uniform operating conditions can be defined that would suit all countries and regions. But, if one wanted to have different operating conditions for different climates/building types, then a set of three of four would seem desirable for each climate/building type.

7. <u>Will all calculated energy ratings be required to use ISO 13790-2007 as the standard for building simulation and modeling?</u>

It is clearly desirable to have a calculated energy ratings based on an ISO standard for building simulation and modeling. Note my comment about the need to use multiple sets of operating conditions for the simulations. The country or region can decide with of the sets will be used as the basis for the ratings and/or building energy codes, while also reporting results that would obtain with the use of the different sets of operating conditions.

I am not in a position to comment on whether the U.S. would be willing to sign on to the development of an international standard for building energy ratings. Having a choice among sets of operating conditions may make this more palatable for the United States.

7. <u>Will provisions to prevent manipulation of reference building calculations be included in the Standard?</u>

If it is necessary to simulate the performance of a standard reference building (generally needed for commercial buildings; may not necessarily be needed for all residential buildings), then very specific software "rule sets" for the configuration of the standard reference building are needed and should be included in the standard.

Comments Received from the RESNET International Initiatives Task Force on the "Hot Topics" Associated with the Development of ISO TC163 WG3

Paolo Bertoldi, European Commission

As stated during the meeting in Asilomar, I strongly support the use of primary energy, and not site energy, this is the only way to capture fuel switching, including microgenaration.

Vicki Davis, Salt River Project

I have no additional comments to offer

Karen Faerber-Hall, Eco-Wise Living

2. Can ISO prescribe one common numerical expression of energy performance?

Assuming that 'unit area' is being used to describe a portion of a building delineated by solid walls, acknowledging a shape factor makes sense as it enewable the substantial differences shape can make in the efficiency of heating/cooling/ventilation and thus of energy performance. Suggest that an occupancy type factor also be considered. Within a unit area, the intended use of the space sets some meaningful boundaries on what is efficient energy performance. E.g. a corridor would have fundamentally different energy performance criteria than a galley-style kitchen of similar dimensions. As I am new to the discussion, perhaps these issues have already been resolved, but in defining a 'unit area' are we considering such factors as room position (with and without exterior façade) type of façade (glazing area, shading device, façade orientation), as well as the specifics of room treatment (lighting, heating, cooling), ventilation systems and air conditioning?

8. What are the boundaries of the building to be used for rating purposes?

If a building has been previously rated, we should be able to rate a remodeling or renovation of part of that building. Likewise, an addition could be rated separately as well as being incorporated into a revised rating of the building as a whole. To consider the building as a system, we need to look at the entire building site – parking lot, landscaping, etc. While exterior to the building, these features are inextricably bound to the use of the building and therefore a part of its energy performance profile.

9. Will household appliances be included in residential ratings?

Buildings have a base rating that is calculated and that should include high efficiency appliances. Buildings also have a operational rating which takes into account occupant enewabl. An international standard must enewable both and provide a way to reconcile the *two. For example, an minimally acceptable operational rating might be 90% of the base(calculated) rating.*

5. Do ratings include (or allow inclusion of) measured energy use ratings?

Perspective 2 is by far the most realistic. Measured energy use also ignores the tremendous differences in the conversion factors for site energy to primary energy from country to county due to technologies employed even when comparing similar energy sources.

6. Can a set of uniform operating conditions as a function of climate and building type and space use be defined?

Life style expectations even within developed countries are a serious obstacle to developing a set of uniform operating conditions. For example, in the UK, standard occupancy assumptions include the specification that heating is required for 9 hours /day on winter weekdays and 16 hours/day on winter weekend days during which the living room will be maintained at 21°C (~70°F) and the rest of the home will be maintained at 18°C (~65°F). In New Zealand, with a similar winter climate, the standard occupancy assumptions for winter specify a constant 20°C (68°F) throughout the house all day every day. Perhaps each country could establish appropriate life style expectation assumptions (broken down urban/rural or by region, etc.), and the standard could specify the attainment of say plus or minus 5% of the appropriate levels. That way, as a country's expectations evolved, existing buildings could be re-rated against the newer assumptions and appropriate remediation recommended whilst new buildings would be rated against the most current assumptions.

Victor Imgarten, Clean Sweep Chimney Service

1. Can ISO prescribe a single choice for the aggregation of all energy uses?

Would each country welcome a single approach? Can each country afford to meet a single approach method? Does EU have a greater concern about CO2 vs. general energy savings? Which way provides the greatest and fastest way for all to benefit? Personally I see a general rating as the greatest benefit to all.

2. Can ISO prescribe one common numerical expression of energy performance?

What would be defined in an energy unit area? Is the current minimum code all that is usually required or is it superseded regularly in current construction practices?

10. What are the boundaries of the building to be used for rating purposes?

Defining a building should be part of any plan. Parts of any building should be able to be rated with full understanding of why parts would be not rated and how it may impact the rest of the building if changes are made. What would define a parking lot? Would a homeowner with a street lamp become libel during an audit? Can a parking lot become a separate part of the audit?

11. Will household appliances be included in residential ratings?

I somewhat disagree with the statement that the appliance is related to the user. It has been my experience in Europe that during new construction the homeowner is very involved in choosing all appliances and is more likely to follow the advice of the trade's people. When updating current appliances some direction with specific guidelines should be given.

6. Can a set of uniform operating conditions as a function of climate and building type and space use be defined?

Well put points and I see no way to make it equal outside of measured energy use with climate locations factored in.

12. Will provisions to prevent manipulation of reference building calculations be included in the Standard?

Yes

Chris Maher, Thermo-Scan Inspections

13. *Yes , a single choice can allow comparisons. I prefer #1.*

14. *Yes, a single choice can be used. I prefer #1.*

15. *Parts of a multi-use building would need to be broken out by zones and rated. Locally there is an office building with an indoor ice rink attached. Another example is a school with an indoor competition pool attached. Parking lot lighting, fountain pumps, unconditiuoned parking garage ventilation and other need to be account for separately.*

16. *In total agreement to include appliances.*

5. Good rationale.

6. Possible two or three sets of uniform conditions to a least get regional comparisons.

7. ?

17. *Yes, I agree.*

John Meeks, Apple Blossom Insulation

Hot Topic 1.- Yes

Hot Topic 2. - Yes, if there is agreement

Hot Topic 3.- The thermal envelope should be the boundary for the rating portion. However all pieces should be in the carbon footprint, ie… parking lots and lighting in said, backfill recycled asphalt vs concrete vs grass lots.

Hot Topic 4. – All permanently mounted appliances as well as those used for cooking and cleaning, entertainment, and personal hygiene.

Hot Topic 5.- No. That is like my car that the EPA says gets 32 mpg and actually gets 25. There should be regional task forces that evaluate and set these based on cultures and current conditions. Actual real life readings should be taken on all electrical and gas appliances.

Hot Topic 6. – No, see # 5

Hot Topic 7. – Yes. We must express to our political leaders the importance of this. It will also take education of the general public as to the cost and benefits.

Hot Topic 8. – Yes

David Meisegeier, ICF International

18. Can ISO prescribe a single choice for the aggregation of all energy uses?

Yes, in fact I think it is critical to use a single aggregation of all energy use. I would advocate primary energy use as the clearest foundational approach, since we are rating the energy use of a home. Conversions from this can always be made if someone wanted to assess the home's performance on another scale, e.g., the emitted mass of CO_2, etc.

19. Can ISO prescribe one common numerical expression of energy performance?

Yes and no. I think there should be one common numerical expression of energy performance and that it should be the actual energy used (more on this below). However, I think it is fine to build off of that common expression if someone wanted to make a relative comparison.

20. What are the boundaries of the building to be used for rating purposes?

What constitutes a building? My definition would be anything that flows through the electric and gas meter (or equivalent for fuel oil, propane, wood, etc.). For example, if the parking lot lighting flows through the same meter as the rest of the building, then its efficiency affects the energy use and hence performance of that structure and thus should be considered within the boundary of the building.

Can parts of a building be rated? I would apply the same logic as above – anything going through the meter has to be accounted for in the rating. So if a structure has 2 or more meters then those respective areas can be individually metered. For example, if the building in question has mixed use – say retail and a restaurant on the first floor and apartments on the second and *above floors – then each space could be rated IF they had individual meters. Further, the entire structure could be rated by combining the energy flowing through the sum of all meters.*

How are district heating and cooling system efficiencies to be handled as a function of distance? Source energy use would properly account for this.

How are solar systems to be handled? I would treat it as another fuel source. If a home had PV and was truly off the grid, it (the home) would still have energy needs, and it is that consumption that we should be rating. If the home produced more energy than it consumed then it would act as a power plant – and the rating should reflect that as well.

21. Will household appliances be included in residential ratings?

Yes. The energy consumed by household appliances goes through the meter and hence should be included.

5. Do ratings include (or allow inclusion of) measured energy use ratings?

I think the rating should be based on measured energy and further, I think that the rating should be created such that it can account for all the contributors to the homes energy consumption – architectural features, HVAC system efficiencies, envelop efficiencies, plug loads, etc. Hand in hand with this is the need to create a standard set of operating assumptions for each building type. This would allow different aspects of the buildings energy use to be rated, all through the same metric. For example, at the highest level it could assess the actual total energy consumed by the building. By employing different standard sets of operating assumptions, aspects affecting energy consumption that are variable could be fixed. For example, defining and employing a standard for occupant behavior would allow the energy performance of the "fixed" components (e.g., envelop, HVAC, etc) of the home to be assessed. Conversely, it would also allow the occupants behavior on energy consumption to be assessed.

6. Can a set of uniform operating conditions as a function of climate and building type and space use be defined?

Yes, one set can be created which could be used "universally" regardless of life style differences around the world, but others could also be created for comparing energy consumption locally. This would allow relative comparisons on either a global or local level, all on the same metric.

7. Will all calculated energy ratings be required to use ISO 13790-2007 as the standard for building simulation and modeling?

I think there should be one, and only one, standard for building simulation and modeling. Otherwise we'll end up where we are today with most of the world using SI units and the US using customary units.

22. Will provisions to prevent manipulation of reference building calculations be included in the Standard?

Yes, with the exception that the user should be able to select from many (pre-defined) references, e.g., different versions of codes.

Frank Migneco, EAM Associates

1. Can ISO prescribe a single choice for the aggregation of all energy uses?

Is there the potential of units of measure differences between English and metric based systems? Who is the audience? Builders and homeowners care about number one and that drives the dynamics in the markets absent regulatory interventions. It should be a simple layperson approach and the policy and regulatory ratings used by those audiences. A rater/Provider can not be expected to be in a business position to address all of the various players' reporting needs.

2. Can ISO prescribe one common numerical expression of energy performance?

Is there the potential of units of measure differences between English and metric based systems? It has to be an expression of performance platform that allows for regional climatic differences as well as policy and regulatory based mandates and requirements/standards.

3. What are the boundaries of the building to be used for rating purposes?

This needs to be answered first before decisions are made on the other items in this list. Possible basis can be metered services of the premise which in commercial settings would include outdoor lighting. It is similar to the situation in multifamily housing situations where premise occupants pay the electric bills (residential meters) and the outdoor lighting is on a separate meter on a commercial rate in the management's name. Holistically it is an integral whole usage scenario that makes prudent sense so lost opportunities is minimized.

4. Will household appliances be included in residential ratings?

Appliances and lighting need to be considered in a minimum to project total premise operating cost and savings. If the technology or measure is not addressed i.e. energy efficient water heating, then the appliance itself needs to be accounted for in the total energy budget of the premise.

5. Do ratings include (or allow inclusion of) measured energy use ratings?

Lifestyle and usage habits and patterns can not be accounted for other than in a baseline standard. This is not about full social engineering of occupants but of the premises they occupy.

6. Can a set of uniform operating conditions as a function of climate and building type and space use be defined?

See above and how would tier time-of use and critical peak pricing tariffs *be considered?*

7. Will all calculated energy ratings be required to use ISO 13790-2007 as the standard for building simulation and modeling?

What is the projected cost to participate and what are the expected outcomes as to the benefits and features to the US Market. If US needs are not addressed then participation would be marginal at best.

8. Will provisions to prevent manipulation of reference building calculations be included in the Standard?

This is in play in the US today. We are aware of "Programs" that changed the reference home to be tailored to their region and program attributes. As an accredited provider we have ability to change the reference home. For example when the 13.00 SEER standard hit programs where changed to reflect this as the new baseline and in some programs was raised as the baseline was higher than 13.00 SEER.

Additional Comments:

1. What are the benefits to RESNET for participation in this initiative?
2. What are the projected costs to participate?
3. What has RESNET spent to date on this initiative?
4. How does RESNET's Board see this initiative and the time RESNET staff spends on it benefiting members?

L. Javier Ruiz - LEED AP, Southwest Energy Conservation Services, LLC

2. Can ISO prescribe one common numerical expression of energy performance?

A combination of energy per unit area with an index referenced to minimum code requirements could be appropriate, this way building owners, can have a clearer energy performance reference per unit, but also compared to code requirements.

23. What are the boundaries of the building to be used for rating purposes?

What constitutes a building?

Describing exactly what constitutes a building has too many variables, the characteristic that do need to be more specific are; is the conditioned building, retail, residential, office, warehouse, etc… Once we know this parameters then we can start describing what constitutes a building. In the case of just determining the boundaries of the building for rating purposes, we probably need to separate conditioned from unconditioned areas, but is very important not to oversee the unconditioned areas for the rating purposes since there are some buildings that their unconditioned areas have a considerable impact on the energy consumption, pools, parking lots, exterior lighting, well pumps, storage, etc.

Can parts of a building be rated?

Definitely, this will encourage the benchmarking of individual energy performance between retrofitted building areas in one same building. Sometimes you have building owners that only own or manage a portion of a building and they are looking to know how efficient their portion of building is or could be if improved.

Are energy uses external to the building included (e.g. parking lot lighting)?

They should but as a separate item of their rating, ex. You could actually have 3 numbers, internal uses, external uses and combined.

How are district heating and cooling system efficiencies to be handled as a function of distance? How are solar systems to be handled?

Very important to include but not only solar but onsite enewable in general that service directly the building in question. Onsite enewable should have a separate number, in order not to loose sight of the actual performance of the rated building, this will or can prevent unnecessary capital investment of onsite renewable energy production to fully offset the building energy demand, and maximize the optimum energy efficiency of the building. Additionally, there should be an easy to understand number to be combined with the rating number of the building to keep track if your building is still a net zero building. Also by having a separate number building owners can certainly be encourage to upgrade certain component in the future when new technologies become online.

24. Will household appliances be included in residential ratings?

Appliances due have a major impact on heating, cooling and energy consumption in general. The inclusion of major appliances should be something to consider upfront to show the actual impact of these major appliances, but I do understand that sometimes a rating agency doesn't have the information about those appliances since occupant may supply their own, in this case there should be a clause in the rating documentation advising of the impact on energy consumption that appliances can have in the residence.

6. Can a set of uniform operating conditions as a function of climate and building type and space use be defined?

Even though it would be ideal to have a set of uniform operating conditions to facilitate international comparisons, many variables could be over/under done. But an effort and commitment of standardizing parameters would be beneficial for all parties (countries) involved, by achieving an standardization of operating conditions, this would help to actually have a comparison parameter between countries and serve as a benchmark for energy efficiency and conservation efforts in different countries.

7. Will all calculated energy ratings be required to use ISO 13790-2007 as the standard for building simulation and modeling?

In an effort of international standardization, both current U.S. practices-standards and ISO standards should align themselves. This is probably something that will not happen overnight, because of time and upfront investment for modifications and upgrades, but it would certainly be in the right direction to achieve international standardization.

25. Will provisions to prevent manipulation of reference building calculations be included in the Standard?

Very important, reference building manipulation is something that definitely should be included in any forthcoming ISO standards, when trying to receive an official rating number. For reference purposes user should be able to build their own baseline building and compare the improved building, but not for rating purposes.

Carl Seville, Seville Consulting

3. Can ISO prescribe a single choice for the aggregation of all energy uses?

Yes

4. Can ISO prescribe one common numerical expression of energy performance?

Yes - energy per unit area

26. What are the boundaries of the building to be used for rating purposes?

Two possible criteria – interior occupied space and exterior occupied space. Interior will be conditioned in almost all environments, most exterior spaces have electrical load, some have heating and even AC such as restaurants.

How are solar systems to be handled? –*Noted by how much power they offset*

27. Will household appliances be included in residential ratings?

Yes all built in as well as typical freestanding such as microwave, washer, dryer. In commercial and industrial situations, consider including typical equipment used in facility.

28. Do ratings include (or allow inclusion of) measured energy use ratings?

Measured energy use is the quickest and easiest metric to obtain and is therefore the least expensive and intrusive means of obtaining a building rating

29. Can a set of uniform operating conditions as a function of climate and building type and space use be defined?

Yes, cannot control usage. We can set usage criteria: Occupants determine their use by type (retail, restaurant, lab, school, etc for commercial; response to lifestyle questions, # of occupants, ages (residential)

Appendix C
Creating ISO Standard Reference Residential Buildings

1 Reference Building and Certified Building Configuration

1.1 General. Except as specified by this Section, the Reference Building and Certified Building shall be configured and analyzed using identical methods and techniques.

1.2 Building Specifications. The Reference Building and Certified Building shall be configured and analyzed as specified by Table 1**.**

Table 1. Specifications for the Reference and Certified Buildings

Building Component	Reference Building	Certified Building
Above-grade walls:	Type: wood frame Gross area: same as Certified Building U-Factor: from Table 2 Solar absorptance = 0.75 Far infrared emittance = 0.90	Same as Certified Building Same as Certified Building Same as Certified Building Same as Certified Building Same as Certified Building
Conditioned Basement walls:	Type: same as Certified Building Gross area: same as Certified Building U-Factor: from Table 2 with the insulation layer on the interior side of walls	Same as Certified Building Same as Certified Building Same as Certified Building
Floors over unconditioned spaces:	Type: wood frame Gross area: same as Certified Building U-Factor: from Table 2	Same as Certified Building Same as Certified Building Same as Certified Building
Ceilings:	Type: wood frame Gross area: same as Certified Building U-Factor: from Table 2	Same as Certified Building Same as Certified Building Same as Certified Building
Roofs:	Type: composition shingle on wood sheathing Gross area: same as Certified Building Solar absorptance = 0.75 Far infrared emittance = 0.90	Same as Certified Building Same as Certified Building Same as Certified Building Same as Certified Building
Attics:	Type: vented with aperture = 1m^2 per 300 m^2 ceiling area	Same as Certified Building
Foundations:	Type: same as Certified Building Gross Area: same as Certified Building U-Factor / R-value: from Table 2	Same as Certified Building Same as Certified Building Same as Certified Building
Crawlspaces:	Type: vented with net free vent	Same as the Certified

Table 1. Specifications for the Reference and Certified Buildings

Building Component	Reference Building	Certified Building
	aperture = 1m^2 per 150 m^2 of crawlspace floor area. U-factor: from Table 2 for floors over unconditioned spaces	Building, but not less net free ventilation area than the Reference Building unless an approved ground cover in accordance with IRC 408.1 is used, in which case, the same net free ventilation area as the Certified Building down to a minimum net free vent area of 1m^2 per 1,500 m^2 of crawlspace floor area. Same as Certified Building
Doors:	Area: 3.7 m^2 Orientation: North U-factor: same as fenestration from Table 2	Same as Certified Building Same as Certified Building Same as Certified Building
Glazing: [(a)]	Total area [(b)] =18% of conditioned floor area Orientation: equally distributed to four (4) cardinal compass orientations (N,E,S,&W) U-factor: from Table 2 SHGC: from Table 2 Interior shade coefficient: Summer = 0.70 Winter = 0.85 External shading: none	Same as Certified Building Same as Certified Building Same as Certified Building Same as Certified Building Same as Reference Building [(c)] Same as Certified Building
Skylights	None	Same as Certified Building
Thermally isolated sunrooms	None	Same as Certified Building
Air exchange rate	Specific Leakage Area (SLA) [(d)] = 0.0004 (assuming no energy recovery)	For residences that are not tested, the same as the Reference Building For residences without mechanical ventilation systems that are tested in accordance with ASHRAE Standard 119, Section 5.1, the measured air exchange rate [(e)] but not less than 0.35 ach For residences with

Table 1. Specifications for the Reference and Certified Buildings

Building Component	Reference Building	Certified Building
		mechanical ventilation systems that are tested in accordance with ASHRAE Standard 119, Section 5.1, the measured air exchange rate [e] combined with the mechanical ventilation rate,[f] which shall not be less than L/s = 0.05 x CFA(m^2) + 3.5 x (Nbr+1)
Mechanical ventilation:	None, except where a mechanical ventilation system is specified by the Certified Building, in which case:	Same as Certified Building
	Annual vent fan energy use: kWh/yr = 0.4243*CFA(m^2) + 29.565*(N_{br}+1) (per dwelling unit) where: CFA = conditioned floor area (m^2) N_{br} = number of bedrooms	Same as Certified Building
Internal gains:	IGain = 5.246 + 0.075*CFA (m2) + 1.203*N_{br} (kWh/day per dwelling unit)	Same as Reference Building, except as provided by Section 1.2.5.
Internal mass:	An internal mass for furniture and contents of 0.34 kg per square meter of floor area	Same as Reference Building, plus any additional mass specifically designed as a Thermal Storage Element [g] but not integral to the building envelope or structure
Structural mass:	For masonry floor slabs, 80% of floor area covered by R-0.35 carpet and pad, and 20% of floor directly exposed to room air	Same as Certified Building
	For masonry basement walls, same as Certified Building, but with insulation required by Table 2 located on the interior side of the walls	Same as Certified Building
	For other walls, for ceilings, floors, and interior walls, wood	Same as Certified Building

Table 1. Specifications for the Reference and Certified Buildings

Building Component	Reference Building	Certified Building
	frame construction	
Heating systems [h],[i]	Fuel type: same as Certified Building Efficiencies: Electric: air source heat pump with prevailing federal minimum efficiency Non-electric furnaces: natural gas furnace with prevailing federal minimum efficiency Non-electric boilers: natural gas boiler with prevailing federal minimum efficiency Capacity: sized in accordance with Section 2.1.5 of this Standard.	Same as Certified Building [i] Same as Certified Building Same as Certified Building Same as Certified Building Same as Certified Building
Cooling systems [h],[k]	Fuel type: Electric Efficiency: in accordance with prevailing federal minimum standards Capacity: sized in accordance with Section 2.1.5 of this Standard.	Same as Certified Building [k] Same as Certified Building Same as Certified Building
Service water heating systems [h] [m]	Fuel type: same as Certified Building Efficiency: in accordance with prevailing federal minimum standards Use (L/day): $113.6 * N_{du} + 37.9 * N_{br}$ where N_{du} = number of dwelling units Tank temperature: 49 C	Same as Certified Building [m] Same as Certified Building Same as Reference Building Same as Reference Building
Thermal distribution systems:	A thermal distribution system efficiency (DSE) of 0.80 shall be applied to both the heating and cooling system efficiencies.	As specified by Table 3, except when tested in accordance with ASHRAE Standard 152-2004[n], and then either calculated through hourly simulation or calculated in accordance with ASHRAE Standard 152-2004
Thermostat	Type: manual Temperature setpoints: cooling temperature set point = 26 C;	Type: Same as Certified Building Temperature setpoints: same

Table 1. Specifications for the Reference and Certified Buildings

Building Component	Reference Building	Certified Building
	heating temperature set point = 20 C	as the Reference Building, except as required by Section 2.1.2

Table 1 Notes:

(a) Glazing shall be defined as sunlight-transmitting fenestration, including the area of sash, curbing or other framing elements, that enclose conditioned space. Glazing includes the area of sunlight-transmitting fenestration assemblies in walls bounding conditioned basements. For doors where the sunlight-transmitting opening is less than 50% of the door area, the glazing area is the sunlight transmitting opening area shall be used. For all other doors, the glazing area is the rough frame opening area for the door, including the door and the frame.

(b) For Buildings with conditioned basements and for multi-family attached Buildings the following formula shall be used to determine total window area:

$A_F = 0.18 \times A_{FL} \times F_A \times F$

where:

A_F = Total fenestration area

A_{FL} = Total floor area of directly conditioned space

F_A = (Above-grade thermal boundary gross wall area) / (above-grade boundary wall area + 0.5 x below-grade boundary wall area)

F = (Above-grade thermal boundary wall area) / (above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater

and where:

Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions

Above-grade thermal boundary wall is any portion of a thermal boundary wall not in contact with soil

Below-grade boundary wall is any portion of a thermal boundary wall in soil contact

Common wall is the total wall area of walls adjacent to another conditioned living unit, not including foundation walls.

(c) For fenestrations facing within 15 degrees of due south that are directly coupled to thermal storage mass, the winter interior shade coefficient shall be permitted to increase to 0.95 in the Certified Building.

(d) Where Leakage Area (L) is defined in accordance with Section 5.1 of ASHRAE Standard 119 and where SLA = L / CFA (where L and CFA are in the same units).
Either hourly calculations using the procedures given in the 2001 *ASHRAE Handbook of Fundamentals*, Chapter 26, page 26.21, equation 40 (Sherman-Grimsrud model) or calculations yielding equivalent results shall be used to determine the energy loads resulting from air exchange.

(e) Tested envelope leakage shall be determined and documented by a Certified Rater using the on-site inspection protocol as specified in Appendix A under “Blower Door Test.”
Either hourly calculations using the procedures given in the 2001 *ASHRAE Handbook of Fundamentals*, Chapter 26, page 26.21, equation 40 (Sherman-Grimsrud model) or calculations yielding equivalent results shall be used to determine the energy loads resulting from air exchange.

(f) The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with equation 43 of 2001 *ASHRAE Handbook of Fundamentals* page 26.24 in combination with the" Whole-house Ventilation" provisions of 2001 *ASHRAE Handbook of Fundamentals*, page 26.19 for intermittent mechanical ventilation.

(g) Thermal storage element shall mean a component not normally part of the floors, walls, or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase change containers. A thermal storage element must be in the same room as fenestration that faces within 15 degrees of due south, or must be connected to such a room with pipes or ducts that allow the element to be actively charged.

(h) For a Certified Building with multiple heating, cooling, or water heating systems using different fuel types, the applicable system capacities and fuel types shall be weighted in accordance with the loads distribution (as calculated by accepted engineering practice for that equipment and fuel type) of the subject multiple systems. For the Reference Building, the prevailing federal minimum efficiency shall be assumed except that the efficiencies given in Table 1(a) below will be assumed when:

1) A type of device not covered by NAECA is found in the Certified Building;
2) The Certified Building is heated by electricity using a device other than an air source heat pump; or
3) The Certified Building does not contain one or more of the required HVAC equipment systems.

Table 1(a). Default Reference Building Heating and Cooling Equipment Efficiencies (i) (k) (m) (n)

Certified Building Fuel	**Function**	**Reference Building Device**
Electric	Heating	6.8 HSPF air source heat pump
Non-electric warm air furnace or space heater	Heating	78% AFUE gas furnace
Non-electric boiler	Heating	80% AFUE gas boiler
Any type	Cooling	13 SEER electric air conditioner
Biomass System (1)	Heating	63% Efficiency

Table 1(a) Notes:

(1) Biomass fuel systems should not be included in ratings when then are considered "*supplemental* systems", i.e. where an automatic system, sized to meet the load of the house exists. Biomass systems should only be included in the rating in those situations where the automatic heating system is not large enough to meet the load of the house, and a biomass fuel system is in place to meet the balance of the load, or where there is only a biomass fuel system in place. In the situation where there are two systems that together meet the load, the biomass system shall be assigned only that part of the load that cannot be met by the automatic system.

(i) For a Certified Building without a proposed heating system, a heating system with the prevailing federal minimum efficiency shall be assumed for both the Reference Building and Certified Building. For electric heating systems, the prevailing federal minimum efficiency air-source heat pump shall be selected.

(k) For a Certified Building without a proposed cooling system, an electric air conditioner with the prevailing federal minimum efficiency shall be assumed for both the Reference Building and the Certified Building.

(m) For a Certified Building with a non-storage type water heater, a 40-gallon storage-type water heater with the prevailing federal minimum efficiency and with the same fuel as the proposed water heater shall be assumed for the Reference Building. For a Certified Building without a proposed water heater, a 40-gallon storage-type water heater with the prevailing federal minimum efficiency with the same fuel as the predominant heating fuel type shall be assumed for both the Certified and Reference Building.

(n) Tested duct leakage shall be determined and documented by a Certified Rater using the on-site inspection protocol as specified in Appendix A under "Air leakage (ducts)".

Table 2. Component Heat Transfer Characteristics for Residential Reference Building [a]

Climate Zone [b]	Fenestration and Opaque Door U-Factor	Glazed Fenestration Assembly SHGC	Ceiling U-Factor	Frame Wall U-Factor	Floor Over Unconditioned Space U-Factor	Basement Wall U-Factor [c]	Slab-on-Grade [d,e] R-Value & Depth
1	8.69	0.40	0.20	0.49	0.38	2.71	0
2	8.69	0.40	0.20	0.49	0.38	2.71	0
3	6.61	0.40	0.20	0.49	0.28	2.71	0
4 except Marine	3.12	0.55	0.17	0.49	0.28	0.35	1.76, 0.6 m
5 and Marine 4	2.61	0.55	0.17	0.36	0.19	0.35	1.76, 0.6 m
6	2.61	0.55	0.15	0.36	0.19	0.35	1.76, 1.2 m
7 and 8	2.61	0.55	0.15	0.34	0.19	0.35	1.76, 1.2 m

Table 2 Notes:

a. Units for listed U-Factors and R-Values are W/m^2-K and m^2-K/W, respectively. U-Factors are given for structural composite only (interior and exterior air film heat transfer coefficients are not included).
b. Climates zones shall be as specified by the 2004 Supplement to the International Energy Conservation Code.
c. For basements where the conditioned space boundary comprises the basement walls.
d. R-0.9 shall be added to the required R-value for slabs with embedded heating
e. Insulation shall extend downward from the top of the slab vertically to the depth indicated.

Table 3. Default Distribution System Efficiencies for Inspected Systems [a]

Distribution System Configuration and Condition:	**Forced Air Systems**	**Hydronic Systems [b]**
Distribution system components located in unconditioned space	0.80	0.95
Distribution systems entirely located in conditioned space [c]	0.88	1.00
Proposed "reduced leakage" with entire air distribution system located in the conditioned space [d]	0.96	
Proposed "reduced leakage" air distribution system with components located in the unconditioned space	0.88	
"Ductless" systems [e]	1.00	

Table 3 Notes:

(a) Default values given by this table are for distribution systems as rated, which meet minimum IECC 2000 requirements for duct system insulation.

(b) Hydronic Systems shall mean those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed loop piping and that do not depend on ducted, forced air flows to maintain space temperatures.

(c) Entire system in conditioned space shall mean that no component of the distribution system, including the air handler unit or boiler, is located outside of the conditioned space boundary.

(d) Proposed "reduced leakage" shall mean substantially leak free to be leakage of not greater than 0.15 L/s to outdoors per square meter of conditioned floor area and not greater than 0.46 L/s total air leakage per square meter of conditioned floor area at a pressure differential of 25 Pascal across the entire system, including the manufacturer's air handler enclosure. Total air leakage of not greater than 0.15 L/s per square meter of conditioned floor area at a pressure difference of 25 Pascal across the entire system, including the manufacturer's air handler enclosure, shall be deemed to meet this requirement without measurement of air leakage to outdoors. This rated condition shall be specified as the required performance in the construction documents and requires confirmation through field-testing of installed systems as documented by a Certified Rater.

(e) Ductless systems may have forced airflow across a coil but shall not have any ducted airflows external to the manufacturer's air handler enclosure.

1.2.1 All enclosure elements shall use framing fractions that are consistent with and representative of reality. Default enclosure framing fractions are provided by Table 4.

Table 4. Default Framing Fractions for Enclosure Elements

Enclosure Element	Frame **Spacing (cm o.c.)**	Default **Frame Fraction (% area)**

Table 4. Default Framing Fractions for Enclosure Elements

Enclosure Element	Frame Spacing (cm o.c.)	Default Frame Fraction (% area)
Walls (standard):		
@40.6 cm o.c.	40.6	23%
@61.0 cm o.c.	61.0	20%
Walls (advanced):		
@40.6 cm o.c.	40.6	19%
@61.0 cm o.c.	61.0	16%
Structural.Insulated.Panels	121.9	10%
Floors (standard):		
@40.6 cm o.c.	40.6	13%
@61.0 cm o.c.	61.0	10%
Floors (advanced):		
@40.6 cm o.c.	40.6	11%
@61.0 cm o.c.	61.0	8%
Ceilings (standard trusses):		
@40.6 cm o.c.	40.6	14%
@61.0 cm o.c.	61.0	11%
Ceilings (advanced trusses – "raised heel"):		
@40.6 cm o.c.	40.6	10%
@61.0 cm o.c.	61.0	7%
Ceilings (conventional framing):		
@40.6 cm o.c.	40.6	13%
@61.0 cm o.c.	61.0	9%

1.2.2 Insulation Inspections: All enclosure elements for the Certified Building shall have their insulation assessed in accordance with this Standard. Installed cavity insulation shall be rated as Grade I, II, or III in accordance with the on-site inspection procedures of Appendix A. (This can be provided)

1.2.2.1 The Reference Building enclosure elements shall be modeled assuming Grade I insulation. Default values for Certified Building insulation that is not inspected according to the procedures of Appendix A shall be in accordance with the requirements of Grade III as given in Section 1.2.2.2 and shall be recorded as “not inspected” in the rating information.

Exceptions:

(a) Modular and manufactured housing using IPIA (In-Plant Inspection Agent) inspections may be substituted for the inspection. However, housing manufacturer shall include RESNET insulation inspection details and requirements in their “DAPIA” (Design Approval Primary Inspection Agency) packages submitted to HUD which are used by IPIA’s for their factory inspections.

(b) Structural Insulated Panels (SIP’s), Insulated Concrete Forms (ICF’s), and other similar insulated manufactured assemblies. Note that manufacturer’s claims of "equivalent" R-values based on reduced air leakage or other secondary effects may not be used; only the thermal resistance values for the actual materials as found in ASHRAE Fundamentals may be used.

(c) A RESNET-approved, third-party audited installer certification program may be substituted under the conditions specified in the RESNET approval process. (Don't know exactly how to deal with this?)

1.2.2.2 Insulation Assessment: Insulated surfaces categorized as "Grade I" shall be modeled such that the insulation R-value within the cavity is considered at its measured (for loose fill) or labeled value, including other adjustments such as compression, and cavity fill versus continuous, for the insulated surface area (not including framing or other structural materials which shall be accounted for separately). Insulated surfaces categorized as "Grade II" shall be modeled such that there is no insulation R-value for 2% of the insulated surface area and its measured or labeled value, including other adjustments such as compression and cavity fill versus continuous, for the remainder of the insulated surface area (not including framing or other structural materials). Insulated surfaces categorized as "Grade III" shall be modeled such that there is no insulation R-value for 5% of the insulated surface area and its measured or labeled value, including other adjustments such as compression and cavity fill versus continuous, for the remainder of the insulated surface area (not including framing or other structural materials). Other building materials, including framing, sheathing, and air films shall be assigned aged or settled -values according to ASHRAE Fundamentals. In addition, the following accepted conventions shall be used in modeling Certified Building insulation enclosures:

1.2.2.2.1 Insulation that does not cover framing members shall not be modeled as if it covers the framing. Insulated surfaces that have continuous insulation (i.e. rigid foam, fibrous batts, loose fill, or sprayed insulation) covering the framing members shall be assessed and modeled according to Section 303.1.4 and combined with the cavity insulation, framing and other materials to determine the overall assembly R-value.

1.2.2.2.2 Compression: for modeling purposes, the base R-value of fibrous insulation that is compressed to less than its full rated thickness in a completely enclosed cavity shall be assessed according to the manufacturer's documentation; in the absence of such documentation, use R-value correction factor (CF) for Compressed Batt or Blanket from Manual J, 8th edition Table A5-1, Section 7-d.

1.2.2.2.3 Where large areas of insulation that is missing, or has a different R-value from the rest of an assembly exist, these areas shall be modeled with the appropriate R-value and assembly description separately from the rest of the assembly. Insulation R-values may not be averaged according to coverage area. For example, if 50 square feet of a wall area has no cavity fill insulation at all, that 50 square feet shall be recorded as a separate building component with no cavity insulation, but with the existing structural components.

1.2.2.2.4 Steel framing in insulated assemblies: calculations for the overall thermal properties of steel-framed walls, ceilings and floors shall be based on the "Thermal Design Guide for Exterior Walls, Publication RG-9405, American Iron and Steel Institute; the "Zone Method" from 2001 ASHRAE Handbook of Fundamentals (page 25.10-11); or equivalent.

1.2.3 Renewable energy systems, using solar, wind or other renewable energy sources, which offset the energy consumption requirements of the Certified Building, shall not be included in the Reference Building.

1.2.4 For non-electric warm furnaces and non-electric boilers, the values in Table 5 shall be used for auxiliary electric (Eae) in the Reference Building.

Table 5 Reference Building Eae Values

System Type	Eae
Oil boiler	330
Gas boiler	170
Oil furnace	439 + 1.61*Capacity (kW)
Gas furnace	149 + 3.02*Capacity (kW)

1.2.5 Lighting and Appliances

1.2.5.1 Lighting. Reference Building annual lighting use per dwelling unit (DU) shall be calculated as kWh/yr-DU = 455 + 0.074 * CFA (where CFA is in m^2) with an internal gain factor equal to 90% of lighting energy use (10% of lighting energy use is assumed to occur outside of the conditioned floor area of the building).

For the purpose of adjusting the annual light fixture energy consumption for calculating the rating, the End Use Load for lighting and appliances (EUL_{LA}) shall be adjusted by adding lighting ΔEUL_{LA}, where ΔEUL_{LA} (kWh/yr/(dwelling unit)) = [29.5 – 5.585*CFA*$FL_{\%}$ – 295.12*$FL_{\%}$ + 0.5586*CFA], and where $FL_{\%}$ is the ratio of Qualifying Light Fixtures to all light fixtures in Qualifying Light Fixture Locations, and CFA is the Conditioned Floor Area in meters. For calculation purposes, the Certified Building shall never have $FL_{\%}$ less than 10%.

For lighting, internal gains in the Certified Building shall be reduced by 90% of the lighting ΔEUL_{LA} calculated in kWh/day using the following equation: $\Delta Igain = 0.90 * \Delta EUL_{LA} /365$.

1.2.5.2 Refrigerators. Reference Building annual refrigerator energy use shall be 775 kWh/yr per dwelling unit.

For the purposes of adjusting the annual refrigerator energy consumption for calculating the rating, the EUL_{LA} shall be adjusted by adding ΔEUL_{LA}, where refrigerator ΔEUL_{LA}(kWh/yr/(dwelling unit)) = Total Annual Energy Consumption of Refrigerators in Certified Building – 775.

For refrigerators, internal gains in the Certified Building shall be reduced by 100% of the refrigerator ΔEUL_{LA} calculated in Btu/day using the following equation: $\Delta Igain = \Delta EUL_{LA} /365$.

1.2.5.3 Mechanical Ventilation System Fans. If ventilation fans are present, the EUL_{LA} shall be adjusted by adding ΔEUL_{LA}, where ΔEUL_{LA} (kWh/year/(dwelling unit)) = Total Annual Energy Consumption of the Ventilation System in the Certified Building – [0.4243*CFA(m^2) + 29.565*(N_{br}+1)] per dwelling unit.

1.2.5.4 Dishwashers. A dishwasher, with annual energy use as specified by Table 6 with an internal gain factor equal to 60% of dishwasher energy use, shall be assumed in the Reference Building. If no labeled dishwasher energy factor is specified for the Certified Building, the Certified Building shall have the same dishwasher annual energy use and internal gain factor as the Reference Building.

Table 6

Bedrooms per Dwelling Unit	**Reference Dishwasher kWh**
1	90
2	126
3	145
4	174
5+	203

For the purposes of calculating dishwasher energy savings and hot water energy savings for calculating the rating, the energy savings shall be calculated based on the following formula using Cycles/Year by number of Bedroom (N_{br}) as specified in Table 7.

Dishwasher annual energy use for each dwelling unit in the Certified Building (kWh/yr) = (0.27) * (cycles/yr/(dwelling unit)) / (dishwasher rated Energy Factor)

Table 7

N_{br} per Dwelling Unit	**Cycles/Yr per Dwelling Unit**
1	154
2	214
3	247
4	296
5+	345

EUL_{LA} shall be adjusted by adding dishwasher ΔEUL_{LA}, where ΔEUL_{LA} (kWh/yr/(dwelling unit)) = (cycles/yr)*[0.27/(dishwasher rated Energy Factor) – 0.587].

Internal gains in the Certified Building shall be reduced by 60% of the dishwasher ΔEUL_{LA} calculated in Btu/day using the following equation: $\Delta Igain = 0.60 * \Delta EUL_{LA}/365$.

The reduction in hot water use (gallons/day) shall be based on the following formula, to be used in adjusting the hot water Use Equation given by Table 1:

Reduction in hot water use (L/day/(dwelling unit)) = [(28.0 L/cycle) – (0.73)/(dishwasher rated Energy Factor in cycles/kWh)/(32.2 K)/(0.000352 kWh/L/K)] * [(cycles/yr/(dwelling unit))/(365 days/year)]

1.2.5.5 Ceiling Fans. If ceiling fans are included in the Certified Building, they shall also be included in the Reference Building. Three (3) ceiling fans shall be assumed in both the Reference Building and the Certified Building. A daily ceiling fan operating schedule equal to 14 full-load hours shall be assumed in both the Reference Building and the Certified Building during periods when ceiling fans are operational. Ceiling fans shall be assumed to operate only during the cooling season, which may be estimated to be all months with an average temperature greater than 17.2 C. The cooling thermostat (but not the heating thermostat) shall be set up by 0.25 ^{o}C in both the Reference and Certified Building during periods when ceiling fans are assumed to operate.

The Reference Building shall use three (3) Standard Ceiling Fans of 42.6 watts each for total full-load fan wattage of 128 watts (42.6 * 3 = 128). The Certified Building shall use the Labeled Ceiling Fan Standardized Watts (LCFSW), also multiplied by three (3) fans to obtain total ceiling fan wattage for the Certified Building. The Certified Building LCFSW shall be calculated as follows:

LCFSW = (3000L/s) / (L/s/watt as labeled at medium speed)

During periods of fan operation, the fan wattage, at 100% internal gain fraction, shall be added to internal gains for both the Reference and Certified Buildings. In addition, annual ceiling fan energy use, for both the Certified and Reference Buildings shall be added to the lighting and appliance end use loads (EUL_{LA}).

If the Certified Building includes On-site Power Production, the Purchased Energy Fraction for the Certified Building shall be used to determine the impact of the On-site Power Production, as follows:

PEfrac = (TEU - OPP) / TEU

Where:

TEU = Total energy use of the Certified Home including all rated and non-rated energy features where all fossil fuel site energy uses are converted to Equivalent Electric Power by multiplying them by the Reference Electricity Production Efficiency of 40%.

OPP = On-site Power Production

2 Operating Condition Assumptions

2.1 All providers shall estimate the annual purchased energy consumption for heating, cooling and hot water for both the Certified Building and the Reference Building using the following assumptions–

2.1.1 Internal heat gains ("IGain" in kWh/day per dwelling unit) from lights, people and equipment of

$$IGain = 5.246 + 0.075*CFA + 1.203*N_{br}$$

where
CFA = conditioned floor area per dwelling unit (m^2)
N_{br} = number of bedrooms per dwelling unit

As adjusted for internal gains from high-efficiency lighting and appliances in the Certified Building as provided by Section 1.2.5.

2.1.2 Where programmable offsets are available in the Certified Building, 1 C temperature control point offsets with an 11 p.m. to 5:59 a.m. schedule for heating and a 9 a.m. to 2:59 p.m. schedule for cooling, and with no offsets assumed for the Reference Building;

2.1.3 When calculating annual purchased energy for cooling, internal latent gains assumed as 0.20 times sensible internal heat gains;

2.1.4 The climatologically most representative TMY or equivalent climate data, which may be interpolated between climate sites if interpolation is established or approved by the accrediting body and consistent for all providers operating within a state.

2.1.5 Manufacturer's Equipment Performance Ratings (e.g., HSPF, SEER, AFUE) *[I do not know what these are in SI units?]* shall be corrected for local climate conditions and mis-sizing of equipment. To determine equipment mis-sizing, the capacity of heating and cooling vapor compression equipment shall be calculated in accordance with ACCA Manual J, Eighth Edition, ASHRAE 2001 Handbook of Fundamentals, or an equivalent computation procedure, using the following assumptions:

2.1.5.1 For the Reference Building:
2.1.5.1.1 Indoor temperatures shall be 24 C for cooling and 21 C for heating.
2.1.5.1.2 Outdoor temperatures shall be the 99.0% and 1.0% design temperatures as published in the ASHRAE Handbook of Fundamentals for the city where the Building is located or the most representative city for which design temperature data are available.
2.1.5.1.3 Infiltration rate in air changes per hour (ach) shall be:

(a) For summer: 1.2 * nL * W
(b) For winter: 1.6 * nL * W
(c) Where: nL = 0.48
(d) W = Weather factor from W Tables in ASHRAE Standard 136

2.1.5.1.4 Mechanical ventilation shall be zero.

2.1.5.1.5 All windows shall have blinds/draperies that are positioned in a manner that gives an Internal Shade Coefficient (ISC) of 0.70 in the summer and an ISC of 0.85 in the winter. These values are represented in ACCA Manual J Eighth Edition as “dark closed blinds” in the summer and “dark, fully drawn roller shades” in the winter.
2.1.5.1.6 Internal heat gains shall be 468.9 watts sensible for appliances plus 67.4 watts sensible and 58.6 watts latent per occupant, with the number of occupants equal to the number of bedrooms plus one.
2.1.5.1.7 Heat pump equipment shall be sized to equal the larger of the heating and cooling season calculations in accordance with these procedures.
2.1.5.1.8 Systems shall be smaller than the size calculated using this procedure plus 30 watts.

2.1.5.2 For the Certified Building:
2.1.5.2.1 Indoor temperatures shall be 24 C for cooling and 21 C for heating.
2.1.5.2.2 Outdoor temperatures shall be the 99.0% and 1.0% design temperatures as published in the ASHRAE Handbook of Fundamentals for the city where the Building is located or the most representative city for which design temperature data are available.
2.1.5.2.3 Infiltration rate shall be either the measured envelope leakage area converted to equivalent natural air changes per hour (ach,nat) or the default value derived above for the Reference Building modified as follows:

(a) For summer: either 1.2 * ach,nat or 1.2 * nL * W
(b) For winter: either 1.6 * ach,nat or 1.6 * nL * W
(c) Where: nL = 0.48
(d) W = Weather factor from W Tables in ASHRAE Standard 136

2.1.5.2.4 Mechanical ventilation shall only be included for systems that are controlled to run every hour or every time the HVAC system operates. Standard bathroom and kitchen ventilation may not be considered as ventilation for sizing purposes.
2.1.5.2.5 Combined infiltration and ventilation may not be less than the ventilation rates required by ASHRAE Standard 62.2-2004, nor greater than nL * W * 1.2 in summer and nL * W * 1.6 in winter.
2.1.5.2.6 Windows shall include observed blinds/draperies. For new Buildings, all windows shall assume blinds/draperies that are positioned in a manner that gives an Internal Shade Coefficient (ISC) of 0.70 in the summer and an ISC of 0.85 in the winter. (These values are represented in ACCA Manual J Eighth Edition as “dark closed blinds” in the summer and “dark fully drawn roller shades” in the winter.)
2.1.5.2.7 Internal heat gains shall be 468.9 watts sensible for appliances plus 67.4 watts sensible and 58.6 watts latent per occupant, with the number of occupants equal to the number of bedrooms plus one.
2.1.5.2.8 Heat pump equipment shall be sized to equal the larger of the heating and cooling season calculations in accordance with these procedures.
2.1.5.2.9 To the degree that the installed equipment for the Certified Building exceeds properly sized equipment in accordance with the above procedures, the manufacturer’s equipment performance rating shall be reduced accordingly.

2.1.6 For heat pumps and air conditioners where a detailed, hourly HVAC simulation is used to separately model the compressor and evaporator energy (including part-load performance), the back-up heating energy, the distribution fan or blower energy and crank case heating energy, the

Manufacturer's Equipment Performance Rating (HSPF and SEER) shall be modified as follows to represent the performance of the compressor and evaporator components alone: HSPF, corr = HSPF, mfg / 0.582 and SEER, corr = SEER, mfg / 0.941. *[We use these correction values based on our definitions of equipment performance, but I do not know how to deal with this on a international basis?]* The energy uses of all components (i.e. compressor and distribution fan/blower; and crank case heater) shall then be added together to obtain the total energy uses for heating and cooling.

2.1.7 Natural ventilation shall be assumed in both the Reference and Certified Buildings during hours when natural ventilation will reduce annual cooling energy use.

2.1.8 When a whole-house fan is present in the Certified Building, it shall operate during hours of favorable outdoor conditions, and no whole-house fan shall be assumed in the Reference Building. The fan energy associated with the whole-house fan shall be included in the energy consumption for the Certified Building's cooling end-use.

2.1.9 Local residential energy or utility rates that–

(a) Are revenue-based and include customer service and fuel charges;
(b) Are updated at least annually; and
(c) Are confirmed by the accrediting body.

Appendix D

TECHNICAL MANAGEMENT BOARD RESOLUTION 5/2009

Energy in Buildings

The Technical Management Board,

Recalling its resolution 130/2008 requesting ISO/CS to convene a meeting with the leadership of ISO/TC 163 *Thermal performance and energy use in the build environment* and ISO/TC 205 *Building environment design* to resolve an overlap in scopes,

Noting the report from the TMB Secretariat on the results of discussions from the meeting held 10 February 2009 at ISO/CS,

Decides

- That the current scope of TC 163 remains unchanged at this point in time. The issue of the scope of TC 163 shall be revisited after the work below has been accomplished.
- That ISO/CS shall carry out a consultation with other TCs on the possible extension to the scope of TC 205 to cover rating and performance of heating and ventilation equipment.
- That a Joint Working Group (JWG) between the two committees be formed and that it shall be co-convened by nominations from the leadership of TC 163 and TC 205 with immediate effect and with a view to having a 1st meeting before end April 2009.
- That all standards and work items in TC 163 relating to the performance of systems and whole buildings that are of interest to TC 205 be transferred to the JWG.
- That all standards and work items in TC 205 concerning energy efficiency and calculation methods that are of interest to TC 163 be transferred to the new JWG.
- That ISO WD 12842 and ISO CD 11368 be progressed together as a single merged work item under the JWG.
- That the new JWG also review all work items of both committees with a view to identifying items that should be transferred to the JWG.

<u>Noting</u> the ISO/SAG-E recommendation that standards for assessment/calculation, rating and labeling and standards for best practice and improvement of energy performance in buildings are urgently needed to facilitate the market for services related to energy in buildings, requests the JWG to consider whether all or some of these standards may be developed under the JWG or either committee and report to ISO/CS by beginning of June 2009,

<u>Further requests</u> that ISO's global relevance policy continue to be applied throughout the work of both committees including any joint work,

<u>And further requests</u> TAG 8 *Building* to convene a dedicated session on the development of an ISO vision for energy performance of buildings to which TCs 163, 205 and 59 *(Building construction)* and other interested committees shall be invited. The vision shall include recommendations on a future technical structure.