Pella® Recommendation for ENERGY STAR® Criteria Revision

A | Department of Energy (DOE) ENERGY STAR® Phase 1 Objectives
1. Modest decline in ENERGY STAR market share
2. Greater use of argon to improve performance
3. Higher performance glass packages
4. Trade-offs with SHGC in northern zones
5. Aluminum windows will have to be thermally broken to qualify.

B | Pella Corporation Statement of Intent
1. Support the use of ENERGY STAR as a means of providing consumers with the ability to select and differentiate energy efficient products in the market place.
2. Cooperate with DOE through ENERGY STAR to drive energy efficiency innovations in window and door products that are affordable and beneficial to consumers.
3. Support WDMA and AAMA positions on future ENERGY STAR criteria for windows, doors and skylights.
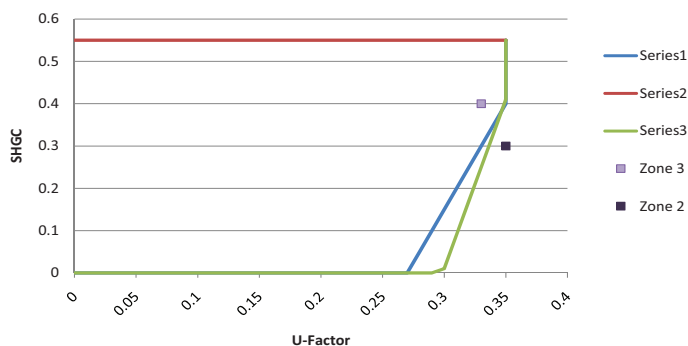
C | Pella Corporation Recommendations
1. Eliminate Zone 5A.
2. Combine Zones 4 and 5 into one zone, or another combination that is representative of climate and design temperatures.
3. Combine Zones 2 and 3 into one zone, or another combination that is representative of climate and design temperatures.
4. Move Sliding Patio Door criteria into Swinging Entry Door Criteria, rename Door Criteria.
5. Pella supports separate criteria for impact-resistant and high altitude units.
6. Postpone setting criteria for Phase 2.
7. SHGC criterion in Zone 1 for Phase 2 is too low.
8. Products manufactured before mandatory date (end of transition period) should be ENERGY STAR qualified based on existing criteria.
9. Mandatory IG testing and related timing should be removed from the DOE analysis.
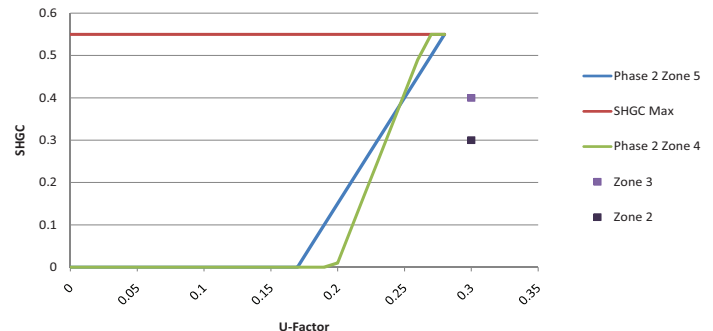
D | Pella Corporation Recommendation Analysis
1. Eliminate Zone 5A.
   a. Zone 5A is for Phase 1 only and will be eliminated in Phase 2.
   b. This zone was created to satisfy local rebates that affect a small population, and therefore will not provide substantial energy benefits.
   c. The DOE should not set criteria in regards to utility rebates – it makes more sense for local utility companies to set rebates based on ENERGY STAR criteria and not for ENERGY STAR criteria to be set based on rebates.
      i. There is no guarantee that existing rebates will continue to offset the payback.
   d. Recommended payback needs to be realized within average time of owning a home.

2. Combine Zones 4 and 5 into one zone, or another combination that is representative of climate and design temperatures.
   a. There is little difference between the performance curves as proposed by DOE.
   b. Combining zones would be easier for consumer to understand.
   c. The small difference between the performance curves as proposed by DOE for Zones 4 and 5 does not warrant the added consumer confusion. The same holds true for Zones 2 and 3 below.


Phase 1 Zones 5, 4, 3, & 2

Phase 2 Zones 5, 4, 3, & 2

D | Pella Corporation Recommendation Analysis

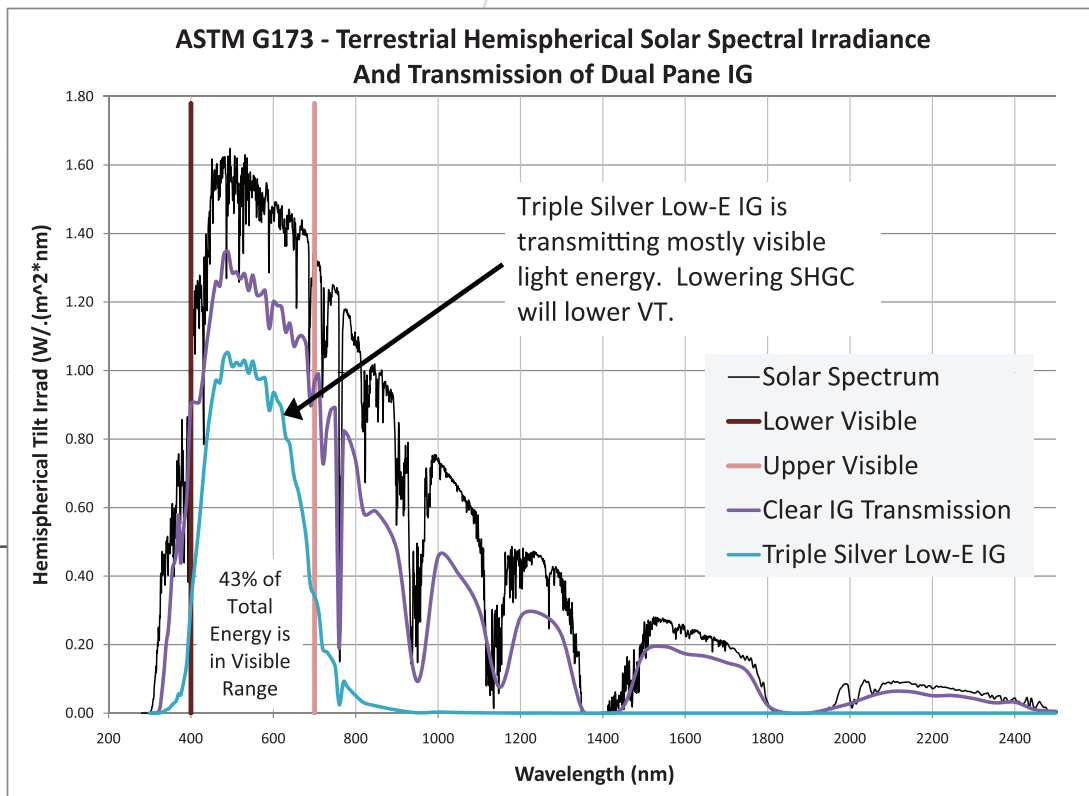3. Combine Zones 2 and 3 into one zone, or another combination that is representative of climate and design temperatures.
   a. The u-factor criteria proposed for these two zones are not significantly different.
   b. Pella is willing to accept a lower SHGC to apply to the single zone.
   c. Combining zones would be easier for consumer to understand.

4. Move Sliding Patio Door criteria into Swinging Entry Door Criteria, rename Door Criteria.
   a. Pella supports a single climate zone.
   b. Sliding patio doors generally have a greater savings because they perform better than hinged doors of the same size in other performance factors (e.g. structural, air and water leakage).
   c. Placing all doors in one criterion would be easier for consumer to understand.
   d. In addition to the above comments, recalculating the cost effectiveness in 2011 doesn't allow time between potentially adjusting criteria and implementing products that meet Phase 2 criteria. Recommend phase is four years after the criteria is set.

5. Pella supports separate criteria for impact-resistant and high altitude units.
   a. Pella wishes to work with the DOE to further examine criteria in this area.

6. Postpone setting criteria for Phase 2.
   a. Pella wishes to partner with DOE to find ways to achieve energy savings goals with a representative energy savings model and technically feasible products.
   b. With non-fenestration products, the DOE sets both mandatory and voluntary criteria. With windows and doors, mandatory criteria are set by local codes. This will limit the ability to maintain separation between mandatory codes and ENERGY STAR voluntary criteria.
   c. Set Phase 2 criteria in 2011 effective 2015 – after 2009 criteria has gone through transition phase.
   d. Given the current economic conditions, Pella suggests the DOE evaluate their objective for low market share. Credit difficulties, low number of housing starts, and high price products may drive market share lower than predicted, negatively impacting energy savings.
   e. Average Annual Whole House HVAC Costs by Zone (per Pella's Resfen5 analysis)
      i. There is greater incremental savings from existing ENERGY STAR qualified products than there is from the existing criteria to proposed Phase 1 or 2. This combined with substantial price increases will make new ENERGY STAR windows less attractive to buy.
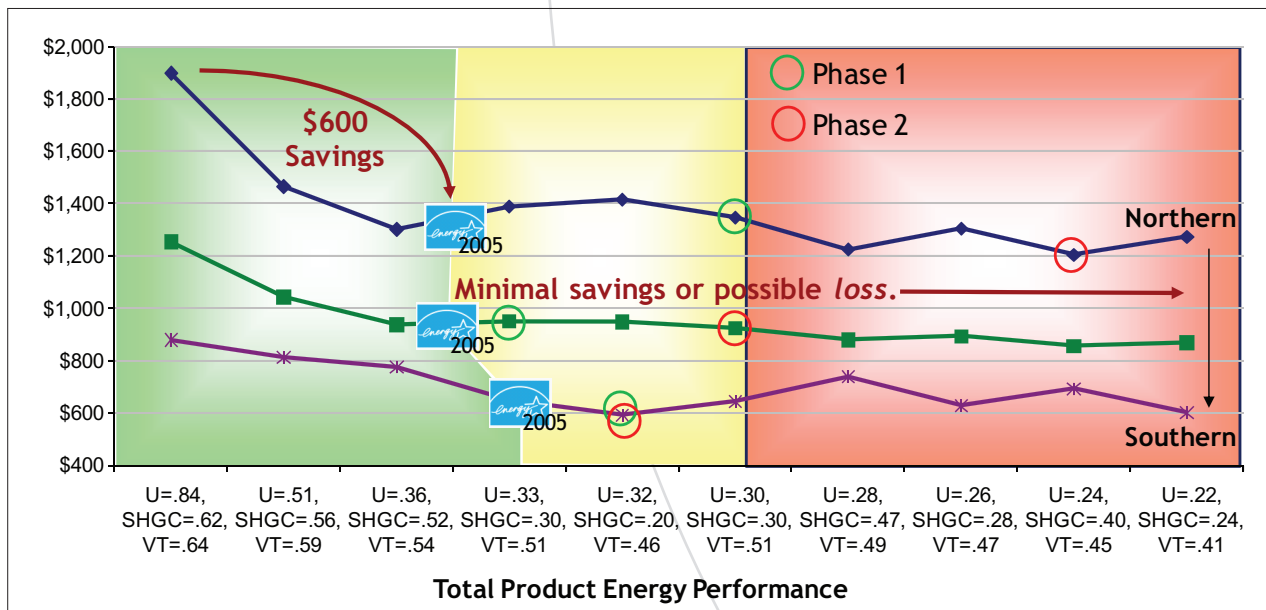
f. The current savings model used by DOE to report the effect of proposed ENERGY STAR changes has uncertainties. Pella supports the analysis submitted by AAMA and WDMA showing the possibility for equivalent energy savings from alternate zones and criteria. Further refinement of the energy savings model is necessary. See attached PowerPoint presentation for a complete summary of Pella's concerns with the energy savings analysis.

D | Pella Corporation Recommendation Analysis

7. SHGC criterion in Zone 1 for Phase 2 is too low.
    a. Requiring a 0.20 SHGC means that at most 51% of natural light can be transmitted through the window. Pella recommends a max SHGC of 0.25 which is possible with advanced Low-E coatings and would allow 64% of natural light to be transmitted through the same window.
    b. Increased energy use due to lighting demand will be needed to compensate for reduced visible light coming through the window.
    c. This plot shows that advanced Low-E coatings already remove the non-visible portion of solar energy. Further lowering SHGC can only occur by removing more of the visible solar energy.

ASTM G173 - Terrestrial Hemispherical Solar Spectral Irradiance And Transmission of Dual Pane IG

8. Products manufactured before mandatory date (end of transition period) should be ENERGY STAR qualified based on existing criteria.
    a. Once product leaves manufacturing facility it is sold and should not require a new label based on Phase 1 criteria.

9. Mandatory IG testing and related timing should be removed from the DOE analysis (Section 4.1.1).
    a. NFRC is working to include IG certification as part of product labeling requirements. Since ENERGY STAR is based on NFRC values, further ENERGY STAR requirements for IG certification are not necessary.

WDMA/DOE/LBNL Joint Meeting

ENERGY STAR 2009 Proposals

November 3, 2008 – Jacksonville, FL

Agenda

- Background
- DOE/LBNL analysis for energy savings
- WDMA technical evaluation – building modeling
- WDMA technical evaluation – energy savings
- WDMA proposed zones and criteria
- WDMA/DOE energy savings comparison
- Conclusions / Actions

Background

- Basis for meeting found in U.S. Department of Energy's ENERGY STAR Program August 11, 2008 report:
  - <u>Windows, Doors, and Skylights; Draft Criteria and Analysis</u> (referred to as "the draft criteria")
  - Prepared by D&R International, Ltd.

- WDMA has completed technical analyses in advance of the November 14, 2008 deadline for public comment.

- WDMA will request that DOE complete additional analysis before releasing final ENERGY STAR criteria.

DOE/LBNL Analysis for Energy Savings

- ENERGY STAR for Windows, Doors, and Skylights is designed to help reduce national energy consumption.

- LBNL established a methodology to evaluate the spacing heating and cooling effects of windows in the residential market.
  - The methodology is documented LBNL's August 1, 2008 report <u>A National Energy Savings Model of US Window Sales.</u>

- From LBNL's methodology and assumptions set forth by D&R International, a resultant national energy savings was determined for both phases of proposed ENERGY STAR criteria.
  - Additional detail of the calculation procedures is found in Appendix B of the draft criteria and in various spreadsheets found at <u>windows.lbl.gov/EStar2008/</u>

DOE/LBNL Analysis for Energy Savings

- Assumptions affecting the analysis result include:
  - Residential HVAC energy consumption of 4 house types calculated by DOE-2 software, including many building modeling techniques/assumptions.
  - Energy consumption regression coefficients from DOE-2 results for 4 house types, in 98 cities nationwide, and with 50 different window types (U & SHGC).
  - Regional window sales information.
  - Market share and penetration rates of various window types.
  - U factor and SHGC of windows used in the model to represent a "code equivalent" baseline.
  - U factor and SHGC of windows used in the model to represent the phase 1 or phase 2 ENERGY STAR product.

- For each phase, the calculated energy consumption from homes using ENERGY STAR windows was compared to energy consumption from homes using Code Equivalent windows.

DOE/LBNL Analysis for Energy Savings

Phase 1 Savings as a function of:

(Energy consumed by homes with Table B-5 windows) – (Energy consumed by homes with Table B-7 windows)

Table B-5: 2006 IECC Window Criteria

IECC Climate Zone	U-Factor		SHGC	
	Requirement	As Modeled	Requirement	As Modeled
8	≤ 0.35	0.35	NR	0.30
7	≤ 0.35	0.35	NR	0.30
6	≤ 0.35	0.35	NR	0.30
5	≤ 0.35	0.35	NR	0.30
4	≤ 0.40	0.40	NR	0.30
3	≤ 0.65	0.65	≤ 0.40	0.30
2	≤ 0.75	0.75	≤ 0.40	0.30
1	≤ 1.20	1.20	≤ 0.40	0.30

Table B-7: Phase 1 ENERGY STAR Criteria and Model Criteria

Climate Zone	U-Factor		SHGC	
	Requirement	As Modeled	Requirement	As Modeled
ES5a	≤ 0.30	0.30	≤ 0.55	0.30
ES5	EP ~ 0.32/0.25	0.32	EP ~ 0.32/0.25	0.25
ES4	EP ~ 0.33/0.25	0.33	EP ~ 0.33/0.25	0.25
ES3	≤ 0.33	0.33	≤ 0.40	0.30
ES2	≤ 0.35	0.35	≤ 0.30	0.30
ES1	≤ 0.50	0.50	≤ 0.25	0.25

(Tables taken from draft criteria.)

DOE/LBNL Analysis for Energy Savings

Phase 2 Savings as a function of:

(Energy consumed by homes with Table B-6 windows) – (Energy consumed by homes with Table B-8 windows)

Table B-6: Proposed 2009 IECC Window Criteria

IECC Climate Zone	U-Factor		SHGC	
	Requirement	As Modeled	Requirement	As Modeled
8	≤ 0.35	0.35	NR	0.30
7	≤ 0.35	0.35	NR	0.30
6	≤ 0.35	0.35	NR	0.30
5	≤ 0.35	0.35	NR	0.30
4	≤ 0.35	0.35	NR	0.30
3	≤ 0.40	0.40	≤ 0.30	0.30
2	≤ 0.50	0.50	≤ 0.30	0.30
1	≤ 0.65	0.65	≤ 0.30	0.30

Table B-8: Phase 2 ENERGY STAR Criteria and Model Criteria

Climate Zone	U-Factor		SHGC	
	Requirement	As Modeled	Requirement	As Modeled
ES5	EP ~ 0.22/0.25	0.22	EP ~ 0.22/0.25	0.25
ES4	EP ~ 0.23/0.25	0.23	EP ~ 0.23/0.25	0.25
ES3	≤ 0.30	0.30	≤ 0.40	0.30
ES2	≤ 0.30	0.30	≤ 0.30	0.30
ES1	≤ 0.45	0.45	≤ 0.20	0.20

(Tables taken from draft criteria.)

DOE/LBNL Analysis for Energy Savings

Phase 1 Savings

Table 6: Source of Energy Savings for Phase 1 Criteria by Zone

Climate Zone	Heating Energy (tBTU)	Cooling Energy (tBTU)	Total Savings (tBTU)
ES5a	0.32	0.01	0.33
ES5	0.06	0.12	0.18
ES4	(0.05)	0.43	0.38
ES3	1.31	0.35	1.65
ES2	3.56	0.53	4.09
ES1	0.96	0.92	1.88
Total	**6.16**	**2.35**	**8.51**

Source: LBNL, 2008. Heating Energy is annual energy reduction in heating load. Cooling Energy is annual energy reduction in cooling load. Total Savings is the total annual energy reduction in both heating and cooling loads.

Note: 4% of total energy savings is from heating energy in the Northern most zones where the proposed criteria are the most costly to achieve.

(Tables taken from draft criteria.)

DOE/LBNL Analysis for Energy Savings

Phase 2 Savings

| Table 16: Source of Primary Energy Savings for Phase 2 Window Criteria by Climate Zone			
Climate Zone	Heating Energy (tBTU)	Cooling Energy (tBTU)	Total Savings (tBTU)
ES 5	1.08	0.36	1.43
ES 4	1.64	1.11	2.76
ES 3	0.72	1.50	2.22
ES 2	0.39	1.96	2.35
ES 1	(0.84)[17]	3.49	2.64
National	2.98	8.42	11.41

Source: Lawrence Berkeley National Laboratory, 2008.

WDMA Technical Evaluation – Building Modeling

- Building modeling technique used by LBNL is inconsistent with Code modeling techniques.
  - LBNL (DOE-2) used equal distribution of windows on all 4 sides of home.
  - Code says equal distribution defines budget for performance path – need to compare with real world distribution of actual house.
  - Building America uses actual distribution and rotates building to N, E, S, and W. Averages results of these four orientations.
  - Next slide (using Resfen5) suggests that LBNL technique is inaccurate for 3 of 4 orientations.

WDMA Technical Evaluation – Building Modeling

Orientation Analysis in Minneapolis
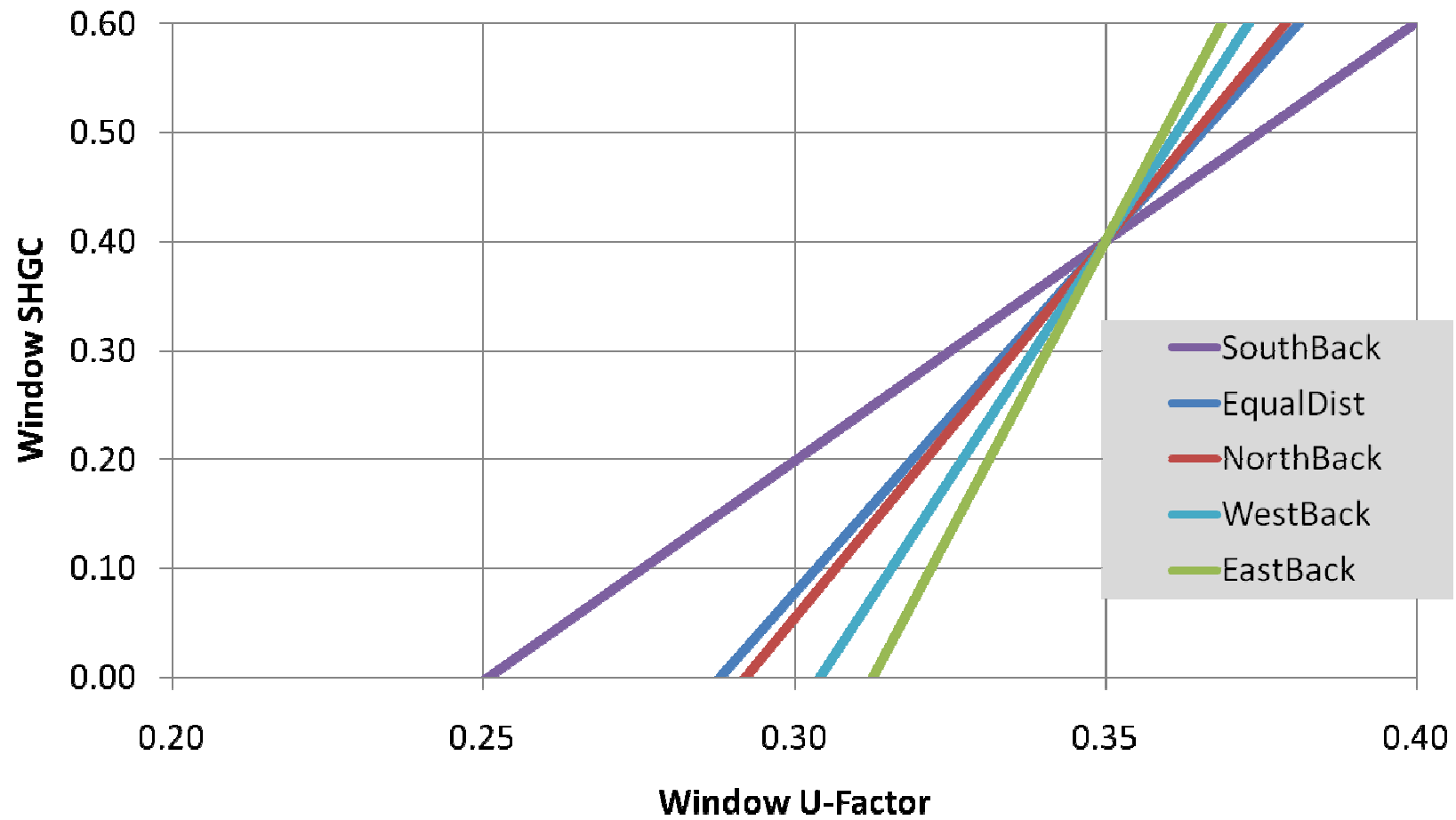
WDMA Technical Evaluation – Building Modeling

- Thermostat settings used by LBNL inconsistent with Code modeling techniques.
  - LBNL (DOE-2) assume all buildings use programmable thermostat with 5°F night (heat) setback.
  - IECC uses fixed set-points (no setback).
  - RECS2005 data suggests that 36% of buildings have programmable thermostat, but that only 23% of buildings use them at night.
  - RECS2005 data suggests less than 2°F night temperature difference for all buildings (includes those homeowners that manually over-ride).

WDMA Technical Evaluation – Building Modeling

- ## Thermostat settings used by LBNL inconsistent with Code modeling techniques (continued).

  – LBNL (DOE-2) used 78°F cooling set-point.

  – RECS2005 suggest that 74°F is cooling set point when people are home and 76°F set point when people are away from home.

  – If RECS cooling set-points are so low relative to IECC why does Energy Star "calibrate" cooling energy at all?

WDMA Technical Evaluation – Building Modeling

- ## Does RESFEN6 or DOE-2 modeling technique meet BESTEST?

  - BESTEST is a protocol used by home energy raters to validate simulation programs.

  - How has Resfen or DOE-2 been validated?

WDMA Technical Evaluation – Building Modeling

- ## Interior Shade Usage
  - Resfen suggests that interior shades are open 2/3 time in winter and closed 2/3 time in summer.
  - For homeowners, the motivation for blind usage is issue of privacy control, not energy savings.
  - Daylight hours in Northern latitudes suggests opposite response: dark for winter morning and daylight in summer morning
  - Do homeowners consciously open to the winter "dark" and close to the summer "light"?
  - Basing energy savings on variable SHGC, as affected by shading use, does not provide a sure result.
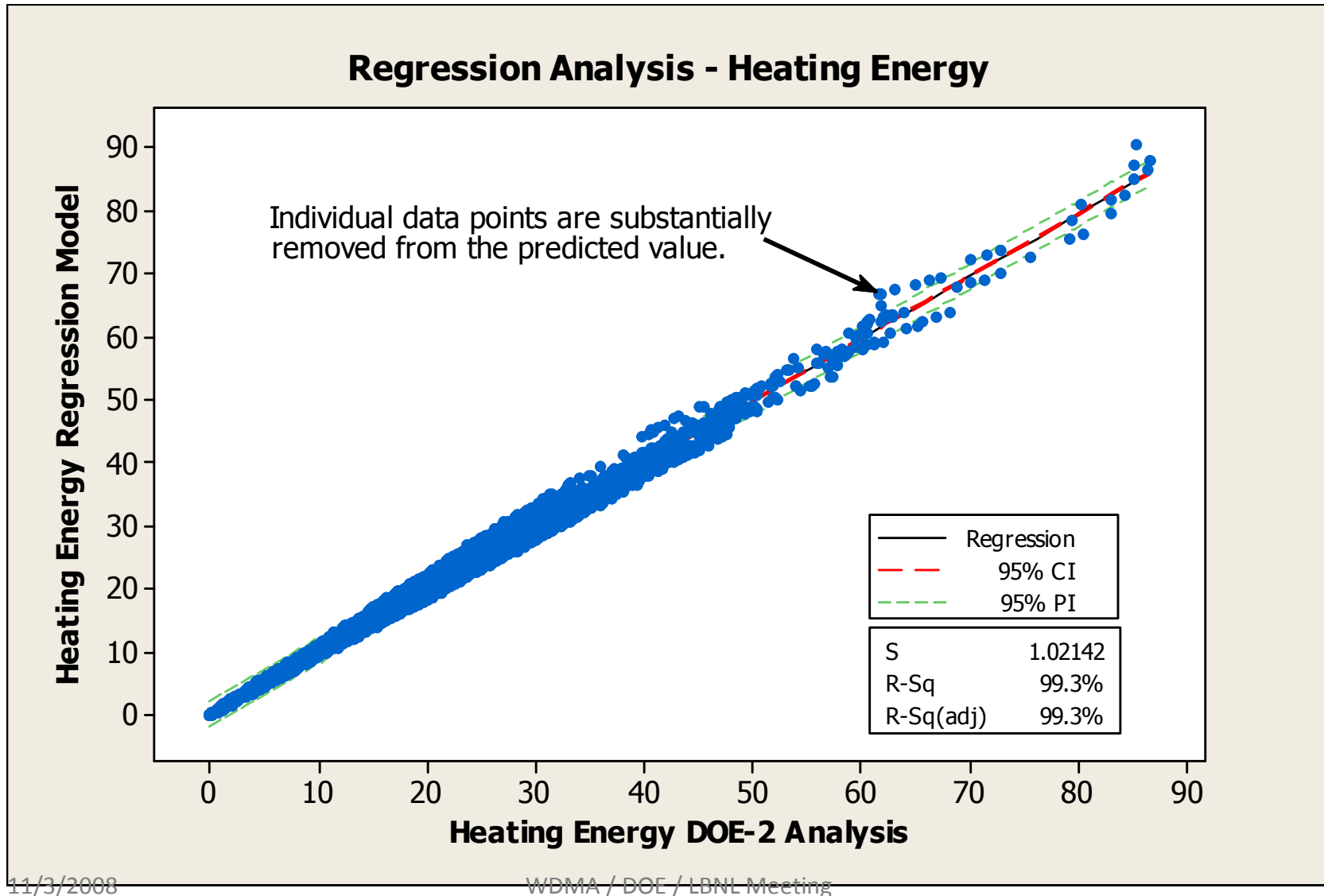
WDMA Technical Evaluation – Energy Savings

- "Code Equivalent" window U and SHGC "As Modeled" are not representative of code compliant analysis
  - Clad wood or vinyl windows common in northern climates achieving maximum U are likely to have SHGC near .33 (higher than the .30 as modeled value in tables B-5 and B-6).
  - Aluminum windows common in southern climates are likely to have higher SHGC, e.g. .40.
  - In previous slide note that all lines intersect at SHGC = 0.40. This is code requirement for baseline analysis in all regions.

WDMA Technical Evaluation – Energy Savings

- The National Energy Savings Model by LBNL uses regression coefficients to express energy consumption as a function of U and SHGC.

- Regression coefficients contain potentially significant inaccuracies in comparing windows.
  - A subset of regression results was provided by LBNL. These represent heating energy from single story homes.
  - The data are fit well by a line, but individual points can vary substantially from the line.

WDMA Technical Evaluation – Energy Savings

Regression Analysis - Heating Energy

Individual data points are substantially removed from the predicted value.

Legend:
- Regression
- 95% CI
- 95% PI

S	1.02142
R-Sq	99.3%
R-Sq(adj)	99.3%

Y-axis: Heating Energy Regression Model
X-axis: Heating Energy DOE-2 Analysis

WDMA Technical Evaluation – Energy Savings

- Appendix B and Section 4 of the draft criteria suggest that penetration rates of various window sales scenarios are factored into the aggregate energy savings calculation.

- Results in Tables 5, 6, 15, and 15 in the draft criteria are based on a spreadsheet at windows.lbl.gov/EStar2008/. The spreadsheet is "LBNL Results Model 44 - 3 Aug.xls "

  - The spreadsheet states "The results presented are Heating Energy and Cooling Energy Use for 6 regions (Zone 6 = Zone 5a). Each number represents all the heating or cooling for all new homes built plus all homes retrofitted with windows in a year. These are annual energy results, for one year's worth of energy. "

- It is unclear from the results in the noted spreadsheet how penetration rates affected the energy savings result.

  - Further clarification of the calculation is requested.

WDMA Proposed Zones and Criteria

- Jim Larsen to add content about our zone selection.

WDMA Proposed Zones and Criteria

- WDMA proposed Phase 1 ENERGY STAR criteria.

Phase 1 WDMA Proposed Criteria and Model Criteria				
	U-Factor		**SHGC**	
Climate Zone	Requirement	As Modeled	Requirement	As Modeled
N	≤ 0.3	0.3	NR	0.33
NC	≤ 0.32	0.32	NR	0.33
SC	≤ 0.35	0.35	≤ 0.3	0.3
S	≤ 0.5	0.5	≤ 0.25	0.25

WDMA Simplified Energy Savings Comparison

- WDMA used information made available by LBNL to conduct a simplified energy savings comparison.
  - The regression equations were applied to calculate average HVAC energy consumption across the 4 house types in the 98 locations.
  - Average energy consumption for the windows of Tables B-5 and B-7 were calculated first and used as a savings baseline.
  - Average energy consumption for the proposed WDMA values were then calculated and savings compared to Table B-5 windows calculated.
  - The % change in savings at each location was calculated comparing the WDMA proposal to the DOE proposal.
  - The % change was averaged across the ENERGY STAR zones and then applied to the savings results from Table 5.

WDMA Simplified Energy Savings Comparison

- Average energy savings is used as a scalar to estimate savings from the WDMA proposal.

- Other assumptions from LBNL and DOE's analysis are held constant.

Table 5: Phase 1 Window Energy Savings by Zone				WDMA Savings Comparable to Table B-5
	Consumption			
Climate Zone	2006 IECC (tBTU)	Phase 1 ENERGY STAR (tBTU)	Savings (tBTU)	Savings (tBTU)
ES5a	12.17	11.84	0.33	0.26
ES5	18.88	18.7	0.18	0.48
ES4	73.93	73.54	0.38	0.79
ES3	62.89	61.24	1.65	1.18
ES2	49.37	45.28	4.09	4.09
ES1	35.29	33.41	1.88	1.88
National			**8.51**	**8.67**

WDMA Simplified Energy Savings Comparison

- The same simplified procedure was used to estimate the effect of adjusting the "Code Equivalent" per WDMA's recommendation.

Table B-5: 2006 IECC Window Criteria - Modified per WDMA				
	U-Factor		**SHGC**	
IECC Climate Zone	Requirement	As Modeled	Requirement	As Modeled
8	≤ 0.35	0.35	NR	0.33
7	≤ 0.35	0.35	NR	0.33
6	≤ 0.35	0.35	NR	0.33
5	≤ 0.35	0.35	NR	0.33
4	≤ 0.40	0.4	NR	0.33
3	≤ 0.65	0.65	≤ 0.40	0.4
2	≤ 0.75	0.75	≤ 0.40	0.4
1	≤ 1.20	1.2	≤ 0.40	0.4

WDMA Simplified Energy Savings Comparison

- The proposed baseline change shows greater Phase 1 savings.

Table 5: Phase 1 Window Energy Savings by Zone				WDMA Savings Comparable to Table B-5	Table 5 Predicted w/ Modified Table B-5	WDMA Savings Comparable to Modified Table B-5
	Consumption					
Climate Zone	2006 IECC (tBTU)	Phase 1 ENERGY STAR (tBTU)	Savings (tBTU)	Savings (tBTU)	Savings (tBTU)	Savings (tBTU)
ES5a	12.17	11.84	0.33	0.26	0.30	0.23
ES5	18.88	18.7	0.18	0.48	0.10	0.40
ES4	73.93	73.54	0.38	0.79	0.32	0.73
ES3	62.89	61.24	1.65	1.18	1.64	1.17
ES2	49.37	45.28	4.09	4.09	5.08	5.08
ES1	35.29	33.41	1.88	1.88	3.83	3.83
National			**8.51**	**8.67**	**11.27**	**11.44**

WDMA Simplified Energy Savings Comparison

- WDMA used additional information made available by LBNL to conduct a second simplified energy savings comparison.

  – The spreadsheet "LBNL Results Model 44 - 3 Aug.xls" was recalculated with active formulae instead results only as provided by LBNL.

  – Some inconsistencies are found in WDMA's calculated result vs. the hard numbers provided by LBNL. For this comparison, the inconsistencies are ignored.

  – A column of heating and cooling energy consumption was added based on WDMA's criteria proposal.

  – The WDMA energy consumption was compared to DOE's Phase 1 ENERGY STAR energy consumption.

WDMA Simplified Energy Savings Comparison

- Using the LBNL spreadsheet as a calculation tool, the WDMA proposal again appears to match or improve upon the DOE Phase 1 proposal for aggregate energy savings.

	SAVINGS (Phase 1 ENERGY STAR)			
TOTAL (tBTU)				
			Relative to	
E* Zone	2006 IECC	2009 IECC	2008 - E*	WDMA Proposal
6	0.41	0.41	0.41	0.15
5	0.23	0.23	0.23	(0.15)
4	(0.41)	(0.41)	(0.41)	(1.67)
3	(0.20)	0.04	1.75	0.04
2	7.69	1.28	1.23	-
1	2.45	(0.09)	1.40	-
Total	10.17	1.47	4.61	(1.64)

Conclusions / Actions

- WDMA concludes that the energy savings analysis in the draft criteria has uncertainties.
- WDMA recommends that the potential errors are evaluated and documented by zone.
  - This includes determining the sensitivity of the savings result to changes in U and SHGC.
- WDMA recommends that the savings analysis be improved by:
  - Either improving the regressing model or
  - Using only DOE-2 actual output.
  - Modifying building modeling assumptions to match code.

Conclusions / Actions

- WDMA concludes from multiple simplified energy savings comparisons, that there is potential to reach energy savings goals through alternate means that are less impactful to consumers and manufacturers.

- WDMA requests LBNL to update the full energy savings model to verify/deny the simplified comparison.