DIPARTIMENTO DI
ARCHITETTURA, INGEGNERIA DELLE
COSTRUZIONI E AMBIENTE COSTRUITO
ABC

POLITECNICO DI MILANO

Hourly Dynamic Calculation Engine based on EN ISO 52016:2017 Standard implemented in TERMOLOG Software.
Building Thermal Envelope and Fabric Loads Test according to ANSI/ASHRAE Standard 140-2017

FINAL REPORT

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Summary

1 Scope of work

Logical Soft has entered into a research contract with the Department of Architecture, Built Environment and Construction Engineering (ABC) of Politecnico di Milano to provide technical-scientific support in the implementation of the hourly dynamic calculation model proposed by EN ISO 52016:2017 Standard in TERMOLOG Software.
The research program consists in the realization of a series of algorithms implemented in Excel sheets to perform the simplified hourly calculation based on an equivalent resistive-capacitive model (R-C) according to the Crank-Nicholson scheme.
After a few months from the contract definition, the new calculation engine has been implemented on the TERMOLOG Software platform and it was possible to carry out tests.
This report presents the results of the validation using method according to ANSI/ASHRAE 140-2017 *Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs and in the Building Energy Simulation Test (BESTEST) and Diagnostic Method* [1] an internationally recognized methodology for comparing the results of energetic simulations of buildings in a dynamic calculation.
When necessary, additional information was provided by the IEA 12B/21C sponsored report, Building Energy Simulation Test (BESTEST) and Diagnostic Method (IEA 1995) [2], which served as the basis for the ANSI/ASHRAE standard.

Symbols

Symbol	Description	Unit
A	area	m^2
C	Heat capacity	J/K
D	depth	m
FF	free float	
R	thermal resistance	m^2K/W
U	thermal transmittance	$W/(m^2K)$
c	specific heat capacity	J/(kg K)
λ	conductivity	W/(m K)
ρ	density	kg/m^3
κ	areal heat capacity	$J/(m^2K)$

2 Description of the methodology

2.1 ANSI/ASHRAE Standard 140-2017

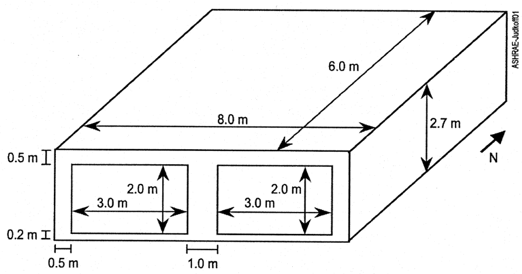
"Comparative tests compare a program to itself or to other simulation programs. This type of testing accomplishes results on two different levels, both validation and debugging.
From a validation perspective, comparative tests are very powerful method of assessment, but it is no substitute for determining if the program is correct since it may be just as equally incorrect as the benchmark program or programs. The biggest strength of comparative testing is the ability to compare any cases that two or more programs can model. This is much more flexible than analytical tests when only specific solutions exist for simple models, and much more flexible than empirical tests when only specific data sets have been collected for usually a very narrow band of operation.
The tests described in ANSI/ASHRAE Standard 140-2017, *Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs* (ANSI Approved) Sections 5.2.1 and 5.2.2, except Case 960, were performed. As stated in its Foreword, Standard 140-2017 is a standard method of test that "*can be used for identifying and diagnosing differences in predictions for whole building energy simulation software that may possibly be caused by software errors. The current set of tests included here consists of comparative tests that focus on building envelope loads.*" [3].
Whole model verification considers the calculation of air temperatures and the sensible energy needs for heating and cooling for a fully year for several cases based on BESTEST 600 and 900 described in ANSI/ASHRAE 140-2017 Standard tests. Table 1 shows the test cases carried out.

Table 1 *Test cases*

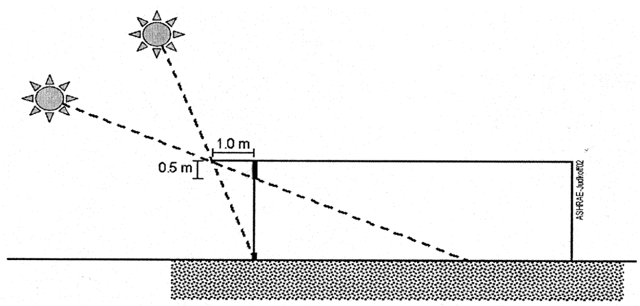
TEST	Geometry	Mass	Windows	Set point	Internal gains (W)	Infiltration (ach)
600	1	Low	2xS	20, 27	200	0,5
600FF	1	Low	2xS	FF	200	0,5
610	2 (1 with 1 m overhang)	Low	2xS +shade	20, 27	200	0,5
620	3	Low	1xE&1xW	20, 27	200	0,5
630	4 (3 with 1 m overhang H & V)	Low	E&W +shade	20, 27	200	0,5
640	1	Low	2xS	20(10), 27	200	0,5
650	1	Low	2xS	27(Venting)	200	0,5
650FF	1	Low	2xS	FF(Venting)	200	0,5
900	1	High	2xS	20, 27	200	0,5
900FF	1	High	2xS	FF	200	0,5
910	2 (1 with 1 m overhang)	High	2xS +shade	20, 27	200	0,5
920	3	High	1xE&1xW	20, 27	200	0,5
930	4 (3 with 1 m overhang H & V)	High	E&W +shade	20, 27	200	0,5
940	1	High	2xS	20(10), 27	200	0,5
950	1	High	2xS	27(Venting)	200	0,5
950FF	1	High	2xS	FF(Venting)	200	0,5

2.2 Geometry and Thermophysical characteristics of the test room

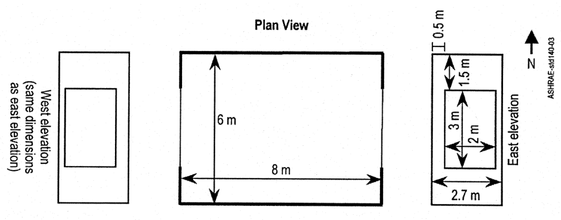
The various test cases refer to a geometry of a single zone with two different types of envelope: lightweight and heavyweight. The geometry of the test room is shown in Figure 1, the geometrical characteristics of the rooms are given in Table 2.



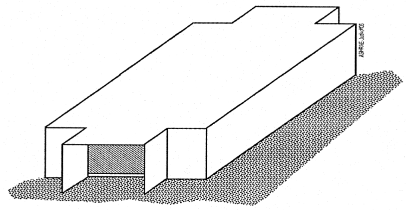
1 - Isometric South Windows unshaded



2 - Section of south windows overhang



3 - East and West windows



4 - Isometric East and West windows with shadings

Figure 1 *Geometry of the test rooms [1]*

Table 2 *Room data*

Component	Area (m^2)
Wall (front)	9.6
Wall (right and left)	16.2
Wall (back)	21.6
Window	12.0
Floor	48.0
Ceiling	48.0
Volume	126.6 m^3

Thermophysical characteristics of the opaque elements of the building envelope are described in Table 3 and

Table 4. As regard the properties of the transparent elements, the window consists of double pane glazing with the following properties:

Transmission coefficient *g*: 0.710
U value glass: 2.823 W/(m²K)
Mobile solar shield: none

Table 3 *Thermophysical characteristics of the building envelope Test case 6XX*

Structure	*D* m	λ W/(mK)	*R* m^2K/W	κ $J/(m^2K)$	ρ kg/m^3	*c* J/(kg K)
External wall (inside to outside)						
Plasterboard	0.012	0.160	0.075	9576	950	840
Fiberglass quilt	0.066	0.040	1.650	665	12	840
Wood siding	0.009	0.140	0.064	4293	530	900
Total surf-surf			1.789			
Floor (inside to outside)						
Timber flooring	0.025	0.140	0.179	19500	650	1200
Insulation	1.003	0.040	25.075	0	0	0
Total surf-surf						
Roof (inside to outside)						
Plasterboard	0.010	0.160	0.063	7980	950	840
Fiberglass quilt	0.1118	0.040	2.794	1127	12	840
Roof deck	0.019	0.140	0.136	9063	530	900
Total surf-surf			2.992			

Table 4 *Thermophysical characteristics of the building envelope Test case 9XX*

Structure	*D* m	λ W/(mK)	*R* m^2K/W	κ $J/(m^2K)$	ρ kg/m^3	*c* J/(kg K)
External wall (inside to outside)						
Concrete block	0.100	0.510	0.196	140000	1400	1000
Foam insulation	0.0615	0.040	1.537	861	10	1400
Wood siding	0.009	0.140	0.064	4293	530	900
Total surf-surf			1.797			
Floor (inside to outside)						
Concrete slab	0.080	1.130	0.071	112000	1400	1000
Insulation	1.007	0.040	25.175	0	0	0
Total surf-surf						
Roof (inside to outside)						
Plasterboard	0.010	0.160	0.063	7980	950	840
Fiberglass quilt	0.1118	0.040	2.794	1127	12	840
Roof deck	0.019	0.140	0.136	9063	530	900
Total surf-surf			2.992			

2.3 Climatic Data

The test building is in DENVER (Colorado). The external climatic data available in input are the values of temperature, humidity and irradiance in the global horizontal component, horizontal diffusion and normal direct.

3 Modeler Report

The specifications as presented in Section 2 - ANSI/ASHRAE Standard 140-2017, were followed to prepare the TERMOLOG models for the test cases described above. In some cases the specification provided redundant input values for a particular element of the building due to the fact different programs require different inputs. The following notes are presented regarding preparation of TERMOLOG BESTEST files.

Hourly Dynamic Method
TERMOLOG implemented the calculation procedure on the overall energy use and energy performance of buildings introduced by EN ISO 52016:2017. This hourly calculation method is based on an equivalent resistive-capacitive model (R-C) according to the Crank-Nicholson scheme: each building element is divided into a number of parallel layers, separated by nodes. For opaque building elements, the number of nodes is 5: the external surface node, three nodes inside the building element and one internal surface node. For windows and door, the number of nodes id 2: external and internal.

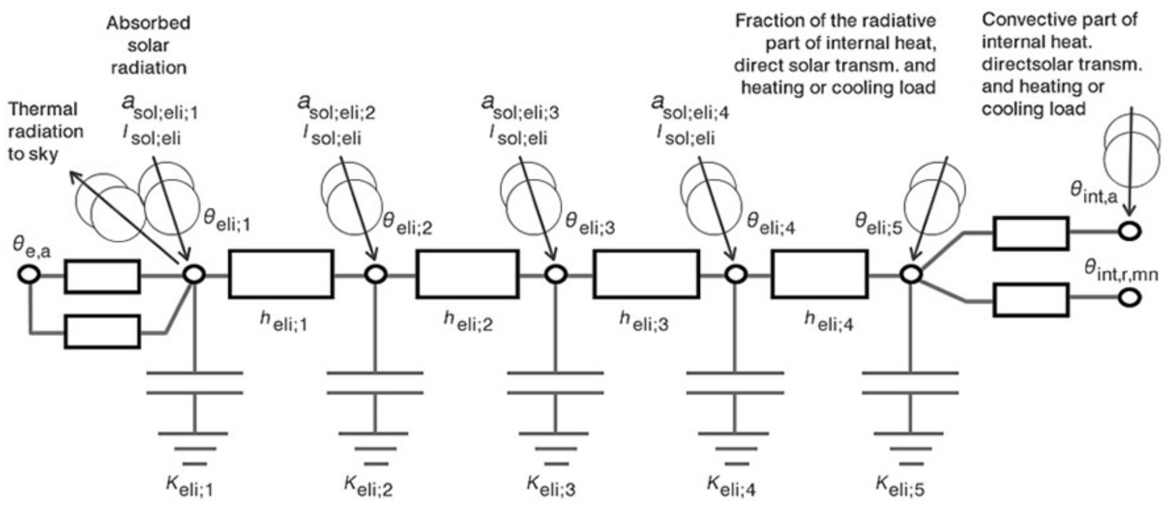


Figure 2 *Illustration of building element "RC" model*

Every calculation formula derives from standard text, with the extra option for set-point temperature (internal air temperature instead of operative temperature as described in the text below).

Modeling assumption and simplification
For the application of this procedure there are few additional simplification inherit from other standards of ISO 52000 series.

- The air temperature is uniform throughout the room or zone.

- The various surfaces of the room or zone elements are isothermal.
- The heat conduction through the room or zone elements is assumed to be one –dimensional.
- The heat storage contribution of thermal bridges is neglected.
- Air spaces within envelope components are treated as air layers bounded by two isothermal and parallel surfaces.
- The spatial distribution of solar radiation within the room is time-indipendent.
- Calculation of view factors between the internal facing surfaces of the construction elements. To avoid that the specific position of the construction is needed as input, these are simplified.
- Calculation of the dynamic heat transfer inside construction elements. To avoid that the specific composition of each layer of the construction is needed as input, these are simplified.
- Calculation of the variable solar transmittance of transparent element. To avoid that the solar angle dependent properties of the transparent elements is needed as input, a constant values is assumed.

Modeling Difficulties

a) Set point temperature

Set point temperature: EN ISO 52016:2017 procedure

In EN ISO 52016:2017, for the calculation of the system specific energy needs or energy load, for heating and cooling, the operative temperature is used for the set-point. The result of this choice is that heating (or cooling) the air at the operative temperature, requires much more power than only heating the air. Heating or cooling up only the air temperature to the set-point does not lead to the thermal comfort that is expected by the occupants. This standard determines heating or cooling temperature set- point and calculates the heating or cooling load with this inequality:

$$if\ \vartheta int, op, ztc, t > \vartheta int, set, C, ztc, t\ take\ \vartheta int, op, set, ztc, t = \vartheta int, set, C, ztc, t$$
$$if\ \vartheta int, op, ztc, < \vartheta int, set, H, ztc, t\ take\ \vartheta int, op, set, ztc, t = \vartheta int, set, H, ztc, t$$

Where

ϑint, op, ztc, t is the operating temperature in free floating conditions [°C]
ϑint, op, set, ztc, t is the required internal operative temperature set − point [°C]
ϑint, set, C, ztc, t is the internal operative temperature set − point for cooling [°C]
ϑint, set, H, ztc, t is the internal operative temperature set − point for heating [°C]

Set point temperature. TERMOLOG extra option

The first development that follow exactly the set-point temperature inherit by EN ISO 52016, calculates a higher peak cooling in comparison to the other simulation software. So we change the approach and now in TERMOLOG, is possible to choose the air temperature instead of the operative temperature for heating or cooling set-point: the calculation procedure is exactly the same introduced by the EN ISO 52016 standard, but the heating and cooling load or energy are calculate with the difference from set-point temperature and air temperature.

With this method TERMOLOG determines heating or cooling temperature set-point with this inequality:

$$if\ \vartheta int, a, ztc, t > \vartheta int, set, C, ztc, t\ take\ \vartheta int, a, set, ztc, t = \vartheta int, set, C, ztc, t$$
$$if\ \vartheta int, a, ztc, < \vartheta int, set, H, ztc, t\ take\ \vartheta int, a, set, ztc, t = \vartheta int, set, H, ztc, t$$

Where

ϑint, a, ztc, t is the operating temperature in free floating conditions [°C]
ϑint, a, set, ztc, t is the required internal temperature set − point [°C]
ϑint, set, C, ztc, t is the internal operative temperature set − point for cooling [°C]
ϑint, set, H, ztc, t is the internal operative temperature set − point for heating [°C]

For the application of this BESTEST the air temperature has been chosen for set-point temperature.

b) Thermophysical properties of opaque elements in contact with ground

To reduce uncertainty regarding testing the other aspects of simulating the building envelope, the floor insulation has been made very thick to effectively decouple the floor thermally from the ground.
For the application of the EN ISO 52016 method, this means that the thermal resistance of the floor can be used in the calculation instead of the effective thermal resistance, with the outdoor air as external environment and not in contact with ground.

Other modeling assumption
Specific heat capacity of air and furniture
For the application of this document, the specific heat capacity is 10000 J/m^{2}K. This value, taken into account for the energy balance on zone level, multiply the useful floor area of the zone and represented the thermal capacity of the internal environment.

Solar absorption coefficient
The solar absorption coefficient of all opaque surfaces is α_{sol} = 0,6.

View factor to the sky
In this method the infrared emittance of exterior opaque surfaces is implicitly assumed as a standard emittance value.

For this application the view factor to the sky are:
F = 1,0 for the roof;
F = 0,5 for the walls.

The difference between the external air temperature and the apparent sky temperature is a fixed value $\Delta\theta_{sky}$=11K for all time intervals t throughout the year.

Convective fractions
The following convective fractions are used:

- Convective fraction of the internal gains $f_{int;c}$ = 0,40;
- Convective fraction of solar radiation $f_{sol;c}$ = 0,10;
- Convective fraction of heating system $f_{H;c}$ = 1,00;
- Convective fraction of cooling system $f_{C;c}$ = 1,00.

The convective fraction of solar radiation fsol,c is done for the energy balance on zone level and for internal surface node [see 6.5.6.2 and 6.5.6.3.3 ISO 52016-1].
The internal node is connected to all internal surface via the surface heat transfer coefficients by convection and to the convective parts of the internal heat gains and the heating cooling load and to the convective part of the solar radiation that is transmitted through transparent building elements.
The thermal radiation part is a simplification, ignoring long wave emissivities, thus long wave reflections. In the sum over all building elements, the actual building element itself is one of the elements.

Climatic data
The hourly values for the external air temperature and the total direct and total diffuse solar radiation for horizontal position, is given in this spreadsheet: http://standards.iso.org/iso/52016/-1/ed-1The available

measured hourly solar radiation data (global radiation, horizontal diffuse radiation and beam normal radiation) have been converted in TERMOLOG in accordance with ISO 52010-1.

4 Comparison between TERMOLOG Software and other simulation software

The results of all the test performed are reported in the attached report generated by the Spreadsheet supplied by ASHRAE.

5 Conclusions

The tests conducted with the TERMOLOG software based on the ANSI/ASHRAE Standard 140-2017 methodology, referred to the energy calculation on the building envelope, demonstrate the goodness of the calculation model (EN ISO Standard 52016:2017) and the goodness of the implementation on TERMOLOG software.

Prof. Giuliano Dall'O'
(Research responsible)

References

1. ANSI/ASHRAE Standard 140-2017, Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs. ASHRAE Inc., 1791 Tullie Circle NE Atlanta, GA 30329.

2. Judkoff, R., and J. Neymark. 1995. International Energy Agency Building Energy Simulation Test (BESTEST) and Diagnostic Method. NREL/TP-472-6231. Golden, CO: National Renewable Energy Laboratory.

3. Robert H. Henninger and Michel J. Witte, 2004, Energy Plus testing with ANSI/ASHRAE Standard 140-2001 (BESTEST), Ernest Orlando Berkeley National Laboratory Berkley, California, USA for U.S. Department of Energy

4. ISO Standard 52016-1:2017 Energy performance of buildings -- Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads -- Part 1: Calculation procedures

ASHRAE Standard 140-2017

Test Results Comparison
for
Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF

Results for TERMOLOG EpiX 8 build 2017.17
(TERMOLOG)
vs.
Informative Annex B8, Section B8.1 Example Results

Prepared By
Politecnico di Milano - ABC dept.
(PoliMI)

Results Developed
01-Mar-2018

ASHRAE Standard 140-2017
Computer Programs, Program Authors, and Producers of Example Results for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF

The programs used to generate the example results are described in Table B11-1. Under the computer program column, the first entry in each cell is the proper program name and version number. The entries in parentheses are the abbreviations for the programs generally used in the tables and charts which follow.

The second column ("Authoring Organization") indicates the national research facility, university, or industry organization with expertise in building science that wrote the simulation software.

The third column ("Implemented By") indicates the national research facility, university, or industry organization with expertise in building science that performed the simulations. The majority of organizations that performed simulations either ran software written by their organization or otherwise ran other building energy simulation software in addition to that written by their organization.

See Standard 140, Annex B11 for further details.

Comparison
Computer Programs, Program Authors, and Producers of Example Results

Computer Program (Abbrev.)	Authoring Organization	Example Results Produced by
BLAST-3.0 level 193 v.1 (BLAST-US/IT)	CERL,[a] United States (U.S.)	NREL,[b] U.S. Politecnico Torino, Italy
DOE-2.1D 14 (DOE21D)	LANL/LBNL,[c] U.S.	NREL, U.S.
ESP-RV8 (ESP-DMU)	Strathclyde University, United Kingdom (U.K.)	De Montfort University, U.K.
SERIRES/SUNCODE 5.7 (SRES/SUN)	NREL/Ecotope, U.S.	NREL, U.S.
SERIRES 1.2 (SRES-BRE)	NREL/BRE,[d] U.S./U.K.	BRE, U.K.
S3PAS	University of Sevilla, Spain	University of Sevilla, Spain
TASE	Tampere University, Finland	Tampere University, Finland
TRNSYS 13.1 (TSYS-BEL/BRE)	University of Wisconsin, U.S.	BRE, U.K. Vrije Universiteit (VUB) Brussels, Belgium

[a]CERL-U.S. Army Construction Engineering Research Laboratories

[b]NREL-National Renewable Energy Laboratory

[c]LANL/LBNL-Los Alamos National Laboratory/Lawrence Berkeley National Laboratory

[d]BRE-Building Research Establishment

ASHRAE Standard 140-2010 Section 5.2 - Building Thermal Envelope and Fabric Load Tests
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results
By Politecnico di Milano - ABC dept. (PoliMI), 01-Mar-2018

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ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results
By Politecnico di Milano - ABC dept. (PoliMI), 01-Mar-2018

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B8-1. Annual Heating Loads (MWh)

Simulation Model:	ESP	BLAST	DOE21D	SRES-SUN	SRES*	S3PAS	TSYS	TASE	Statistics for Example Results				TERMOLOG
Organization or Country:	DMU	US-IT	NREL	NREL	BRE	SPAIN	BEL-BRE	FINLAND	Min	Max	Mean	(Max-Min)/	PoliMI
Case												Mean** (%)	
600 Base Case, South Windows	4.296	4.773	5.709	5.226	5.596	4.882	4.872	5.362	4.296	5.709	5.090	27.8%	4.600
610 S. Windows + Overhang	4.355	4.806	5.786	5.280	5.620	4.971	4.970	5.383	4.355	5.786	5.146	27.8%	4.645
620 East & West Windows	4.613	5.049	5.944	5.554	5.734	5.564	5.073	5.728	4.613	5.944	5.407	24.6%	4.914
630 E&W Windows + Overhang & Fins	5.050	5.359	6.469	5.883	6.001	6.095	5.624		5.050	6.469	5.783	24.5%	5.299
640 Case 600 with Htg Temp. Setback	2.751	2.888	3.543	3.255	3.803	3.065	3.043	3.309	2.751	3.803	3.207	32.8%	2.854
650 Case 600 with Night Ventilation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	----	0.000
900 South Windows	1.170	1.610	1.872	1.897	1.988	1.730	1.655	2.041	1.170	2.041	1.745	49.9%	1.538
910 S. Windows + Overhang	1.575	1.862	2.254	2.174	2.282	2.063	2.097	2.220	1.575	2.282	2.066	34.2%	1.775
920 East & West Windows	3.313	3.752	4.255	4.093	4.058	4.235	3.776	4.300	3.313	4.300	3.973	24.8%	3.628
930 E&W Windows + Overhang & Fins	4.143	4.347	5.335	4.755	4.728	5.168	4.740		4.143	5.335	4.745	25.1%	4.381
940 Case 900 with Htg. Temp. Setback	0.793	1.021	1.239	1.231	1.411	1.179	1.080	1.323	0.793	1.411	1.160	53.3%	1.059
950 Case 900 with Night Ventilation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	----	0.000
960 Sunspace	2.311	2.664	2.928	2.884	2.851	2.943	3.373	2.816	2.311	3.373	2.846	37.3%	
195 Solid Conduction	4.167								4.167	4.167	4.167	0.0%	
200 Surface Convection (Int & Ext IR="off")	5.252								5.252	5.252	5.252	0.0%	
210 Infrared Radiation (Int IR="off", Ext IR="on")	6.456	6.559					6.554	6.967	6.456	6.967	6.634	7.7%	
215 Infrared Radiation (Int IR="on", Ext IR="off")	5.547								5.547	5.547	5.547	0.0%	
220 In-Depth Base Case	6.944	7.215	8.787	8.102	8.127	7.422	7.297	7.437	6.944	8.787	7.666	24.0%	
230 Infiltration	10.376	10.740	12.243	11.633	11.649	11.037	10.840	10.964	10.376	12.243	11.185	16.7%	
240 Internal Gains	5.649	6.009	7.448	6.769	6.786	6.194	6.076	6.234	5.649	7.448	6.396	28.1%	
250 Exterior Shortwave Absorptance	4.751	5.739	7.024	6.608	6.653	5.974	5.764	5.738	4.751	7.024	6.031	37.7%	
270 South Solar Windows	4.510	4.930		5.341	*5.920*		5.047	5.489	4.510	*5.920*	*5.206*	*27.1%*	
280 Cavity Albedo	4.675	5.125		5.937	6.148		5.279	5.841	4.675	6.148	5.501	26.8%	
290 South Shading	4.577	4.959		5.406	*5.942*		5.132	5.509	4.577	*5.942*	*5.254*	*26.0%*	
300 East/West Window	4.761	5.077		5.587	*5.964*		5.124	5.786	4.761	*5.964*	*5.383*	*22.3%*	
310 East/West Shading	5.221	5.327		5.850	*6.165*		5.610		5.221	*6.165*	*5.635*	*16.8%*	
320 Thermostat	3.859	4.209		4.627	*5.141*		4.348	4.840	3.859	*5.141*	*4.504*	*28.5%*	
395 Low Mass Solid Conduction	4.984	4.799	5.835	5.199	5.201	4.967	4.855	4.839	4.799	5.835	5.085	20.4%	
400 Low Mass Opaque Windows	6.900	7.075	8.770	7.966	7.973	7.287	7.166	7.326	6.900	8.770	7.558	24.7%	
410 Low Mass Infiltration	8.596	8.873	10.506	9.726	9.734	9.019	8.936	9.085	8.596	10.506	9.309	20.5%	
420 Low Mass Internal Gains	7.298	7.610	9.151	8.365	8.373	7.774	7.697	7.863	7.298	9.151	8.016	23.1%	
430 Low Mass Ext. Shortwave Absorptance	5.429	6.488	7.827	7.178	7.186	6.662	6.500	6.510	5.429	7.827	6.723	35.7%	
440 Low Mass Cavity Albedo	4.449	4.987		5.652	5.811		5.098	5.642	4.449	5.811	5.273	25.8%	
800 High Mass Opaque Windows	4.868	5.953	7.228	6.611	6.600	6.161	5.940	5.861	4.868	7.228	6.153	38.4%	
810 High Mass Cavity Albedo	1.839	2.446		3.004	2.828		2.567	2.962	1.839	3.004	2.608	44.7%	

* SRES-BRE simulations for cases with interior solar absorptance = 0.9 have an input error that likely affects annual heating and cooling loads by <0.2 MWh/y (2-3%); see Annex B7, Section B7.1.1.

ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results
By Politecnico di Milano - ABC dept. (PoliMI), 01-Mar-2018

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

** ABS[(Max-Min) / (Mean of Example Simulation Results)]

ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results
By Politecnico di Milano - ABC dept. (PoliMI), 01-Mar-2018

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B8-2. Annual Sensible Cooling Loads (MWh)

Simulation Model:	ESP	BLAST	DOE21D	SRES-SUN	SRES*	S3PAS	TSYS	TASE	Statistics for Example Results				TERMOLOG
Organization or Country:	DMU	US-IT	NREL	NREL	BRE	SPAIN	BEL-BRE	FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	PoliMI
Case													
600 Base Case, South Windows	6.137	6.433	7.079	7.278	7.964	6.492	6.492	6.778	6.137	7.964	6.832	26.7%	6.670
610 S. Windows + Overhang	3.915	4.851	4.852	5.448	5.778	4.764	4.601	5.506	3.915	5.778	4.964	37.5%	4.705
620 East & West Windows	3.417	4.092	4.334	4.633	5.004	4.011	3.901	4.351	3.417	5.004	4.218	37.6%	4.087
630 E&W Windows + Overhang & Fins	2.129	3.108	2.489	3.493	3.701	2.489	2.416		2.129	3.701	2.832	55.5%	2.851
640 Case 600 with Htg Temp. Setback	5.952	6.183	6.759	7.026	7.811	6.247	6.246	6.508	5.952	7.811	6.592	28.2%	6.397
650 Case 600 with Night Ventilation	4.816	5.140	5.795	5.894	6.545	5.088	5.119	5.456	4.816	6.545	5.482	31.5%	5.237
900 South Windows	2.132	2.600	2.455	3.165	3.415	2.572	2.485	2.599	2.132	3.415	2.678	47.9%	2.857
910 S. Windows + Overhang	0.821	1.533	0.976	1.872	1.854	1.428	1.326	1.767	0.821	1.872	1.447	72.6%	1.421
920 East & West Windows	1.840	2.616	2.440	2.943	3.092	2.457	2.418	2.613	1.840	3.092	2.552	49.1%	2.630
930 E&W Windows + Overhang & Fins	1.039	1.934	1.266	2.173	2.238	1.439	1.416		1.039	2.238	1.644	73.0%	1.796
940 Case 900 with Htg. Temp. Setback	2.079	2.536	2.340	3.036	3.241	2.489	2.383	2.516	2.079	3.241	2.578	45.1%	2.800
950 Case 900 with Night Ventilation	0.387	0.526	0.538	0.921	0.589	0.551	0.561	0.771	0.387	0.921	0.605	88.2%	0.679
960 Sunspace	0.488	0.666	0.428	0.803	0.718	0.643	0.411	0.786	0.411	0.803	0.618	63.4%	
195 Solid Conduction	0.414								0.414	0.414	0.414	0.0%	
200 Surface Convection (Int & Ext IR="off")	0.570								0.570	0.570	0.570	0.0%	
210 Infrared Radiation (Int IR="off", Ext IR="on")	0.162	0.613					0.668	0.641	0.162	0.668	0.521	97.1%	
215 Infrared Radiation (Int IR="on", Ext IR="off")	0.639								0.639	0.639	0.639	0.0%	
220 In-Depth Base Case	0.186	0.701	0.399	0.827	0.835	0.734	0.737	0.683	0.186	0.835	0.638	101.8%	
230 Infiltration	0.454	0.976	0.692	1.131	1.139	1.020	1.040	0.985	0.454	1.139	0.930	73.7%	
240 Internal Gains	0.415	1.072	0.660	1.239	1.246	1.108	1.114	1.045	0.415	1.246	0.987	84.2%	
250 Exterior Shortwave Absorptance	3.213	2.545	2.177	2.924	2.931	2.486	2.684	3.380	2.177	3.380	2.793	43.1%	
270 South Solar Windows	7.528	8.670		9.828	*10.350*		8.764	8.714	7.528	*10.350*	*8.976*	*31.4%*	
280 Cavity Albedo	4.873	5.895		6.511	7.114		5.761	6.257	4.873	7.114	6.069	36.9%	
290 South Shading	5.204	7.011		7.871	*8.089*		6.699	7.431	5.204	*8.089*	*7.051*	*40.9%*	
300 East/West Window	4.302	5.836		6.665	*7.100*		5.721	5.781	4.302	*7.100*	*5.901*	*47.4%*	
310 East/West Shading	2.732	4.570		5.245	*5.471*		3.727		2.732	*5.471*	*4.349*	*63.0%*	
320 Thermostat	5.061	5.906		6.725	*7.304*		5.956	5.663	5.061	*7.304*	*6.103*	*36.8%*	
395 Low Mass Solid Conduction	0.000	0.011	0.000	0.016	0.014	0.010	0.010	0.011	0.000	0.016	0.009	177.1%	
400 Low Mass Opaque Windows	0.000	0.040	0.002	0.061	0.058	0.042	0.045	0.044	0.000	0.061	0.036	167.3%	
410 Low Mass Infiltration	0.000	0.059	0.010	0.084	0.084	0.063	0.067	0.065	0.000	0.084	0.054	155.5%	
420 Low Mass Internal Gains	0.011	0.147	0.051	0.189	0.188	0.154	0.158	0.143	0.011	0.189	0.130	136.9%	
430 Low Mass Ext. Shortwave Absorptance	0.542	0.617	0.422	0.704	0.684	0.563	0.617	0.875	0.422	0.875	0.628	72.1%	
440 Low Mass Cavity Albedo	3.967	4.172		4.674	5.204		3.975	4.684	3.967	5.204	4.446	27.8%	
800 High Mass Opaque Windows	0.113	0.224	0.055	0.272	0.222	0.195	0.207	0.325	0.055	0.325	0.202	133.9%	
810 High Mass Cavity Albedo	1.052	1.405		1.711	1.708		1.191	1.624	1.052	1.711	1.449	45.5%	

* SRES-BRE (SERIRES 1.2) simulations for cases with interior solar absorptance = 0.9 have an input error that likely affects annual heating and cooling loads by <0.2 MWh/y (2-3%); see Annex B7,

ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results
By Politecnico di Milano - ABC dept. (PoliMI), 01-Mar-2018

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Section B7.1.1. Affected results for Cases 270 and 290 through 320 are indicated by italics

** ABS[(Max-Min) / (Mean of Example Simulation Results)]

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B8-3. Annual Hourly Integrated Peak Heating Loads

Simulation Model:	ESP			BLAST			DOE21D			SRES-SUN			SRES	S3PAS			TSYS			TASE			Example Result Statistics				TERMOLOG		
Organization or Country:	DMU			US-IT			NREL			NREL			BRE*	SPAIN			BEL-BRE			FINLAND			Min	Max	Mean	(Max-Min)/	PoliMI		
Case	kW	Date	Hr	kW	Date	Hr	kW	Date	Hr	kW	Date	Hr		kW	Date	Hr	kW	Date	Hr	kW	Date	Hr	kW	kW	kW	Mean** (%)	kW	Date	Hr
600 Base Case, South Windows	3.437	4-Jan	5	3.940	4-Jan	5	4.045	4-Jan	5	4.258	4-Jan	2		4.037	4-Jan	2	3.931	4-Jan	6	4.354	4-Jan	2	3.437	4.354	4.000	22.9%	3.876	4-Jan	6
610 S. Windows + Overhang	3.437	4-Jan	5	3.941	4-Jan	5	4.034	4-Jan	5	4.258	4-Jan	2		4.037	4-Jan	2	3.922	4-Jan	6	4.354	4-Jan	2	3.437	4.354	3.998	22.9%	3.876	4-Jan	6
620 East & West Windows	3.591	4-Jan	6	3.941	4-Jan	5	4.046	4-Jan	5	4.277	4-Jan	2		4.277	4-Jan	2	3.922	4-Jan	6	4.379	4-Jan	2	3.591	4.379	4.062	19.4%	3.877	4-Jan	6
630 E&W Windows + Overhang & Fins	3.592	4-Jan	7	3.941	4-Jan	5	4.025	4-Jan	5	4.280	4-Jan	2		4.278	4-Jan	2	3.922	4-Jan	6				3.592	4.280	4.006	17.2%	3.877	4-Jan	6
640 Case 600 with Htg. Temp. Setback	5.232	4-Jan	7	5.486	4-Jan	8	5.943	4-Jan	8	6.530	4-Jan	8		6.347	4-Jan	8	5.722	4-Jan	8	6.954	4-Jan	8	5.232	6.954	6.031	28.6%	6.354	4-Jan	7
650 Case 600 with Night Ventilation	0.000			0.000	4-Jan		0.000			0.000				0.000			0.000			0.000			0.000	0.000	0.000	----	0.000		
900 South Windows	2.850	4-Jan	7	3.453	4-Jan	7	3.557	4-Jan	7	3.760	4-Jan	7		3.608	4-Jan	8	3.517	4-Jan	7	3.797	4-Jan	7	2.850	3.797	3.506	27.0%	3.401	4-Jan	6
910 S. Windows + Overhang	2.858	4-Jan	7	3.456	4-Jan	7	3.564	4-Jan	7	3.764	4-Jan	7		3.618	4-Jan	8	3.536	4-Jan	7	3.801	4-Jan	7	2.858	3.801	3.514	26.8%	3.403	4-Jan	6
920 East & West Windows	3.308	4-Jan	7	3.703	4-Jan	7	3.805	4-Jan	7	4.013	4-Jan	7		4.029	4-Jan	7	3.708	4-Jan	7	4.061	4-Jan	7	3.308	4.061	3.804	19.8%	3.638	4-Jan	6
930 E&W Windows + Overhang & Fins	3.355	4-Jan	7	3.732	4-Jan	7	3.832	4-Jan	7	4.042	4-Jan	7		4.064	4-Jan	7	3.744	4-Jan	7				3.355	4.064	3.795	18.7%	3.677	4-Jan	6
940 Case 900 with Htg. Temp. Setback	3.980	4-Jan	7	5.028	4-Jan	8	5.665	4-Jan	8	6.116	4-Jan	8		6.117	4-Jan	8	5.122	3-Jan	9	6.428	4-Jan	8	3.980	6.428	5.494	44.6%	6.246	4-Jan	7
950 Case 900 with Night Ventilation	0.000			0.000			0.000			0.000				0.000			0.000			0.000			0.000	0.000	0.000	----	0.000		
960 Sunspace	2.410	4-Jan	7	2.751	4-Jan	8	2.727	4-Jan	8	2.863	4-Jan	8		2.852	4-Jan	8	2.522	4-Jan	8	2.779	4-Jan	8	2.410	2.863	2.701	16.8%			
195 Solid Conduction	2.004	4-Jan	2																				2.004	2.004	2.004	0.0%			
200 Surface Convection (Int & Ext IR="off")	2.651	4-Jan	5																				2.651	2.651	2.651	0.0%			
210 Infrared Radiation (Int IR="off", Ext IR="on")	2.701	4-Jan	5	2.973	4-Jan	5											2.981	4-Jan	5	3.325	4-Jan	2	2.701	3.325	2.995	20.8%			
215 Infrared Radiation (Int IR="on", Ext IR="off")	2.787	4-Jan	5																				2.787	2.787	2.787	0.0%			
220 In-Depth Base Case	2.867	4-Jan	5	3.280	4-Jan	5	3.465	4-Jan	5	3.695	4-Jan	2		3.348	4-Jan	8	3.336	4-Jan	6	3.520	4-Jan	2	2.867	3.695	3.359	24.7%			
230 Infiltration	4.386	4-Jan	5	4.984	4-Jan	2	4.994	4-Jan	2	5.279	4-Jan	2		5.159	4-Jan	2	4.892	4-Jan	6	5.107	4-Jan	2	4.386	5.279	4.972	18.0%			
240 Internal Gains	2.685	4-Jan	5	3.100	4-Jan	5	3.282	4-Jan	5	3.495	4-Jan	2		3.159	4-Jan	8	3.153	4-Jan	6	3.333	4-Jan	8	2.685	3.495	3.172	25.5%			
250 Exterior Shortwave Absorptance	2.866	4-Jan	5	3.279	4-Jan	5	3.465	4-Jan	5	3.695	4-Jan	2		3.341	4-Jan	6	3.336	4-Jan	6	3.525	4-Jan	2	2.866	3.695	3.358	24.7%			
270 South Windows	2.863	4-Jan	5	3.277	4-Jan	5				3.661	4-Jan	2					3.336	4-Jan	6	3.738	4-Jan	2	2.863	3.738	3.375	25.9%			
280 Cavity Albedo	2.864	4-Jan	5	3.278	4-Jan	5				3.685	4-Jan	2					3.336	4-Jan	6	3.759	4-Jan	2	2.864	3.759	3.384	26.4%			
290 South Shading	2.863	4-Jan	5	3.277	4-Jan	5				3.661	4-Jan	2					3.328	4-Jan	6	3.738	4-Jan	2	2.863	3.738	3.373	25.9%			
300 East/West Window	3.014	4-Jan	6	3.276	4-Jan	5				3.681	4-Jan	2					3.328	4-Jan	6	3.770	4-Jan	2	3.014	3.770	3.414	22.1%			
310 East/West Shading	3.015	4-Jan	6	3.277	4-Jan	5				3.669	4-Jan	2					3.328	4-Jan	6				3.015	3.669	3.322	19.7%			
320 Thermostat	2.861	4-Jan	5	3.275	4-Jan	5				3.651	4-Jan	2					3.336	4-Jan	6	3.735	4-Jan	3	2.861	3.735	3.372	25.9%			
395 Low Mass Solid Conduction	2.062	4-Jan	7	2.209	4-Jan	8	2.328	4-Jan	3	2.385	4-Jan	3		2.263	4-Jan	4	2.221	4-Jan	8	2.270	4-Jan	3	2.062	2.385	2.248	14.4%			
400 Low Mass Opaque Windows	2.867	4-Jan	5	3.280	4-Jan	5	3.476	4-Jan	5	3.695	4-Jan	2		3.342	4-Jan	8	3.336	4-Jan	6	3.520	4-Jan	2	2.867	3.695	3.359	24.6%			
410 Low Mass Infiltration	3.625	4-Jan	5	4.124	4-Jan	5	4.233	4-Jan	5	4.487	4-Jan	2		4.227	4-Jan	2	4.114	4-Jan	6	4.314	4-Jan	2	3.625	4.487	4.161	20.7%			
420 Low Mass Internal Gains	3.443	4-Jan	5	3.944	4-Jan	5	4.050	4-Jan	5	4.287	4-Jan	2		4.044	4-Jan	2	3.931	4-Jan	6	4.126	4-Jan	2	3.443	4.287	3.975	21.2%			
430 Low Mass Ext. Shortwave Absorptance	3.442	4-Jan	5	3.944	4-Jan	5	4.050	4-Jan	5	4.287	4-Jan	2		4.044	4-Jan	2	3.931	4-Jan	6	4.137	4-Jan	2	3.442	4.287	3.976	21.3%			
440 Low Mass Cavity Albedo	3.439	4-Jan	5	3.942	4-Jan	5				4.277	4-Jan	2					3.931	4-Jan	6	4.376	4-Jan	2	3.439	4.376	3.993	23.5%			
800 High Mass Opaque Windows	3.227	4-Jan	5	3.793	4-Jan	7	3.909	4-Jan	7	4.138	4-Jan	2		3.902	4-Jan	8	3.786	4-Jan	7	3.939	4-Jan	7	3.227	4.138	3.813	23.9%			
810 High Mass Cavity Albedo	2.979	4-Jan	7	3.566	4-Jan	7				3.915	4-Jan	7					3.606	4-Jan	7	3.963	4-Jan	7	2.979	3.963	3.606	27.3%			

* SRES-BRE (SERIRES 1.2) simulations did not produce output for this variable.

** ABS[(Max-Min) / (Mean of Example Simulation Results)]

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By Politecnico di Milano - ABC dept. (PoliMI), 01-Mar-2018

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B8-4. Annual Hourly Integrated Peak Sensible Cooling Loads

Simulation Model:	ESP			BLAST			DOE21D			SRES-SUN			SRES	S3PAS			TSYS			TASE			Example Result Statistics				TERMOLOG		
Organization or Country:	DMU			US-IT			NREL			NREL			BRE*	SPAIN			BEL-BRE			FINLAND			Min	Max	Mean	(Max-Min)/	PoliMI		
Case	kW	Date	Hr	kW	Date	Hr	kW	Date	Hr	kW	Date	Hr		kW	Date	Hr	kW	Date	Hr	kW	Date	Hr	kW	kW	kW	Mean** (%)	kW	Date	Hr
600 Base Case, South Windows	6.194	17-Oct	13	5.965	16-Oct	14	6.656	16-Oct	13	6.827	16-Oct	14		6.286	25-Nov	14	6.486	16-Oct	14	6.812	17-Oct	14	5.965	6.827	6.461	13.3%	5.577	17-Oct	12
610 S. Windows + Overhang	5.669	25-Nov	13	5.824	25-Nov	14	6.064	13-Jan	14	6.371	25-Nov	14		6.170	25-Nov	14	5.675	25-Nov	14	6.146	17-Oct	14	5.669	6.371	5.988	11.7%	5.189	25-Nov	13
620 East & West Windows	3.634	26-Jul	16	4.075	26-Jul	17	4.430	26-Jul	17	4.593	26-Jul	17		4.297	26-Jul	17	4.275	26-Jul	17	5.096	26-Jul	16	3.634	5.096	4.343	33.7%	3.791	26-Jul	15
630 E&W Windows + Overhang & Fins	3.072	26-Jul	16	3.704	26-Jul	17	3.588	26-Jul	17	4.116	26-Jul	17		3.665	26-Jul	17	3.608	26-Jul	17				3.072	4.116	3.626	28.8%	3.398	26-Jul	16
640 Case 600 with Htg. Temp. Setback	6.161	17-Oct	13	5.892	16-Oct	14	6.576	16-Oct	14	6.776	16-Oct	14		6.250	25-Nov	14	6.442	16-Oct	14	6.771	17-Oct	14	5.892	6.776	6.410	13.8%	5.499	16-Oct	13
650 Case 600 with Night Ventilation	6.031	17-Oct	13	5.831	16-Oct	14	6.516	16-Oct	14	6.671	16-Oct	14		6.143	25-Nov	14	6.378	17-Oct	14	6.679	17-Oct	14	5.831	6.679	6.321	13.4%	5.404	16-Oct	13
900 South Windows	2.888	17-Oct	14	3.155	6-Oct	15	3.458	17-Oct	14	3.871	17-Oct	14		3.334	17-Oct	15	3.567	17-Oct	15	3.457	17-Oct	15	2.888	3.871	3.390	29.0%	2.983	2-Sep	13
910 S. Windows + Overhang	1.896	17-Oct	15	2.500	21-Oct	15	2.336	17-Oct	15	3.277	17-Oct	15		2.786	17-Oct	15	2.792	17-Oct	15	3.147	17-Oct	15	1.896	3.277	2.676	51.6%	2.559	17-Oct	14
920 East & West Windows	2.385	26-Jul	16	2.933	26-Jul	17	3.109	26-Jul	17	3.487	26-Jul	17		3.071	26-Jul	17	3.050	26-Jul	17	3.505	26-Jul	17	2.385	3.505	3.077	36.4%	2.821	26-Jul	16
930 E&W Windows + Overhang & Fins	1.873	26-Jul	17	2.546	26-Jul	17	2.388	26-Jul	18	3.080	26-Jul	17		2.486	26-Jul	17	2.498	26-Jul	17				1.873	3.080	2.479	48.7%	2.413	26-Jul	16
940 Case 900 with Htg. Temp. Setback	2.888	17-Oct	14	3.155	6-Oct	15	3.458	17-Oct	14	3.871	17-Oct	14		3.334	17-Oct	15	3.567	17-Oct	15	3.457	17-Oct	15	2.888	3.871	3.390	29.0%	2.983	2-Sep	13
950 Case 900 with Night Ventilation	2.033	2-Sep	14	2.621	2-Sep	15	2.664	2-Sep	15	3.170	2-Sep	14		2.677	2-Sep	15	2.686	2-Sep	15	2.867	2-Sep	14	2.033	3.170	2.674	42.5%	2.623	2-Sep	14
960 Sunspace	0.953	16-Aug	16	1.144	26-Jul	16	1.057	26-Jul	16	1.370	26-Jul	16		1.179	26-Jul	16	1.378	26-Jul	16	1.403	26-Jul	16	0.953	1.403	1.212	37.1%			
195 Solid Conduction	0.651	26-Jul	15																				0.651	0.651	0.651	0.0%			
200 Surface Convection (Int & Ext IR="off")	0.863	16-Aug	14																				0.863	0.863	0.863	0.0%			
210 Infrared Radiation (Int IR="off", Ext IR="on")	0.476	16-Aug	16	1.017	26-Jul	15											1.068	26-Jul	16	1.142	26-Jul	15	0.476	1.142	0.926	71.9%			
215 Infrared Radiation (Int IR="on", Ext IR="off")	1.007	11-Aug	14																				1.007	1.007	1.007	0.0%			
220 In-Depth Base Case	0.560	27-Jul	15	1.166	26-Jul	15	0.937	27-Jul	14	1.340	26-Jul	15		1.215	26-Jul	16	1.179	26-Jul	16	1.213	26-Jul	15	0.560	1.340	1.087	71.7%			
230 Infiltration	1.059	27-Jul	15	1.646	26-Jul	15	1.455	27-Jul	14	1.875	26-Jul	15		1.700	26-Jul	15	1.708	26-Jul	16	1.749	26-Jul	15	1.059	1.875	1.599	51.0%			
240 Internal Gains	0.739	27-Jul	15	1.347	26-Jul	15	1.119	27-Jul	14	1.540	26-Jul	15		1.398	26-Jul	16	1.361	26-Jul	16	1.397	26-Jul	15	0.739	1.540	1.272	63.0%			
250 Exterior Shortwave Absorptance	3.360	5-Sep	12	3.036	5-Sep	12	2.605	5-Sep	11	2.590	26-Aug	14		2.258	26-Aug	14	3.228	5-Sep	13	4.912	5-Sep	12	2.258	4.912	3.141	84.5%			
270 South Windows	6.356	25-Nov	13	6.641	25-Nov	14				7.234	16-Oct	14					6.764	17-Oct	14	6.867	16-Oct	14	6.356	7.234	6.772	13.0%			
280 Cavity Albedo	4.444	17-Oct	13	4.631	25-Nov	13				5.220	16-Oct	14					4.786	16-Oct	14	5.236	16-Oct	14	4.444	5.236	4.863	16.3%			
290 South Shading	6.269	13-Jan	13	6.555	25-Nov	14				6.976	25-Nov	14					6.203	25-Nov	14	6.621	25-Nov	14	6.203	6.976	6.525	11.9%			
300 East/West Window	3.404	26-Jul	16	4.093	26-Jul	17				4.657	26-Jul	17					4.278	26-Jul	17	4.929	26-Jul	17	3.404	4.929	4.272	35.7%			
310 East/West Shading	2.848	26-Jul	16	3.749	30-Jun	17				4.164	26-Jul	17					3.589	26-Jul	17				2.848	4.164	3.587	36.7%			
320 Thermostat	5.701	25-Nov	13	5.946	25-Nov	14				6.553	16-Oct	14					6.178	17-Oct	14	6.141	16-Oct	14	5.701	6.553	6.104	14.0%			
395 Low Mass Solid Conduction	0.000			0.362	26-Jul	18	0.000			0.394	26-Jul	17		0.356	26-Jul	18	0.363	26-Jul	18	0.345	26-Jul	18	0.000	0.394	0.260	151.6%			
400 Low Mass Opaque Windows	0.000			0.581	26-Jul	17	0.265	27-Jul	17	0.666	26-Jul	16		0.612	26-Jul	17	0.613	26-Jul	17	0.572	26-Jul	17	0.000	0.666	0.473	140.9%			
410 Low Mass Infiltration	0.035	27-Jul	16	0.699	26-Jul	17	0.413	27-Jul	17	0.814	26-Jul	15		0.724	26-Jul	16	0.743	26-Jul	17	0.710	26-Jul	17	0.035	0.814	0.591	131.8%			
420 Low Mass Internal Gains	0.258	27-Jul	15	0.923	26-Jul	15	0.631	27-Jul	15	1.047	26-Jul	15		0.938	26-Jul	15	0.938	26-Jul	16	0.921	26-Jul	15	0.258	1.047	0.808	97.7%			
430 Low Mass Ext. Shortwave Absorptance	1.493	16-Aug	14	1.772	26-Aug	14	1.427	16-Aug	14	1.762	26-Jul	15		1.575	26-Jul	15	1.798	5-Sep	13	2.578	5-Sep	12	1.427	2.578	1.772	64.9%			
440 Low Mass Cavity Albedo	4.546	17-Oct	13	4.424	16-Oct	14				5.053	16-Oct	14					4.686	16-Oct	14	5.278	17-Oct	14	4.424	5.278	4.797	17.8%			
800 High Mass Opaque Windows	0.585	27-Jul	14	0.967	16-Aug	14	0.743	28-Jul	14	1.352	27-Jul	14		1.028	27-Jul	15	0.983	16-Aug	14	1.358	5-Sep	12	0.585	1.358	1.002	77.1%			
810 High Mass Cavity Albedo	1.852	2-Sep	14	2.357	26-Aug	14				2.991	2-Sep	14					2.344	2-Sep	14	2.862	2-Sep	14	1.852	2.991	2.481	45.9%			

* SRES-BRE (SERIRES 1.2) simulations did not produce output for this variable.

** ABS[(Max-Min) / (Mean of Example Simulation Results)]

ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results
By Politecnico di Milano - ABC dept. (PoliMI), 01-Mar-2018

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B8-5. Free-Float Temperature Output

MAXIMUM ANNUAL HOURLY INTEGRATED ZONE TEMPERATURE

Simulation Model:	ESP			BLAST			DOE21D			SRES-SUN			SRES	S3PAS			TSYS			TASE			Example Result Statistics				TERMOLOG		
Organization or Country:	DMU			US-IT			NREL			NREL			BRE*	SPAIN			BEL-BRE			FINLAND			Min	Max	Mean	(Max-Min)/	PoliMI		
Case	T (°C)	Date	Hr	T (°C)	Date	Hr	T (°C)	Date	Hr	T (°C)	Date	Hr		T (°C)	Date	Hr	T (°C)	Date	Hr	T (°C)	Date	Hr	T (°C)	T (°C)	T (°C)	Mean** (%)	T (°C)	Date	Hr
600FF - Low Mass with S. Windows	64.9	17-Oct	15	65.1	16-Oct	15	69.5	17-Oct	15	68.6	16-Oct	15		64.9	16-Oct	16	65.3	17-Oct	16	65.3	15-Oct	16	64.9	69.5	66.2	6.9%	63.1	17-Oct	15
900FF - High Mass with S. Windows	41.8	17-Oct	15	43.4	2-Sep	16	42.7	2-Sep	15	44.8	2-Sep	15		43.0	2-Sep	15	42.5	17-Oct	15	43.2	15-Sep	15	41.8	44.8	43.1	6.9%	44.5	2-Sep	16
650FF Case 600FF with Night Ventilation	63.2	17-Oct	15	63.5	16-Oct	15	68.2	17-Oct	15	67.0	16-Oct	15		63.3	16-Oct	16	63.7	17-Oct	16	63.8	16-Oct	16	63.2	68.2	64.7	7.7%	61.1	17-Oct	16
950FF Case 900FF with Night Ventilation	35.5	2-Sep	16	36.2	2-Sep	16	35.9	2-Sep	16	38.5	2-Sep	15		36.1	2-Sep	16	35.7	2-Sep	15	37.6	15-Sep	16	35.5	38.5	36.5	8.1%	36.7	2-Sep	16
960 Sunspace	48.9	17-Oct	15	48.9	6-Oct	15	49.0	17-Oct	15	51.0	17-Oct	15		50.2	17-Oct	15	55.3	17-Oct	15	48.9	15-Oct	15	48.9	55.3	50.3	12.8%			

MINIMUM ANNUAL HOURLY INTEGRATED ZONE TEMPERATURE

Simulation Model:	ESP			BLAST			DOE21D			SRES-SUN			SRES	S3PAS			TSYS			TASE			Example Result Statistics				TERMOLOG		
Organization or Country:	DMU			US-IT			NREL			NREL			BRE*	SPAIN			BEL-BRE			FINLAND			Min	Max	Mean	(Max-Min)/	PoliMI		
Case	T (°C)	Date	Hr	T (°C)	Date	Hr	T (°C)	Date	Hr	T (°C)	Date	Hr		T (°C)	Date	Hr	T (°C)	Date	Hr	T (°C)	Date	Hr	T (°C)	T (°C)	T (°C)	Mean** (%)	T (°C)	Date	Hr
600FF - Low Mass with S. Windows	-15.6	4-Jan	7	-17.1	4-Jan	8	-18.8	4-Jan	8	-18.0	4-Jan	7		-17.8	4-Jan	8	-17.8	4-Jan	7	-18.5	8-Jan	9	-18.8	-15.6	-17.6	18.3%	-18.4	4-Jan	8
900FF - High Mass with S. Windows	-1.6	4-Jan	8	-3.2	4-Jan	8	-4.3	4-Jan	8	-4.5	4-Jan	8		-4.0	4-Jan	8	-6.4	4-Jan	8	-5.6	8-Jan	9	-6.4	-1.6	-4.2	111.9%	-3.7	4-Jan	8
650FF Case 600FF with Night Ventilation	-22.6	4-Jan	6	-23.0	4-Jan	7	-21.6	4-Jan	2	-23.0	4-Jan	2		-22.9	4-Jan	2	-22.8	4-Jan	7	-22.9	2-Jan	23	-23.0	-21.6	-22.7	6.2%	-23.0	4-Jan	7
950FF Case 900FF with Night Ventilation	-19.5	4-Jan	6	-20.0	4-Jan	7	-18.6	4-Jan	7	-19.7	4-Jan	7		-20.2	4-Jan	7	-19.3	4-Jan	7	-20.0	7-Jan	22	-20.2	-18.6	-19.6	8.2%	-19.8	4-Jan	7
960 Sunspace	2.7	6-Feb	6	1.6	6-Feb	7	3.9	6-Feb	7	3.1	6-Feb	7		1.4	6-Feb	6	-2.8	4-Jan	8	-0.4	5-Feb	7	-2.8	3.9	1.4	492.6%			

AVERAGE ANNUAL HOURLY INTEGRATED ZONE TEMPERATURE

Simulation Model:	ESP	BLAST	DOE21D	SRES-SUN	SRES	S3PAS	TSYS	TASE	Example Result Statistics				TERMOLOG
Organization or Country:	DMU	US-IT	NREL	NREL	BRE	SPAIN	BEL-BRE	FINLAND	Min	Max	Mean	(Max-Min)/	PoliMI
Case	T (°C)	T (°C)	T (°C)	T (°C)	T (°C)	T (°C)	T (°C)	T (°C)	T (°C)	T (°C)	T (°C)	Mean** (%)	T (°C)
600FF - Low Mass with S. Windows	25.1	25.4	24.6	25.5	25.9	25.2	24.5	24.2	24.2	25.9	25.1	6.8%	25.9
900FF - High Mass with S. Windows	25.5	25.9	24.7	25.5	25.7	25.2	24.5	24.5	24.5	25.9	25.2	5.9%	25.9
650FF Case 600FF with Night Ventilation	18.2	18.7	19.1	19.0	19.6	18.4	18.0	18.4	18.0	19.6	18.7	8.7%	18.9
950FF Case 900FF with Night Ventilation	14.1	14.3	14.3	15.0	14.3	14.0	14.5	14.6	14.0	15.0	14.4	6.7%	14.3
960 Sunspace	27.5	27.7	28.0	28.7	28.5	28.0	29.0	26.4	26.4	29.0	28.0	9.0%	

* SRES-BRE (SERIRES 1.2) simulations did not produce output for this variable.

** ABS[(Max-Min) / (Mean of Example Simulation Results)]

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B8-6. Low Mass Basic Sensitivity Tests

ANNUAL HEATING [MWh]									Statistics for Example Results				
Case	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
610-600 Heat, S. Shade	0.059	0.033	0.077	0.054	0.024	0.089	0.098	0.021	0.021	0.098	0.057	135.4%	0.046
620-600 Heat, E&W Orient.	0.317	0.276	0.235	0.328	0.138	0.682	0.201	0.366	0.138	0.682	0.318	171.1%	0.315
630-620 Heat, E&W Shade	0.437	0.310	0.525	0.329	0.267	0.531	0.551		0.267	0.551	0.421	67.4%	0.385
640-600 Heat, Htg. Setback	-1.545	-1.885	-2.166	-1.971	-1.793	-1.817	-1.829	-2.053	-2.166	-1.545	-1.882	33.0%	-1.746

ANNUAL SENSIBLE COOLING [MWh]									Statistics for Example Results				
Case	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
610-600 Cool, S. Shade	-2.222	-1.582	-2.227	-1.830	-2.186	-1.728	-1.891	-1.272	-2.227	-1.272	-1.867	51.1%	-1.965
620-600 Cool, E&W Orient.	-2.720	-2.341	-2.745	-2.645	-2.960	-2.481	-2.591	-2.427	-2.960	-2.341	-2.614	23.7%	-2.582
630-620 Cool, E&W Shade	-1.288	-0.984	-1.845	-1.140	-1.303	-1.522	-1.485		-1.845	-0.984	-1.367	63.0%	-1.236
Comparison	-0.185	-0.250	-0.320	-0.252	-0.153	-0.245	-0.246	-0.270	-0.320	-0.153	-0.240	69.5%	-0.272
650-600 Cool, Night Vent	-1.321	-1.293	-1.284	-1.384	-1.419	-1.404	-1.373	-1.322	-1.419	-1.284	-1.350	10.0%	-1.433

PEAK HEATING [kW]									Statistics for Example Results				
Case	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE*	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
610-600 Heat, S. Shade	0.000	0.001	-0.011	0.000		0.000	-0.008	0.000	-0.011	0.001	-0.003	458.2%	0.000
620-600 Heat, E&W Orient.	0.154	0.001	0.001	0.019		0.240	-0.008	0.025	-0.008	0.240	0.062	402.7%	0.001
630-620 Heat, E&W Shade	0.001	0.000	-0.021	0.003		0.001	0.000		-0.021	0.003	-0.003	900.0%	0.000
640-600 Heat, Htg. Setback	1.795	1.546	1.898	2.272		2.310	1.792	2.600	1.546	2.600	2.030	51.9%	2.478

PEAK SENSIBLE COOLING [kW]									Statistics for Example Results				
Case	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE*	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
610-600 Cool, S. Shade	-0.525	-0.141	-0.592	-0.456		-0.116	-0.811	-0.666	-0.811	-0.116	-0.472	147.1%	-0.388
620-600 Cool, E&W Orient.	-2.560	-1.890	-2.226	-2.234		-1.989	-2.211	-1.716	-2.560	-1.716	-2.118	39.8%	-1.786
630-620 Cool, E&W Shade	-0.562	-0.371	-0.842	-0.477		-0.632	-0.667		-0.842	-0.371	-0.592	79.6%	-0.393
640-600 Cool, Htg. Setback	-0.033	-0.073	-0.080	-0.051		-0.036	-0.044	-0.041	-0.080	-0.033	-0.051	91.8%	-0.078
650-600 Cool, Night Vent	-0.163	-0.134	-0.140	-0.156		-0.143	-0.108	-0.133	-0.163	-0.108	-0.140	39.2%	-0.173

* SRES-BRE (SERIRES 1.2) simulations did not produce output for this variable.
** ABS[(Max-Min) / (Mean of Example Simulation Results)]

Table B8-7. High Mass Basic Sensitivity Tests

ANNUAL HEATING [MWh]									Statistics for Example Results				
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
900-600 Mass, Heat	-3.126	-3.163	-3.837	-3.329	-3.608	-3.152	-3.217	-3.321	-3.837	-3.126	-3.344	21.3%	-3.062
910-900 Heat, S. Shade	0.405	0.252	0.382	0.277	0.294	0.333	0.442	0.179	0.179	0.442	0.321	82.1%	0.237
920-900 Heat, E&W Orient.	2.143	2.142	2.383	2.196	2.070	2.505	2.121	2.259	2.070	2.505	2.227	19.5%	2.090
930-920 Heat, E&W Shade	0.830	0.595	1.080	0.662	0.670	0.933	0.964		0.595	1.080	0.819	59.2%	0.753
940-900 Heat, Htg. Setback	-0.377	-0.589	-0.633	-0.666	-0.577	-0.551	-0.575	-0.718	-0.718	-0.377	-0.586	58.2%	-0.479
960-900 Heat, Sunspace	1.141	1.054	1.056	0.987	0.863	1.213	1.718	0.775	0.775	1.718	1.101	85.7%	

ANNUAL SENSIBLE COOLING [MWh]									Statistics for Example Results				
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
900-600 Mass, Cool	-4.005	-3.833	-4.624	-4.113	-4.549	-3.920	-4.007	-4.179	-4.624	-3.833	-4.154	19.0%	-3.812
910-900 Cool, S. Shade	-1.311	-1.067	-1.479	-1.293	-1.561	-1.144	-1.159	-0.832	-1.561	-0.832	-1.231	59.2%	-1.436
920-900 Cool, E&W Orient.	-0.292	0.016	-0.015	-0.222	-0.323	-0.115	-0.067	0.014	-0.323	0.016	-0.126	270.1%	-0.228
930-920 Cool, E&W Shade	-0.801	-0.682	-1.174	-0.770	-0.854	-1.018	-1.002		-1.174	-0.682	-0.900	54.7%	-0.834
940-900 Cool, Htg. Setback	-0.053	-0.064	-0.115	-0.129	-0.174	-0.083	-0.102	-0.083	-0.174	-0.053	-0.100	120.5%	-0.057
950-900 Cool, Night Vent	-1.745	-2.074	-1.917	-2.244	-2.826	-2.021	-1.924	-1.828	-2.826	-1.745	-2.072	52.2%	-2.178
960-900 Cool, Sunspace	-1.644	-1.934	-2.027	-2.362	-2.697	-1.929	-2.074	-1.813	-2.697	-1.644	-2.060	51.1%	

PEAK HEATING [kW]									Statistics for Example Results				
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE*	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
900-600 Mass, Heat	-0.587	-0.487	-0.488	-0.498		-0.429	-0.414	-0.557	-0.587	-0.414	-0.494	35.0%	-0.474
910-900 Heat, S. Shade	0.008	0.003	0.007	0.004		0.010	0.019	0.004	0.003	0.019	0.008	207.6%	0.002
920-900 Heat, E&W Orient.	0.458	0.250	0.248	0.253		0.421	0.192	0.264	0.192	0.458	0.298	89.4%	0.237
930-920 Heat, E&W Shade	0.047	0.029	0.027	0.029		0.035	0.036		0.027	0.047	0.034	59.1%	0.038
940-900 Heat, Htg. Setback	1.130	1.575	2.108	2.356		2.509	1.606	2.631	1.130	2.631	1.988	75.5%	2.845
960-900 Heat, Sunspace	-0.440	-0.702	-0.830	-0.897		-0.756	-0.995	-1.018	-1.018	-0.440	-0.805	71.8%	

PEAK SENSIBLE COOLING [kW]									Statistics for Example Results				
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE*	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
900-600 Mass, Cool	-3.306	-2.810	-3.198	-2.956		-2.952	-2.919	-3.355	-3.355	-2.810	-3.071	17.7%	-2.594
910-900 Cool, S. Shade	-0.992	-0.655	-1.122	-0.594		-0.548	-0.775	-0.310	-1.122	-0.310	-0.714	113.8%	-0.424
920-900 Cool, E&W Orient.	-0.503	-0.222	-0.349	-0.384		-0.263	-0.517	0.048	-0.517	0.048	-0.313	180.5%	-0.162
930-920 Cool, E&W Shade	-0.512	-0.387	-0.721	-0.407		-0.585	-0.552		-0.721	-0.387	-0.527	63.3%	-0.409
940-900 Cool, Htg. Setback	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000	-----	0.000
950-900 Cool, Night Vent	-0.855	-0.534	-0.794	-0.701		-0.657	-0.881	-0.590	-0.881	-0.534	-0.716	48.4%	-0.360
960-900 Cool, Sunspace	-1.935	-2.011	-2.401	-2.501		-2.155	-2.189	-2.054	-2.501	-1.935	-2.178	26.0%	

* SRES-BRE (SERIRES 1.2) simulations did not produce output for this variable.
** ABS[(Max-Min) / (Mean of Example Simulation Results)]

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B8-8. Low Mass In-Depth (Cases 195 thru 320) Sensitivity Tests

ANNUAL HEATING [MWh]									Statistics for Example Results				
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES* BRE	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
200-195 Surface Convection	1.085								1.085	1.085	1.085	0.0%	
210-200 Ext IR (Int IR "off")	1.204								1.204	1.204	1.204	0.0%	
220-215 Ext IR (Int IR "on")	1.397								1.397	1.397	1.397	0.0%	
215-200 Int IR (Ext IR "off")	0.295								0.295	0.295	0.295	0.0%	
220-210 Int IR (Ext IR "on")	0.488	0.656					0.743	0.470	0.470	0.743	0.589	46.3%	
230-220 Infiltration	3.432	3.525	3.456	3.531	3.522	3.615	3.543	3.527	3.432	3.615	3.519	5.2%	
240-220 Internal Gains	-1.295	-1.206	-1.339	-1.333	-1.341	-1.228	-1.221	-1.203	-1.341	-1.203	-1.271	10.9%	
250-220 Ext Solar Abs.	-2.193	-1.476	-1.763	-1.494	-1.474	-1.448	-1.533	-1.699	-2.193	-1.448	-1.635	45.6%	
270-220 South Windows	-2.434	-2.285		-2.761	*-2.207*		-2.250	-1.948	-2.761	-1.948	*-2.314*	*35.1%*	
280-270 Cavity Albedo	0.165	0.195		0.596	*0.228*		0.232	0.352	0.165	0.596	*0.295*	*146.3%*	
Comparison	-0.651	-0.721		-0.714	*-0.779*		-0.699	-0.649	*-0.779*	-0.649	*-0.702*	*18.5%*	
290-270 South Shading	0.067	0.029		0.065	*0.022*		0.085	0.020	0.020	0.085	*0.048*	*135.4%*	
300-270 E&W Windows	0.251	0.147		0.246	*0.044*		0.077	0.297	*0.044*	0.297	*0.177*	*142.9%*	
310-300 E&W Shading	0.460	0.250		0.263	*0.201*		0.486		*0.201*	0.486	*0.332*	*85.8%*	

ANNUAL SENSIBLE COOLING [MWh]													
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES* BRE	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
200-195 Surface Convection	0.156								0.156	0.156	0.156	0.0%	
210-200 Ext IR (Int IR "off")	-0.408								-0.408	-0.408	-0.408	0.0%	
220-215 Ext IR (Int IR "on")	-0.453								-0.453	-0.453	-0.453	0.0%	
215-200 Int IR (Ext IR "off")	0.069								0.069	0.069	0.069	0.0%	
220-210 Int IR (Ext IR "on")	0.024	0.088					0.069	0.042	0.024	0.088	0.056	114.8%	
230-220 Infiltration	0.268	0.275	0.293	0.304	0.304	0.286	0.303	0.302	0.268	0.304	0.292	12.3%	
240-220 Internal Gains	0.229	0.371	0.261	0.412	0.411	0.374	0.377	0.362	0.229	0.412	0.350	52.3%	
250-220 Ext Solar Abs.	3.027	1.844	1.778	2.097	2.096	1.752	1.947	2.697	1.752	3.027	2.155	59.2%	
270-220 South Windows	7.342	7.969		9.001	*9.515*		8.027	8.031	7.342	*9.515*	*8.314*	*26.1%*	
280-270 Cavity Albedo	-2.655	-2.775		-3.317	*-3.236*		-3.003	-2.457	-3.317	*-2.457*	*-2.907*	*29.6%*	
320-270 Thermostat	-2.467	-2.764		-3.103	*-3.046*		-2.808	-3.051	-3.103	-2.467	*-2.873*	*22.1%*	
290-270 South Shading	-2.324	-1.659		-1.957	*-2.261*		-2.065	-1.283	-2.324	-1.283	*-1.925*	*54.1%*	
300-270 E&W Windows	-3.226	-2.834		-3.163	*-3.250*		-3.043	-2.933	*-3.250*	-2.834	*-3.075*	*13.5%*	
310-300 E&W Shading	-1.570	-1.266		-1.420	*-1.629*		-1.994		-1.994	-1.266	*-1.576*	*46.2%*	

PEAK HEATING [kW]									Statistics for Example Results				
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES* BRE	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
200-195 Surface Convection	0.647								0.647	0.647	0.647	0.0%	
210-200 Ext IR (Int IR "off")	0.050								0.050	0.050	0.050	0.0%	
220-215 Ext IR (Int IR "on")	0.080								0.080	0.080	0.080	0.0%	
215-200 Int IR (Ext IR "off")	0.136								0.136	0.136	0.136	0.0%	
220-210 Int IR (Ext IR "on")	0.166	0.307					0.356	0.195	0.166	0.356	0.256	74.1%	
230-220 Infiltration	1.519	1.704	1.529	1.584		1.811	1.556	1.587	1.519	1.811	1.613	18.1%	
240-220 Internal Gains	-0.182	-0.180	-0.183	-0.200		-0.189	-0.183	-0.187	-0.200	-0.180	-0.186	10.7%	
250-220 Ext Solar Abs.	-0.001	-0.001	0.000	0.000		-0.007	0.000	0.005	-0.007	0.005	-0.001	2100.0%	
270-220 South Windows	-0.004	-0.003		-0.034			0.000	0.218	-0.034	0.218	0.035	711.9%	
280-270 Cavity Albedo	0.001	0.001		0.024			0.000	0.021	0.000	0.024	0.009	255.3%	
320-270 Thermostat	-0.002	-0.002		-0.010			0.000	-0.003	-0.010	0.000	-0.003	294.1%	
290-270 South Shading	0.000	0.000		0.000			-0.008	0.000	-0.008	0.000	-0.002	500.0%	
300-270 E&W Windows	0.151	-0.001		0.020			-0.008	0.032	-0.008	0.151	0.039	411.4%	
310-300 E&W Shading	0.001	0.001		-0.012			0.000		-0.012	0.001	-0.002	520.0%	

PEAK SENSIBLE COOLING [kW]									Statistics for Example Results				
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES* BRE	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
200-195 Surface Convection	0.212								0.212	0.212	0.212	0.0%	
210-200 Ext IR (Int IR "off")	-0.387								-0.387	-0.387	-0.387	0.0%	
220-215 Ext IR (Int IR "on")	-0.447								-0.447	-0.447	-0.447	0.0%	
215-200 Int IR (Ext IR "off")	0.144								0.144	0.144	0.144	0.0%	
220-210 Int IR (Ext IR "on")	0.084	0.149					0.111	0.071	0.071	0.149	0.104	75.2%	
230-220 Infiltration	0.499	0.480	0.518	0.535		0.485	0.529	0.536	0.480	0.536	0.512	10.9%	
240-220 Internal Gains	0.179	0.181	0.182	0.200		0.183	0.183	0.184	0.179	0.200	0.185	11.4%	
250-220 Ext Solar Abs.	2.800	1.870	1.668	1.250		1.043	2.049	3.699	1.043	3.699	2.054	129.3%	
270-220 South Windows	5.796	5.475		5.894			5.585	5.654	5.475	5.894	5.681	7.4%	
280-270 Cavity Albedo	-1.912	-2.010		-2.014			-1.978	-1.631	-2.014	-1.631	-1.909	20.1%	
320-270 Thermostat	-0.655	-0.695		-0.681			-0.586	-0.726	-0.726	-0.586	-0.669	20.9%	
290-270 South Shading	-0.087	-0.086		-0.258			-0.561	-0.246	-0.561	-0.086	-0.248	191.9%	
300-270 E&W Windows	-2.952	-2.548		-2.577			-2.486	-1.938	-2.952	-1.938	-2.500	40.6%	
310-300 E&W Shading	-0.556	-0.344		-0.493			-0.689		-0.689	-0.344	-0.520	66.3%	

* SRES-BRE (SERIRES 1.2) simulations for cases with interior solar absorptance = 0.9 have an input error that likely affects annual heating and cooling load sensitivities by <0.2 MWh/y. (<6% for heating, <3% for cooling); see Annex B7, Section B7.1.1. Affected results involving Cases 270 and 290 throiugh 320 are indicated with italics.

** ABS[(Max-Min) / (Mean of Example Simulation Results)]

ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results
By Politecnico di Milano - ABC dept. (PoliMI), 01-Mar-2018

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B8-9. Low Mass In-Depth (Cases 395 thru 440) Sensitivity Tests

ANNUAL HEATING [MWh]									Statistics for Example Results				
	ESP	BLAST	DOE21D	SRES-SUN	SRES	S3PAS	TSYS	TASE				(Max-Min)/	TERMOLOG
CASES	DMU	US-IT	NREL	NREL	BRE	SPAIN	BEL-BRE	FINLAND	Min	Max	Mean	Mean** (%)	PoliMI
400-395 Surf. Conv. & IR	1.916	2.276	2.935	2.767	2.772	2.320	2.311	2.487	1.916	2.935	2.473	41.2%	
410-400 Infiltration	1.696	1.798	1.736	1.760	1.761	1.732	1.770	1.759	1.696	1.798	1.752	5.8%	
420-410 Internal Gains	-1.298	-1.263	-1.355	-1.361	-1.361	-1.245	-1.239	-1.222	-1.361	-1.222	-1.293	10.8%	
430-420 Ext Solar Abs.	-1.869	-1.122	-1.324	-1.187	-1.187	-1.112	-1.197	-1.353	-1.869	-1.112	-1.294	58.5%	
600-430 South Windows	-1.133	-1.715	-2.118	-1.952	-1.590	-1.780	-1.628	-1.148	-2.118	-1.133	-1.633	60.3%	
440-600 Cavity Albedo	0.153	0.214		0.426	0.215		0.226	0.280	0.153	0.426	0.252	108.2%	

ANNUAL SENSIBLE COOLING [MWh]									Statistics for Example Results				
	ESP	BLAST	DOE21D	SRES-SUN	SRES	S3PAS	TSYS	TASE				(Max-Min)/	TERMOLOG
CASES	DMU	US-IT	NREL	NREL	BRE	SPAIN	BEL-BRE	FINLAND	Min	Max	Mean	Mean** (%)	PoliMI
400-395 Surf. Conv. & IR	0.000	0.029	0.002	0.045	0.044	0.032	0.034	0.033	0.000	0.045	0.027	164.1%	
Comparison	0.000	0.019	0.008	0.023	0.026	0.021	0.022	0.021	0.000	0.026	0.018	148.2%	
420-410 Internal Gains	0.011	0.088	0.041	0.105	0.104	0.091	0.090	0.078	0.011	0.105	0.076	123.6%	
430-420 Ext Solar Abs.	0.531	0.470	0.371	0.515	0.496	0.409	0.460	0.732	0.371	0.732	0.498	72.5%	
600-430 South Windows	5.595	5.816	6.657	6.574	7.280	5.929	5.875	5.903	5.595	7.280	6.204	27.2%	
440-600 Cavity Albedo	-2.170	-2.261		-2.604	-2.760		-2.517	-2.094	-2.760	-2.094	-2.401	27.7%	

PEAK HEATING [kW]									Statistics for Example Results				
	ESP	BLAST	DOE21D	SRES-SUN	SRES	S3PAS	TSYS	TASE				(Max-Min)/	TERMOLOG
CASES	DMU	US-IT	NREL	NREL	BRE*	SPAIN	BEL-BRE	FINLAND	Min	Max	Mean	Mean** (%)	PoliMI
400-395 Surf. Conv. & IR	0.805	1.071	1.148	1.310		1.079	1.115	1.250	0.805	1.310	1.111	45.4%	
410-400 Infiltration	0.758	0.844	0.757	0.792		0.885	0.778	0.794	0.757	0.885	0.801	16.0%	
420-410 Internal Gains	-0.182	-0.180	-0.183	-0.200		-0.183	-0.183	-0.188	-0.200	-0.180	-0.186	10.8%	
430-420 Ext Solar Abs.	-0.001	0.000	0.000	0.000		0.000	0.000	0.011	-0.001	0.011	0.001	840.0%	
600-430 South Windows	-0.005	-0.004	-0.005	-0.029		-0.007	0.000	0.217	-0.029	0.217	0.024	1031.1%	
440-600 Cavity Albedo	0.002	0.002		0.019			0.000	0.022	0.000	0.022	0.009	244.4%	

PEAK SENSIBLE COOLING [kW]									Statistics for Example Results				
	ESP	BLAST	DOE21D	SRES-SUN	SRES	S3PAS	TSYS	TASE				(Max-Min)/	TERMOLOG
CASES	DMU	US-IT	NREL	NREL	BRE*	SPAIN	BEL-BRE	FINLAND	Min	Max	Mean	Mean** (%)	PoliMI
400-395 Surf. Conv. & IR	0.000	0.219	0.265	0.272		0.256	0.251	0.227	0.000	0.272	0.213	127.8%	
410-400 Infiltration	0.035	0.118	0.148	0.148		0.112	0.130	0.138	0.035	0.148	0.118	95.4%	
420-410 Internal Gains	0.223	0.224	0.218	0.233		0.214	0.195	0.211	0.195	0.233	0.217	17.7%	
430-420 Ext Solar Abs.	1.235	0.849	0.796	0.715		0.637	0.861	1.657	0.637	1.657	0.964	105.8%	
600-430 South Windows	4.701	4.193	5.229	5.065		4.711	4.688	4.234	4.193	5.229	4.689	22.1%	
440-600 Cavity Albedo	-1.648	-1.541		-1.774			-1.800	-1.534	-1.800	-1.534	-1.659	16.0%	

* SRES-BRE (SERIRES 1.2) simulations did not produce output for this variable.
** ABS[(Max-Min) / (Mean of Example Simulation Results)]

ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results
By Politecnico di Milano - ABC dept. (PoliMI), 01-Mar-2018

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B8-10. High Mass Basic and In-Depth Sensitivity Tests

ANNUAL HEATING [MWh]									Statistics for Example Results				
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
800-430 Mass, w/ Op. Win.	-0.561	-0.535	-0.599	-0.567	-0.586	-0.501	-0.560	-0.649	-0.649	-0.501	-0.570	26.0%	
900-800 Himass, S. Win.	-3.698	-4.343	-5.356	-4.714	-4.612	-4.431	-4.285	-3.820	-5.356	-3.698	-4.407	37.6%	
900-810 Himass, Int. Sol. Abs.	-0.669	-0.836		-1.107	-0.840		-0.912	-0.921	-1.107	-0.669	-0.881	49.7%	
910-610 Mass, w/ S. Shade	-2.780	-2.944	-3.532	-3.106	-3.338	-2.908	-2.873	-3.163	-3.532	-2.780	-3.081	24.4%	-2.870
920-620 Mass, w/ E&W Win.	-1.300	-1.297	-1.689	-1.461	-1.676	-1.329	-1.297	-1.428	-1.689	-1.297	-1.435	27.3%	-1.287
930-630 Mass w/ E&W Shade	-0.907	-1.012	-1.134	-1.128	-1.273	-0.927	-0.884		-1.273	-0.884	-1.038	37.5%	-0.919
940-640 Mass, w/ Htg. Setback	-1.958	-1.867	-2.304	-2.024	-2.392	-1.886	-1.963	-1.986	-2.392	-1.867	-2.048	25.6%	-1.794

ANNUAL SENSIBLE COOLING [MWh]									Statistics for Example Results				
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
800-430 Mass, w/ Op. Win.	-0.429	-0.393	-0.367	-0.432	-0.462	-0.368	-0.410	-0.550	-0.550	-0.367	-0.426	42.9%	
900-800 Himass, S. Win.	2.019	2.376	2.400	2.893	3.193	2.377	2.278	2.274	2.019	3.193	2.476	47.4%	
900-810 Himass, Int. Sol. Abs.	1.080	1.195		1.454	1.707		1.294	0.975	0.975	1.707	1.284	57.0%	
910-610 Mass, w/ S. Shade	-3.094	-3.318	-3.876	-3.576	-3.924	-3.336	-3.275	-3.739	-3.924	-3.094	-3.517	23.6%	-3.284
920-620 Mass, w/ E&W Win.	-1.577	-1.476	-1.894	-1.690	-1.912	-1.554	-1.483	-1.738	-1.912	-1.476	-1.666	26.2%	-1.458
930-630 Mass w/ E&W Shade	-1.090	-1.174	-1.223	-1.320	-1.463	-1.050	-1.000		-1.463	-1.000	-1.189	39.0%	-1.055
940-640 Mass, w/ Htg. Setback	-3.873	-3.647	-4.419	-3.990	-4.570	-3.758	-3.863	-3.992	-4.570	-3.647	-4.014	23.0%	-3.597
950-650 Mass, w/ Night Vent	-4.429	-4.614	-5.257	-4.973	-5.956	-4.537	-4.558	-4.685	-5.956	-4.429	-4.876	31.3%	-4.558

PEAK HEATING [kW]									Statistics for Example Results				
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE*	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
800-430 Mass, w/ Op. Win.	-0.215	-0.151	-0.141	-0.149		-0.142	-0.144	-0.198	-0.215	-0.141	-0.163	45.4%	
900-800 Himass, S. Win.	-0.377	-0.340	-0.352	-0.378		-0.294	-0.269	-0.142	-0.378	-0.142	-0.307	76.7%	
900-810 Himass, Int. Sol. Abs.	-0.129	-0.113		-0.155			-0.089	-0.166	-0.166	-0.089	-0.130	59.1%	
910-610 Mass, w/ S. Shade	-0.579	-0.485	-0.470	-0.494		-0.419	-0.386	-0.553	-0.579	-0.386	-0.484	39.9%	-0.473
920-620 Mass, w/ E&W Win.	-0.283	-0.238	-0.241	-0.264		-0.248	-0.214	-0.318	-0.318	-0.214	-0.258	40.4%	-0.238
930-630 Mass w/ E&W Shade	-0.237	-0.209	-0.193	-0.238		-0.214	-0.178		-0.238	-0.178	-0.211	28.5%	-0.200
940-640 Mass, w/ Htg. Setback	-1.252	-0.458	-0.278	-0.414		-0.230	-0.600	-0.526	-1.252	-0.230	-0.537	190.4%	-0.108

PEAK SENSIBLE COOLING [kW]									Statistics for Example Results				
CASES	ESP DMU	BLAST US-IT	DOE21D NREL	SRES-SUN NREL	SRES BRE*	S3PAS SPAIN	TSYS BEL-BRE	TASE FINLAND	Min	Max	Mean	(Max-Min)/ Mean** (%)	TERMOLOG PoliMI
800-430 Mass, w/ Op. Win.	-0.908	-0.805	-0.684	-0.410		-0.547	-0.816	-1.220	-1.220	-0.410	-0.770	105.2%	
900-800 Himass, S. Win.	2.303	2.188	2.715	2.519		2.306	2.584	2.099	2.099	2.715	2.388	25.8%	
900-810 Himass, Int. Sol. Abs.	1.036	0.798		0.880			1.223	0.595	0.595	1.223	0.906	69.3%	
910-610 Mass, w/ S. Shade	-3.773	-3.324	-3.728	-3.094		-3.384	-2.883	-2.999	-3.773	-2.883	-3.312	26.9%	-2.630
920-620 Mass, w/ E&W Win.	-1.249	-1.142	-1.321	-1.106		-1.226	-1.225	-1.591	-1.591	-1.106	-1.266	38.3%	-0.970
930-630 Mass w/ E&W Shade	-1.199	-1.158	-1.200	-1.036		-1.179	-1.110		-1.200	-1.036	-1.147	14.3%	-0.985
940-640 Mass, w/ Htg. Setback	-3.273	-2.737	-3.118	-2.905		-2.916	-2.875	-3.314	-3.314	-2.737	-3.020	19.1%	-2.516
950-650 Mass, w/ Night Vent	-3.998	-3.210	-3.852	-3.501		-3.466	-3.692	-3.812	-3.998	-3.210	-3.647	21.6%	-2.781

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

* SRES-BRE (SERIRES 1.2) simulations did not produce output for this variable.
** ABS[(Max-Min) / (Mean of Example Simulation Results)]

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Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B8-11. Annual Transmissivity Coefficient of Windows

(ANNUAL UNSHADED TRANSMITTED SOLAR RADIATION)/(ANNUAL UNSHADED INCIDENT SOLAR RADIATION)

Simulation Model:	ESP	DOE21D	SRES-SUN	SRES	S3PAS	TSYS	TASE	Statistics for Example Results				TERMOLOG
Organization or Country:	DMU	NREL	NREL	BRE	SPAIN	BEL-BRE	FINLAND				(Max-Min)/	PoliMI
Case								Min	Max	Mean	Mean* (%)	
620 West	0.674	0.681	0.687	0.657	0.641	0.654	0.648	0.641	0.687	0.663	7.0%	
600 South	0.650	0.671	0.652	0.650	0.628	0.647	0.623	0.623	0.671	0.646	7.5%	

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

Table B8-12. Annual Shading Coefficient of Window Shading Devices: Overhangs & Fins

(1-(ANNUAL SHADED TRANSMITTED SOLAR RADIATION)/(ANNUAL UNSHADED TRANSMITTED SOLAR RADIATION))

Simulation Model:	ESP	DOE21D	SRES-SUN	SRES	S3PAS	TSYS	TASE	Statistics for Example Results				TERMOLOG
Organization or Country:	DMU	NREL	NREL	BRE	SPAIN	BEL-BRE	FINLAND				(Max-Min)/	PoliMI
Case								Min	Max	Mean	Mean* (%)	
Comparison	0.182	0.346	0.196	0.216	0.329	0.339		0.182	0.346	0.268	61.2%	
610/600 South	0.170	0.209	0.165	0.188	0.183	0.205	0.115	0.115	0.209	0.177	53.5%	

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

Table B8-13. Case 600 Annual Incident Solar Radiation (kWh/m^2)

Simulation Model:	ESP	DOE21D	SRES-SUN	SRES	S3PAS	TSYS	TASE	Statistics for Example Results				TERMOLOG
Organization or Country:	DMU	NREL	NREL	BRE	SPAIN	BEL-BRE	FINLAND				(Max-Min)/	PoliMI
Case								Min	Max	Mean	Mean* (%)	
North	427	434	456	407	457	367	453	367	457	429	20.9%	430
East	959	1155	1083	1217	1082	1101	962	959	1217	1080	23.9%	1150
West	1086	1079	1003	857	1002	1012	1090	857	1090	1018	22.9%	1047
South	1456	1566	1476	1468	1474	1522	1468	1456	1566	1490	7.4%	1547
Horizontal	1797	1831	1832	1832	1832	1832	1832	1797	1832	1827	1.9%	1849

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

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By Politecnico di Milano - ABC dept. (PoliMI), 01-Mar-2018

Note: The statistics in the tables below are based on the Standard 140 informative example results.
These statistics do not have any substantial importance and are not to be interpreted as acceptance criteria.

Table B8-14. Case 600 Annual Transmitted Solar Radiation - Unshaded (kWh/m^2)

Simulation Model:	ESP	DOE21D	SRES-SUN	SRES	S3PAS	TSYS	TASE	Statistics for Example Results				TERMOLOG
Organization or Country:	DMU	NREL	NREL	BRE	SPAIN	BEL-BRE	FINLAND				(Max-Min)/	PoliMI
Case								Min	Max	Mean	Mean* (%)	
West	732	735	689	563	642	662	706	563	735	676	25.5%	
South	946	1051	962	954	926	984	914	914	1051	962	14.2%	

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

Table B8-15. Case 600 Annual Transmitted Solar Radiation - Shaded (kWh/m^2)

Simulation Model:	ESP	DOE21D	SRES-SUN	SRES	S3PAS	TSYS	TASE	Statistics for Example Results				TERMOLOG
Organization or Country:	DMU	NREL	NREL	BRE	SPAIN	BEL-BRE	FINLAND				(Max-Min)/	PoliMI
Case								Min	Max	Mean	Mean* (%)	
West	599	481	554	441	431	438		431	599	491	34.2%	
South	785	831	803	775	757	782	809	757	831	792	9.3%	

* ABS[(Max-Min) / (Mean of Example Simulation Results)]

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Figure B8-1. BESTEST BASIC
Annual Incident Solar Radiation

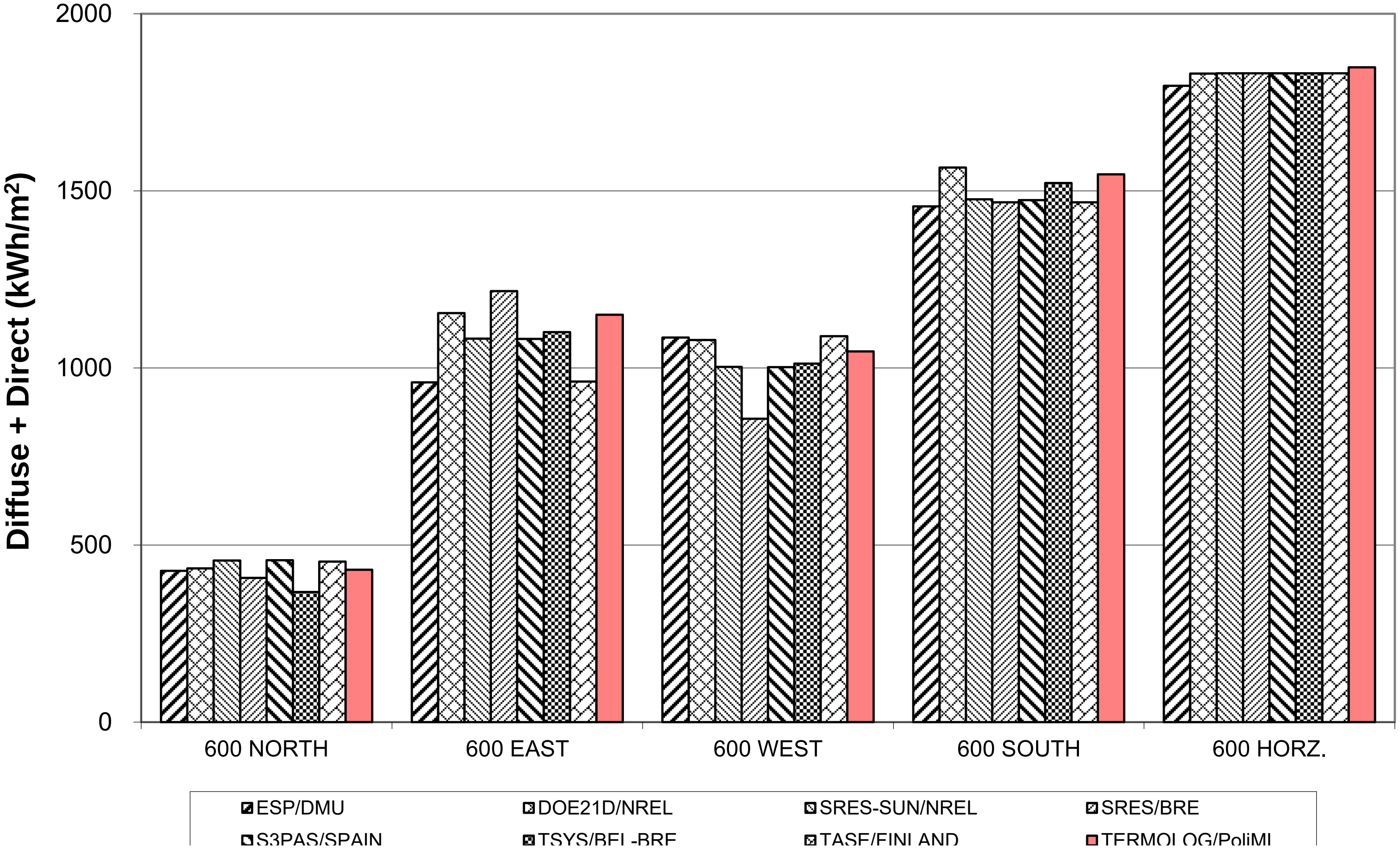

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Figure B8-2. BESTEST BASIC
Annual Transmitted Solar Radiation - Unshaded

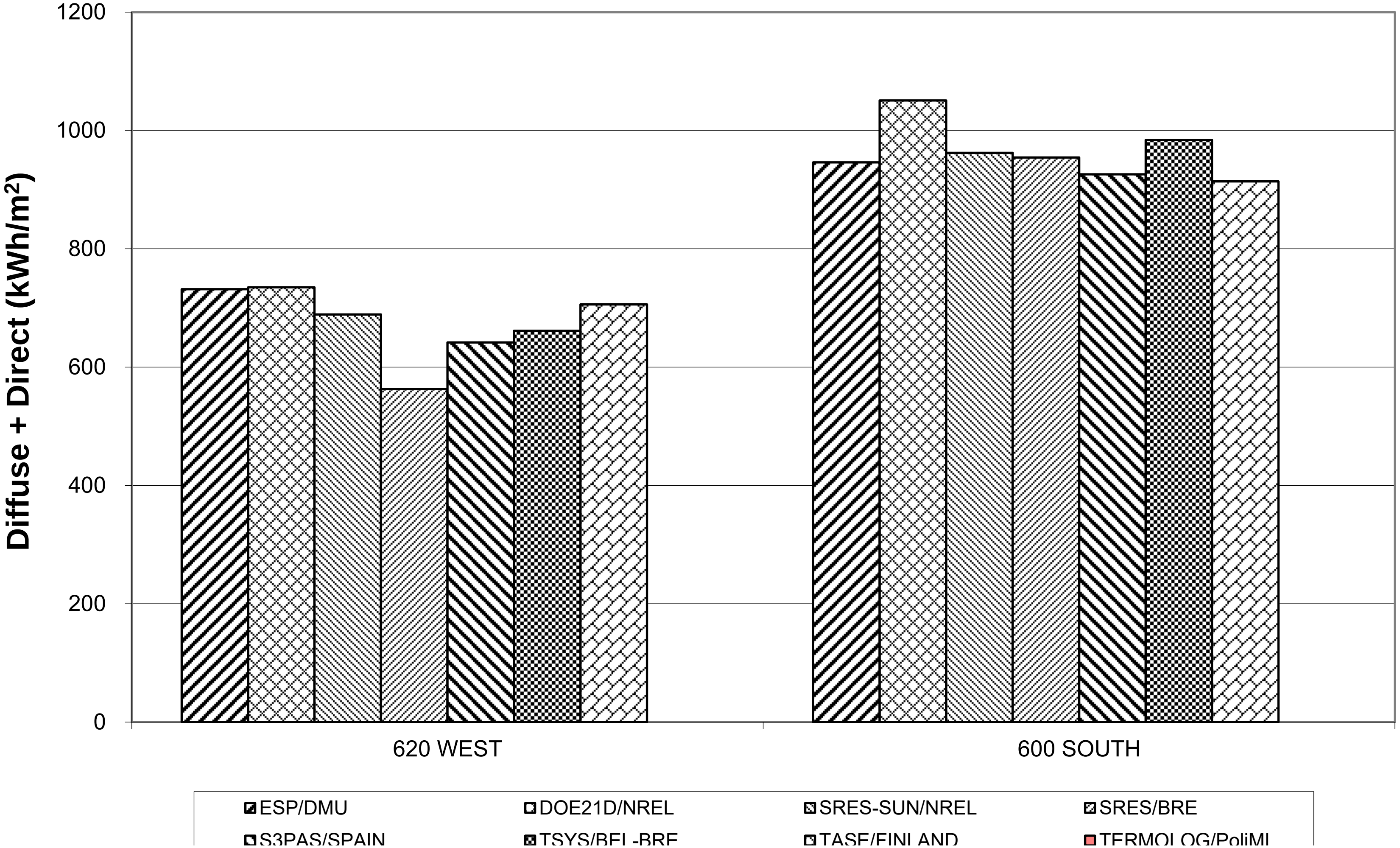

Figure B8-2. BESTEST BASIC
Annual Transmitted Solar Radiation - Unshaded

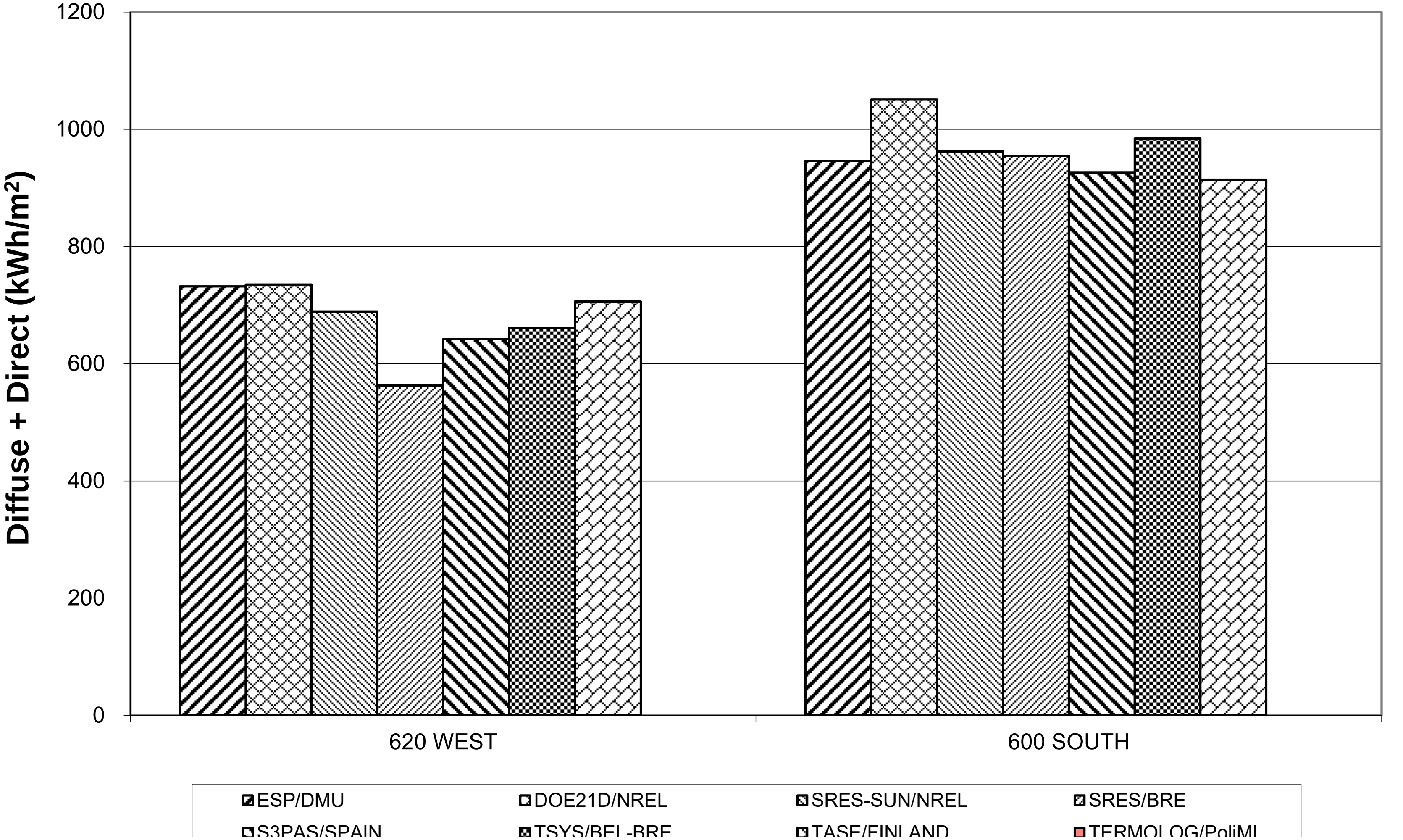

Figure B8-4. BESTEST BASIC
Annual Transmissivity Coefficient of Windows
(Unshaded Transmitted)/(Incident Solar Radiation)

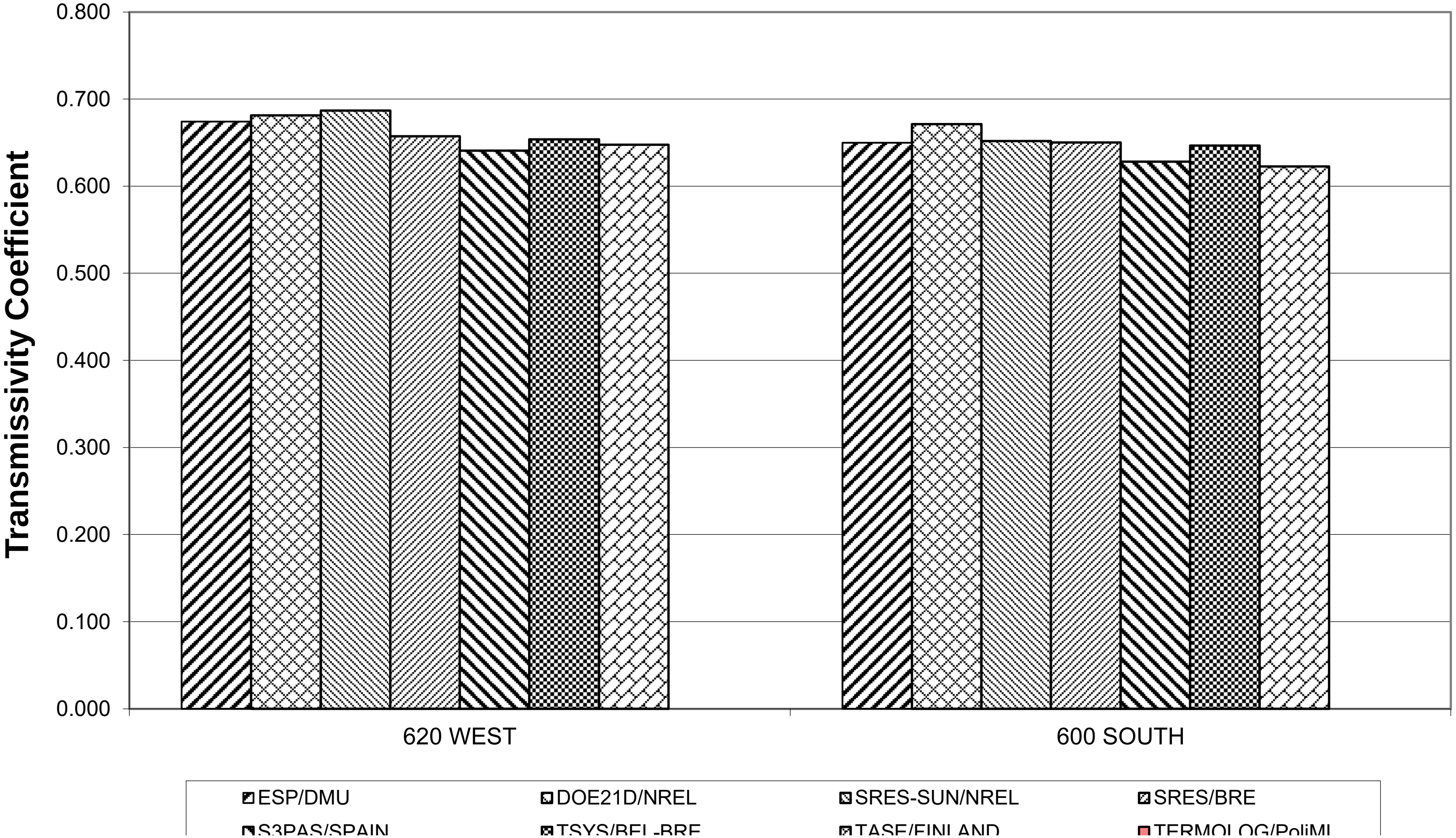

Figure B8-5. BESTEST BASIC
Annual Overhang and Fin Shading Coefficients
(1-(Shaded)/(Unshaded)) Transmitted Solar Radiation

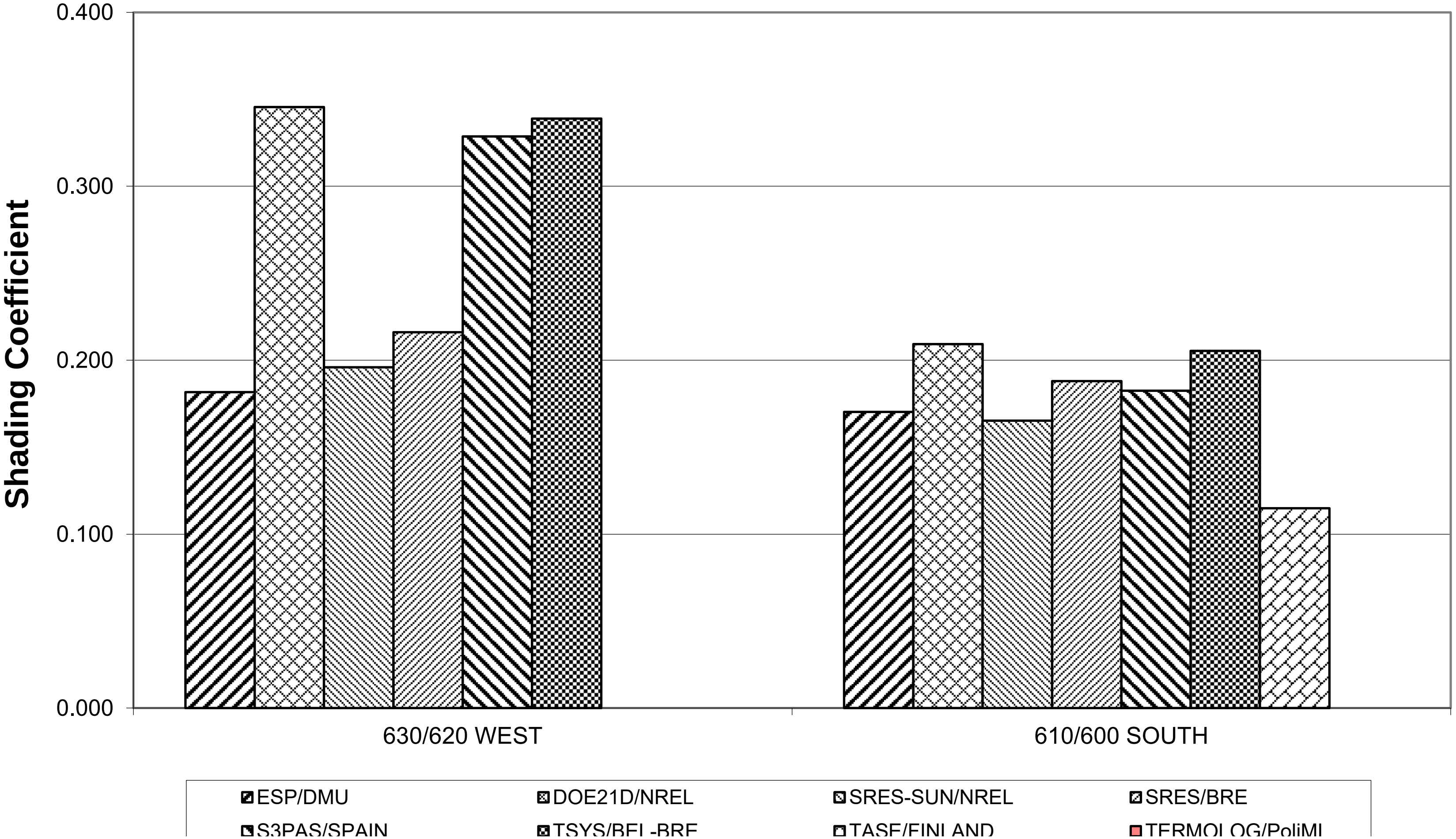

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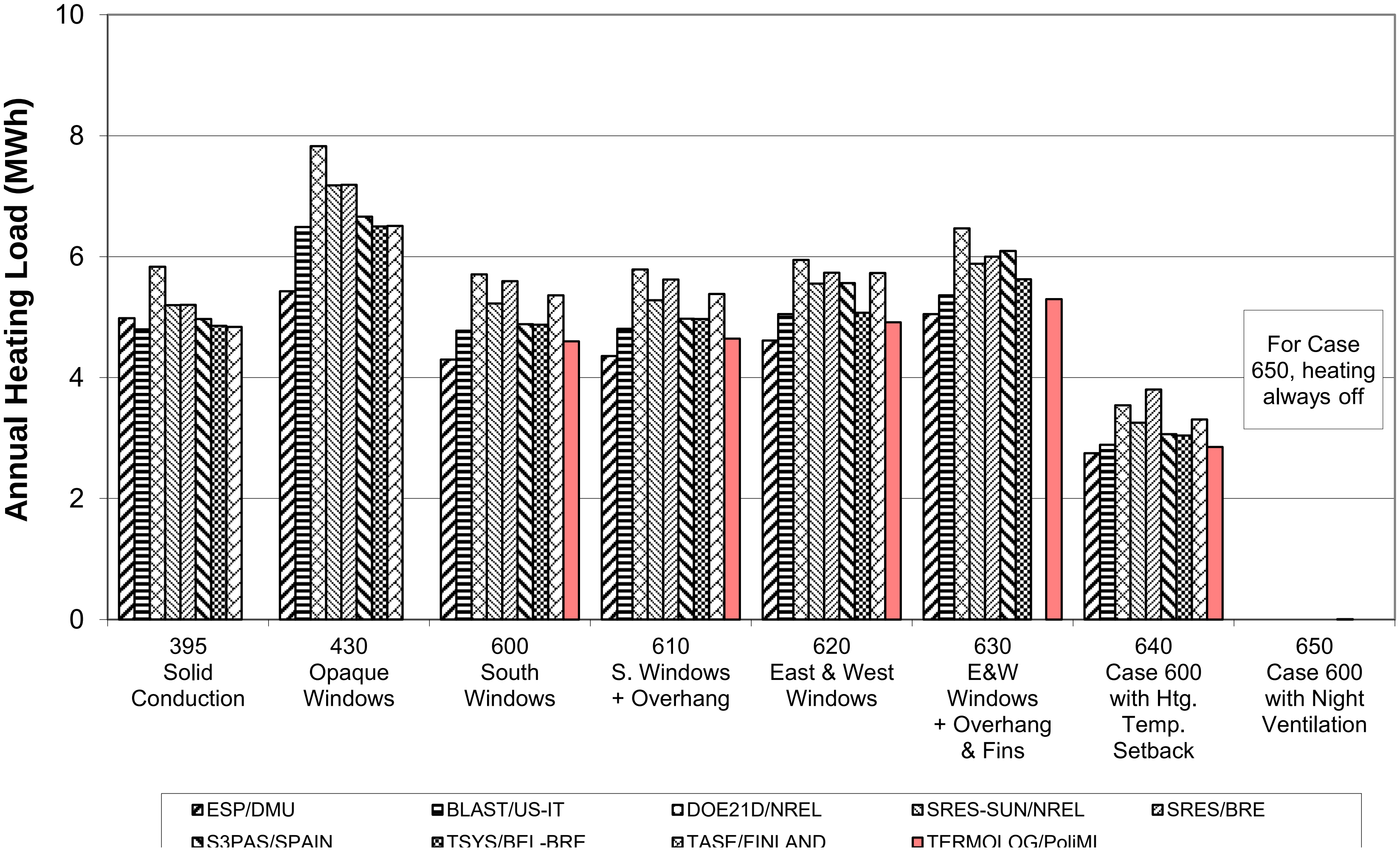
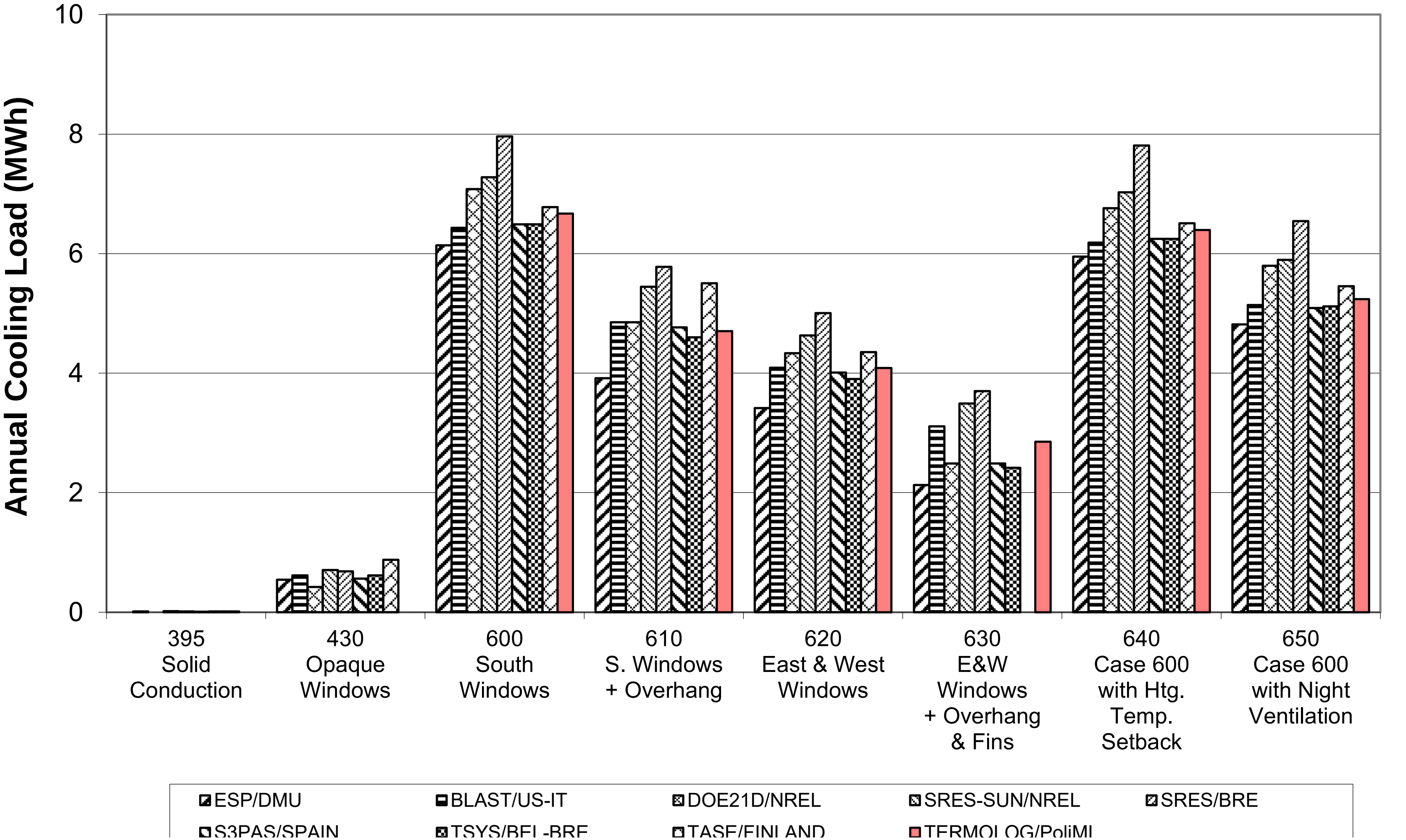
Figure B8-6. BESTEST BASIC
Low Mass Annual Heating



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-7. BESTEST BASIC
Low Mass Annual Sensible Cooling



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-8. BESTEST BASIC
Low Mass Peak Heating

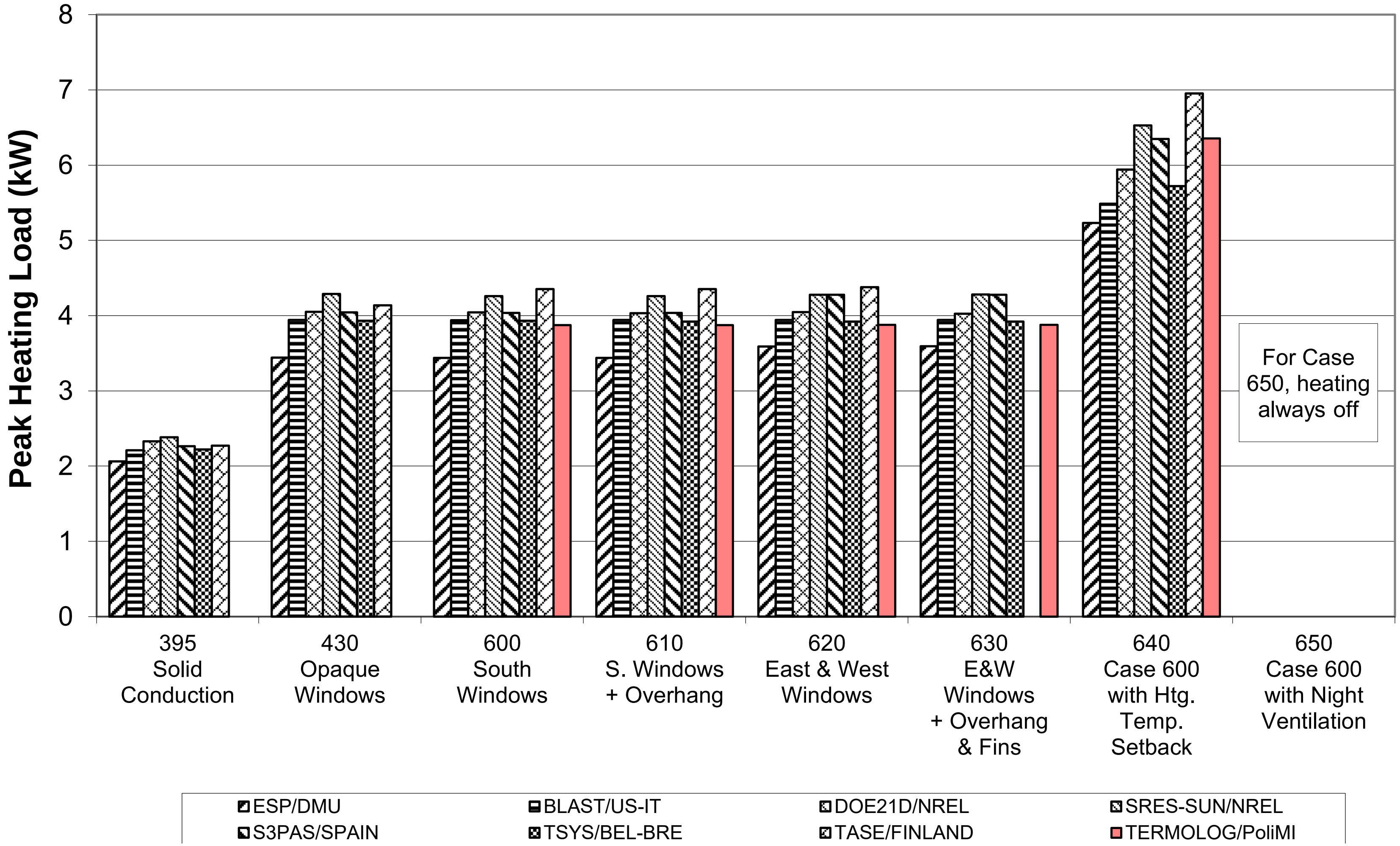


Figure B8-9. BESTEST BASIC
Low Mass Peak Sensible Cooling

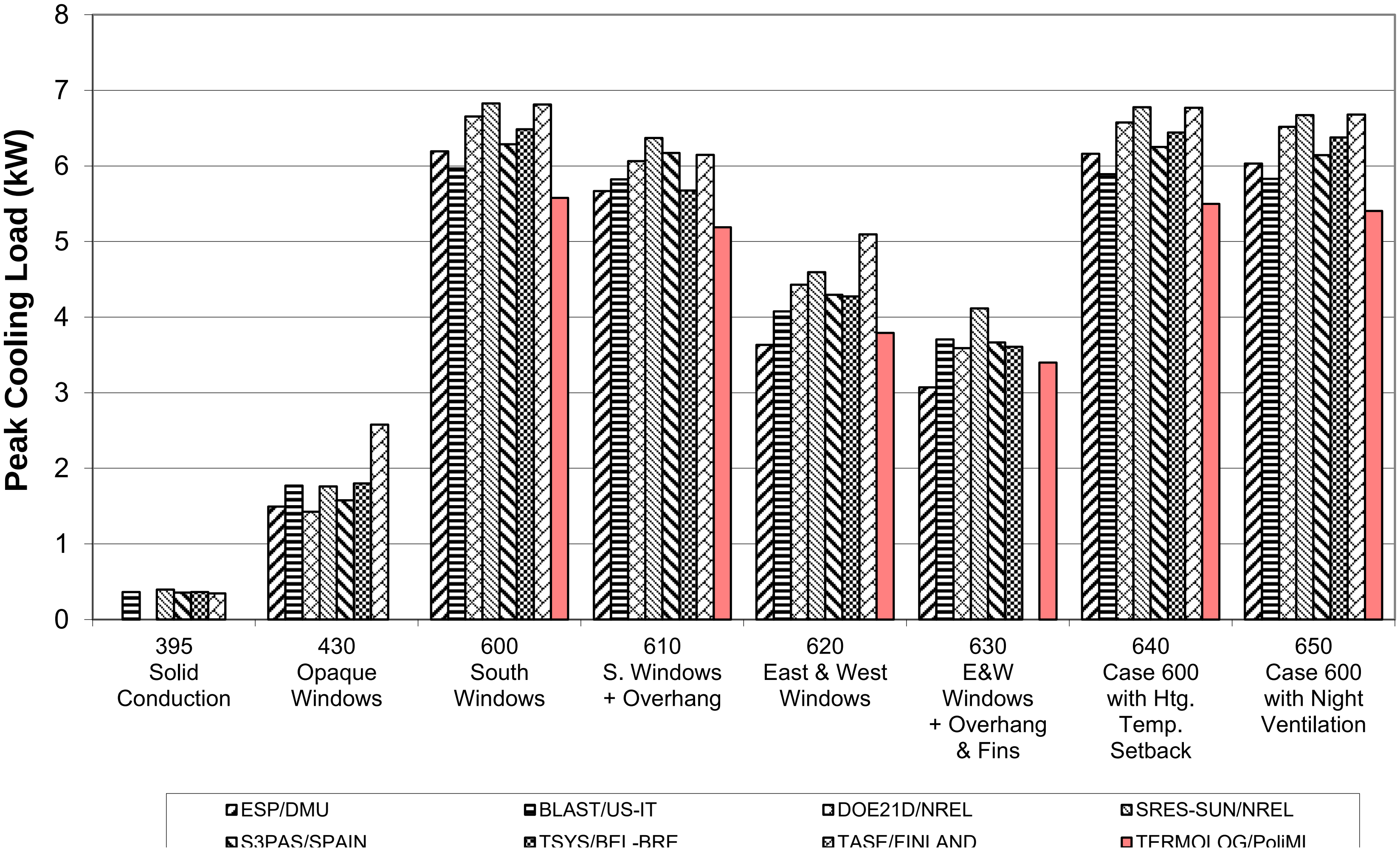
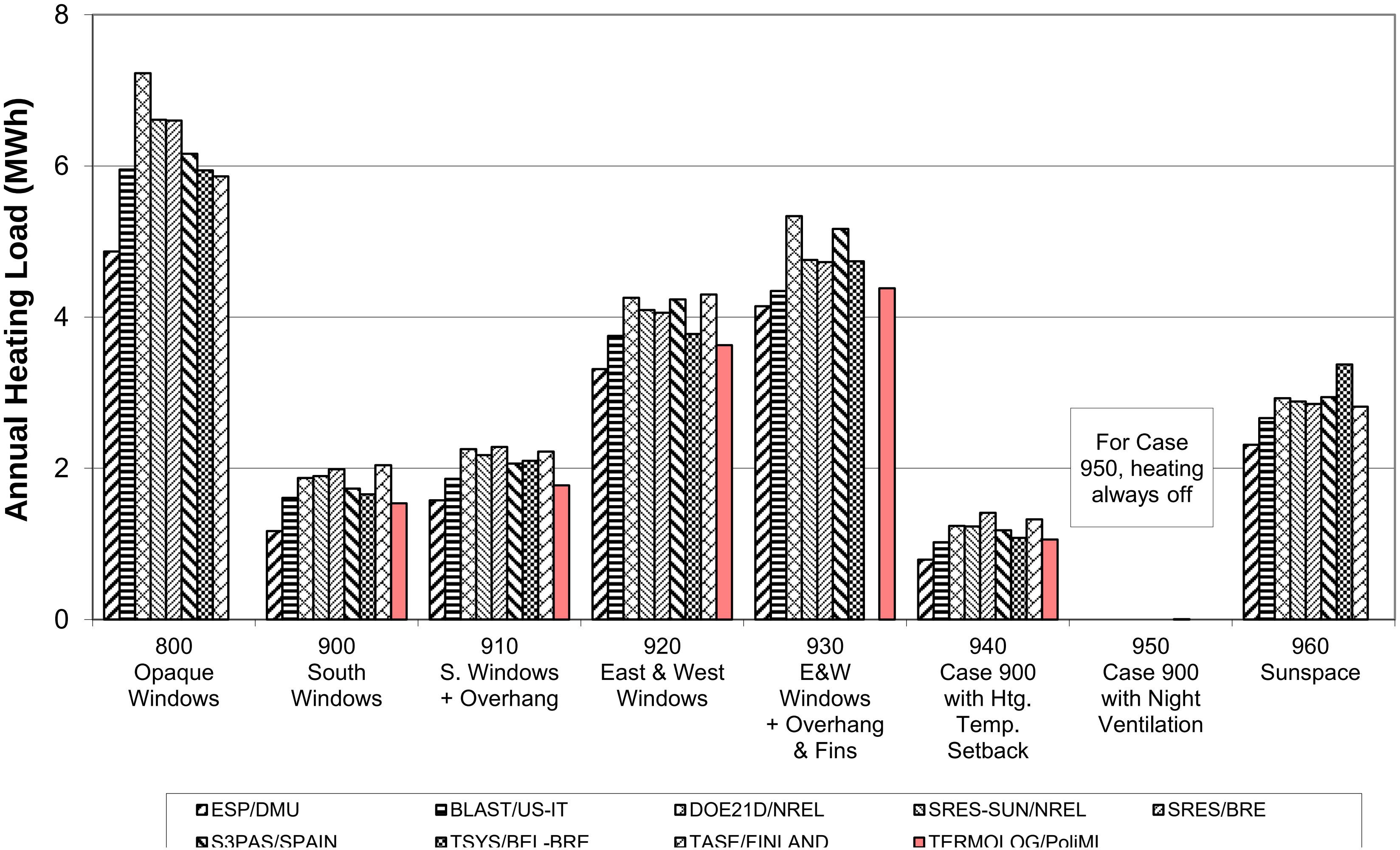
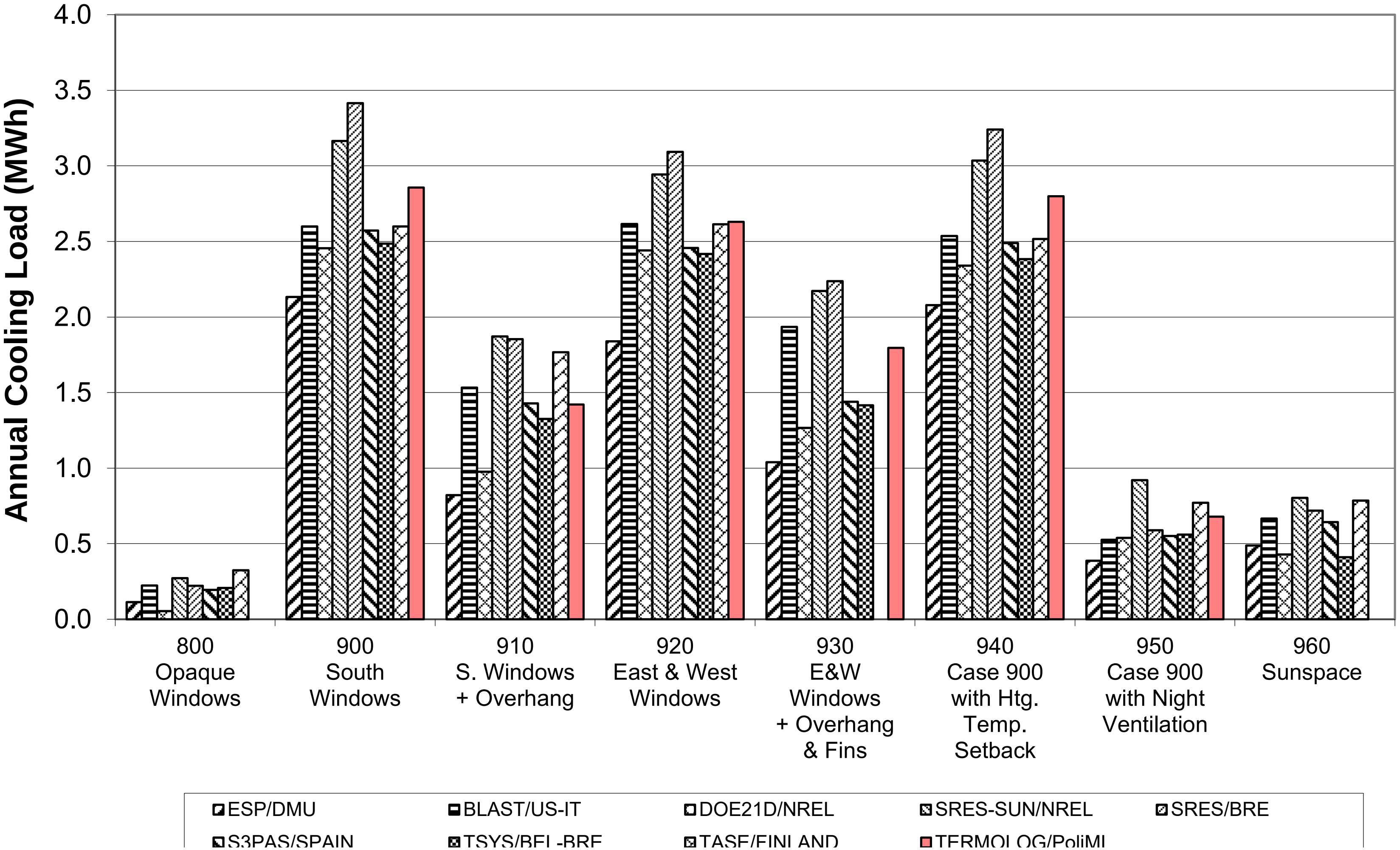


Figure B8-10. BESTEST BASIC
High Mass Annual Heating



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-11. BESTEST BASIC
High Mass Annual Sensible Cooling



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TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

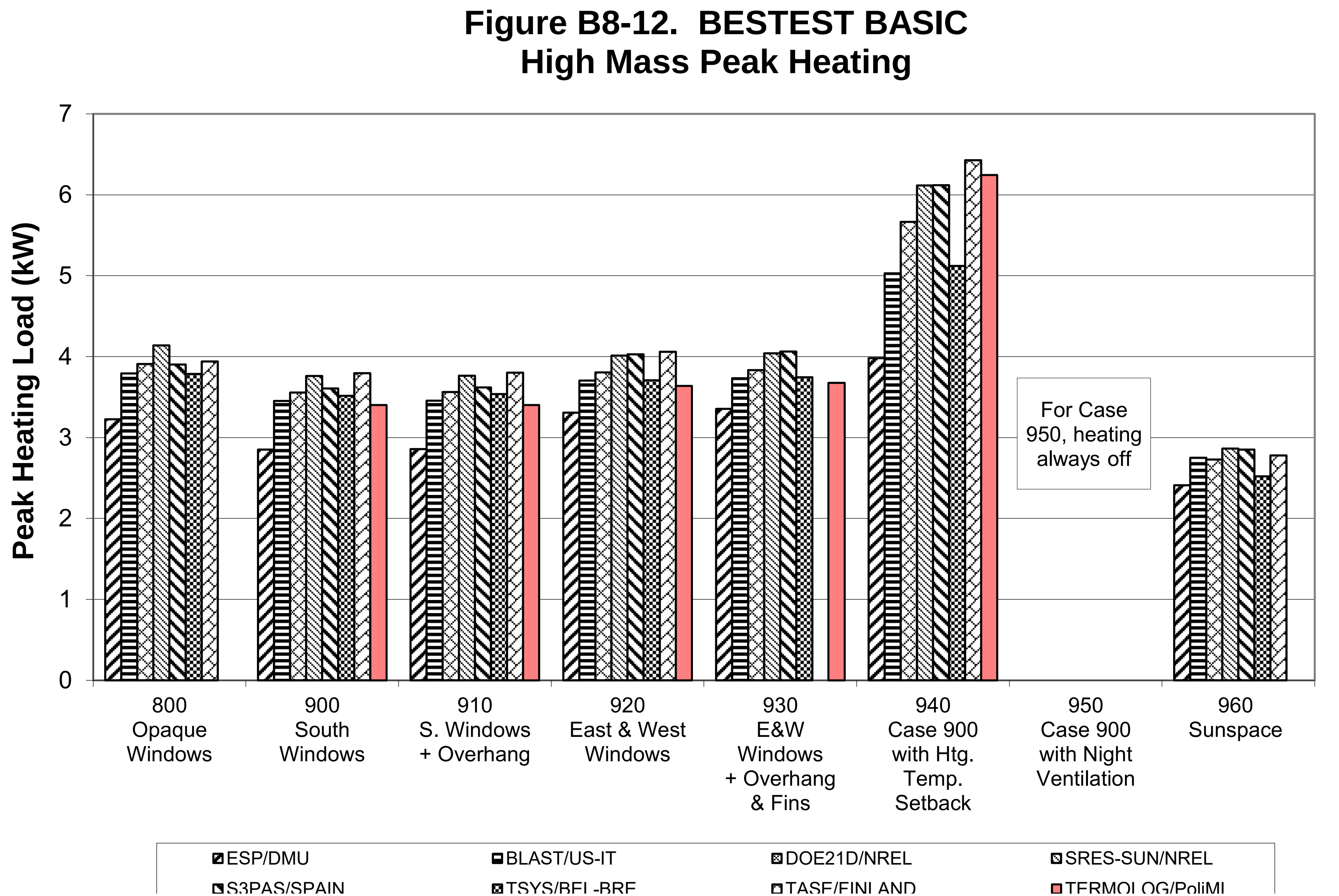

Figure B8-13. BESTEST BASIC
High Mass Peak Sensible Cooling

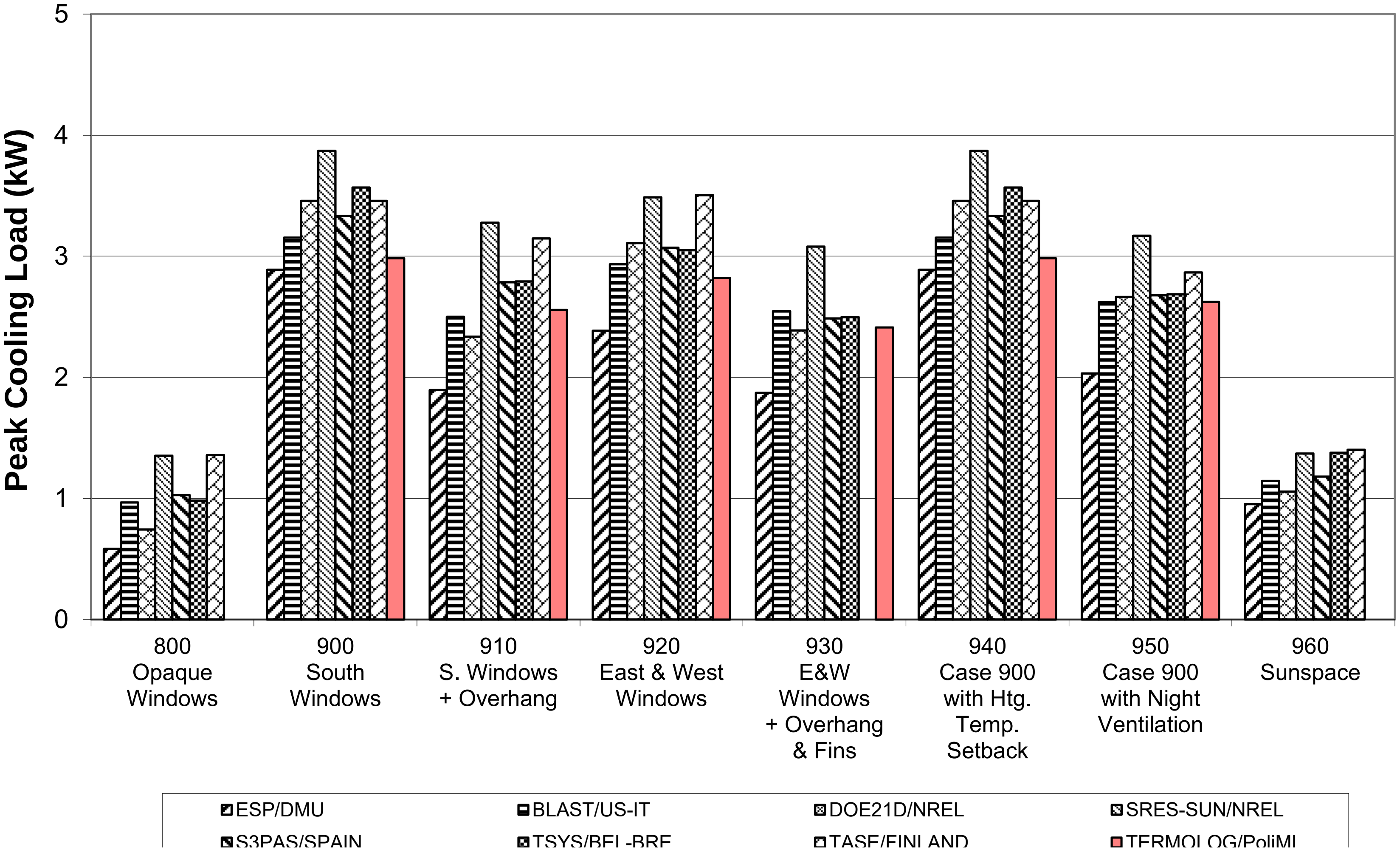

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Figure B8-14. BESTEST BASIC
Maximum Hourly Annual Temperature
Free-Float Cases

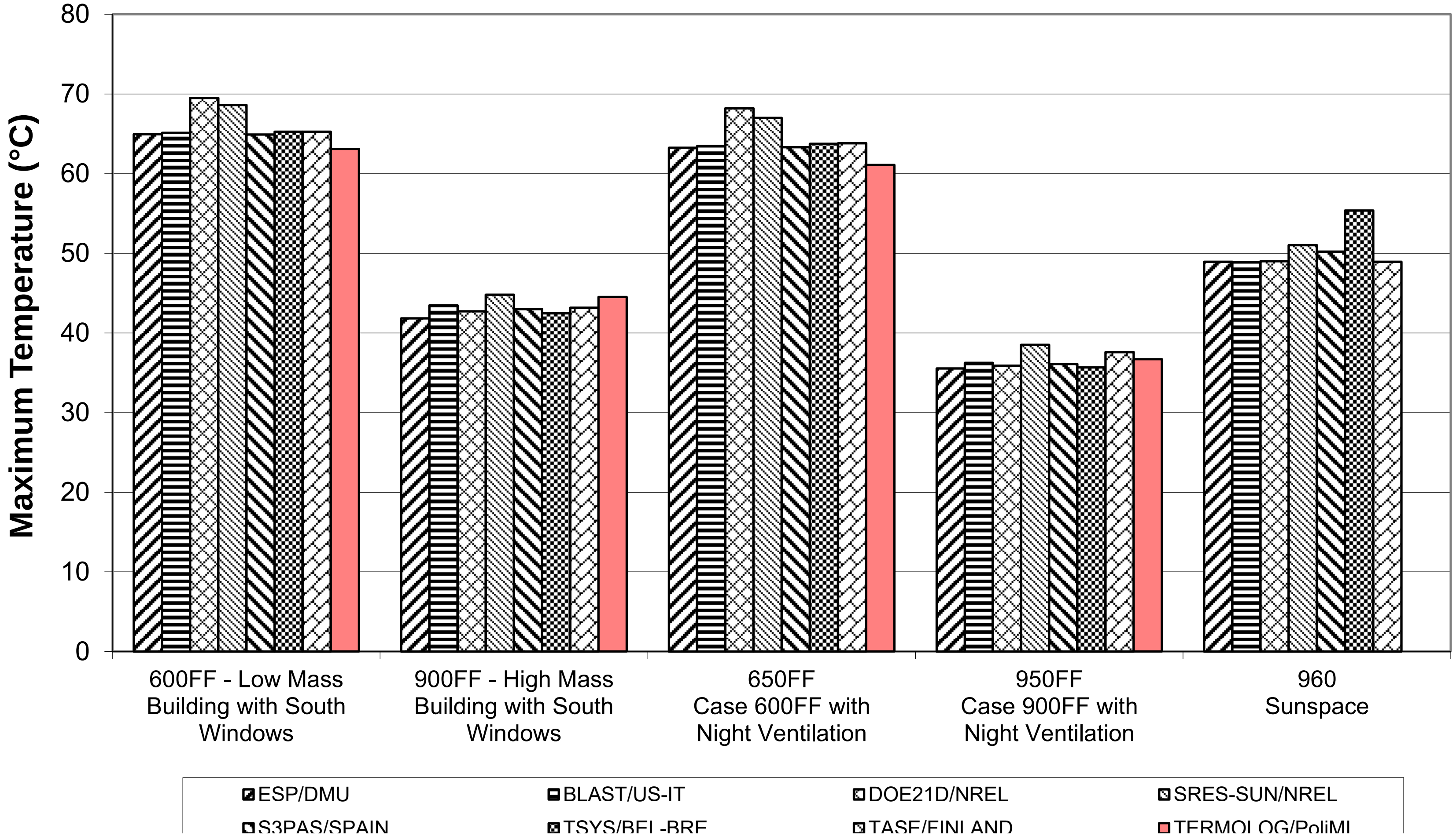

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Figure B8-15. BESTEST BASIC
Minimum Hourly Annual Temperature
Free-Float Cases

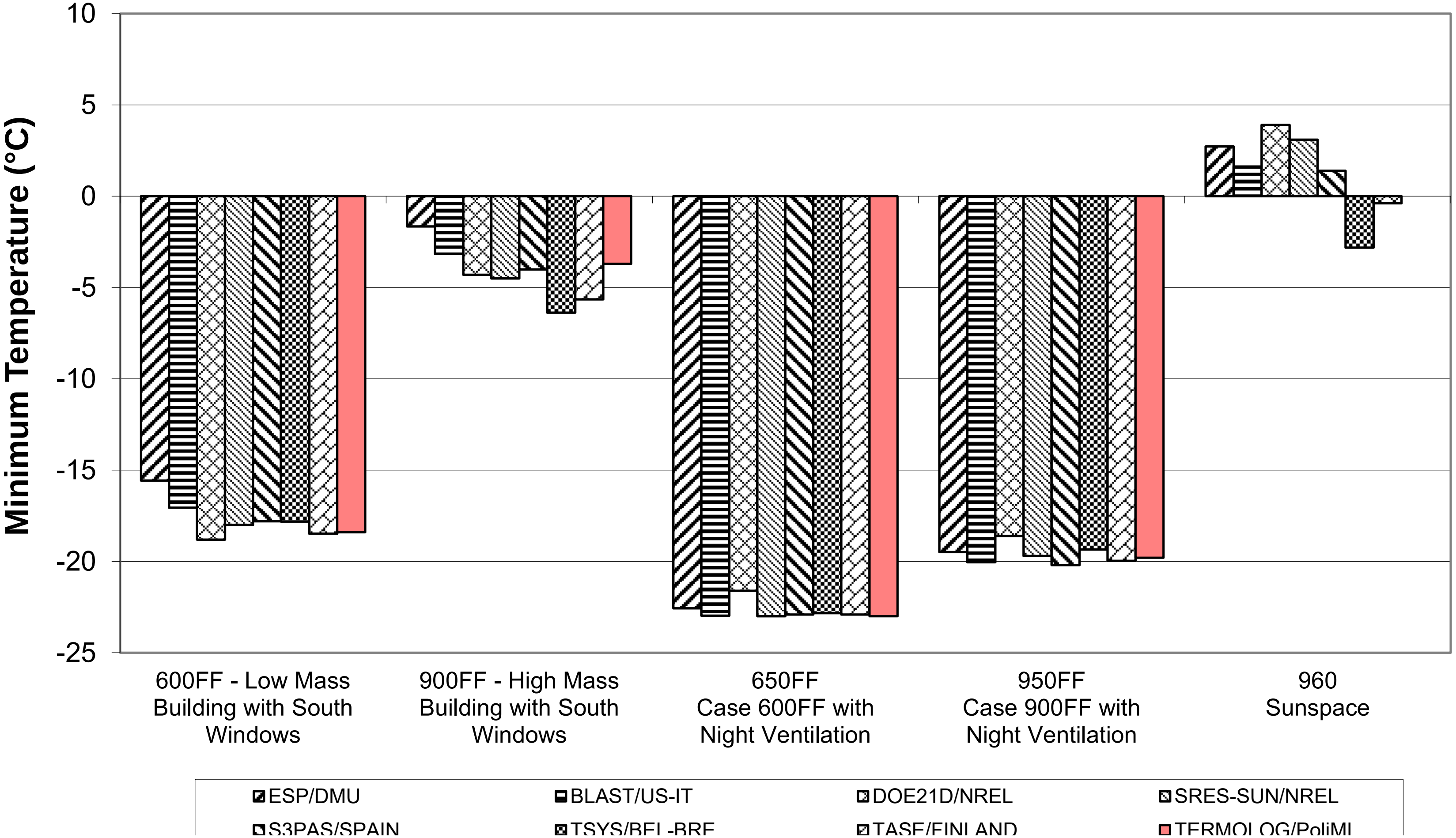
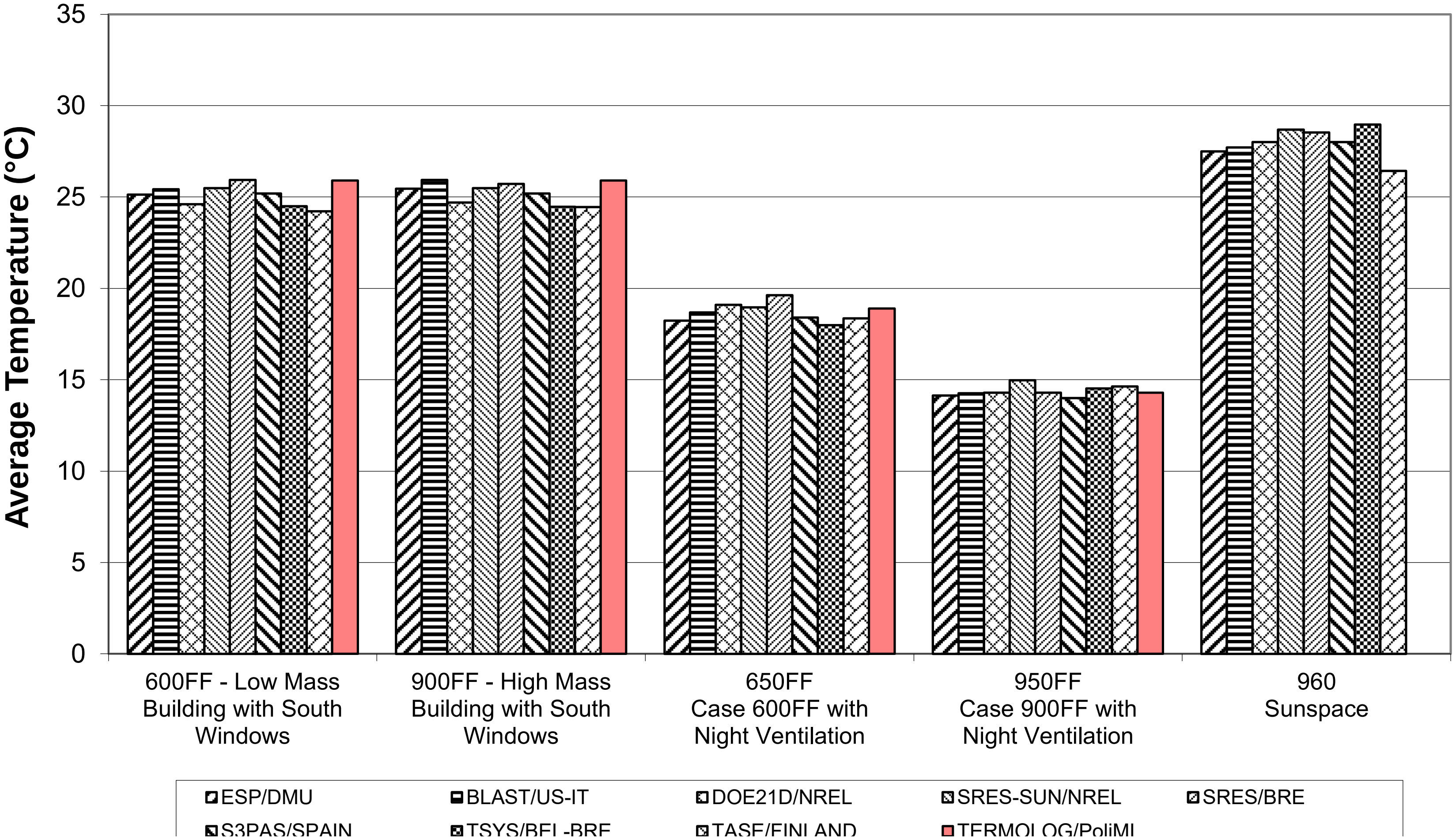


Figure B8-16. BESTEST BASIC
Average Hourly Annual Temperature
Free-Float Cases



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
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Figure B8-17. BESTEST BASIC
South Window Shading (Delta)
Annual Heating and Sensible Cooling

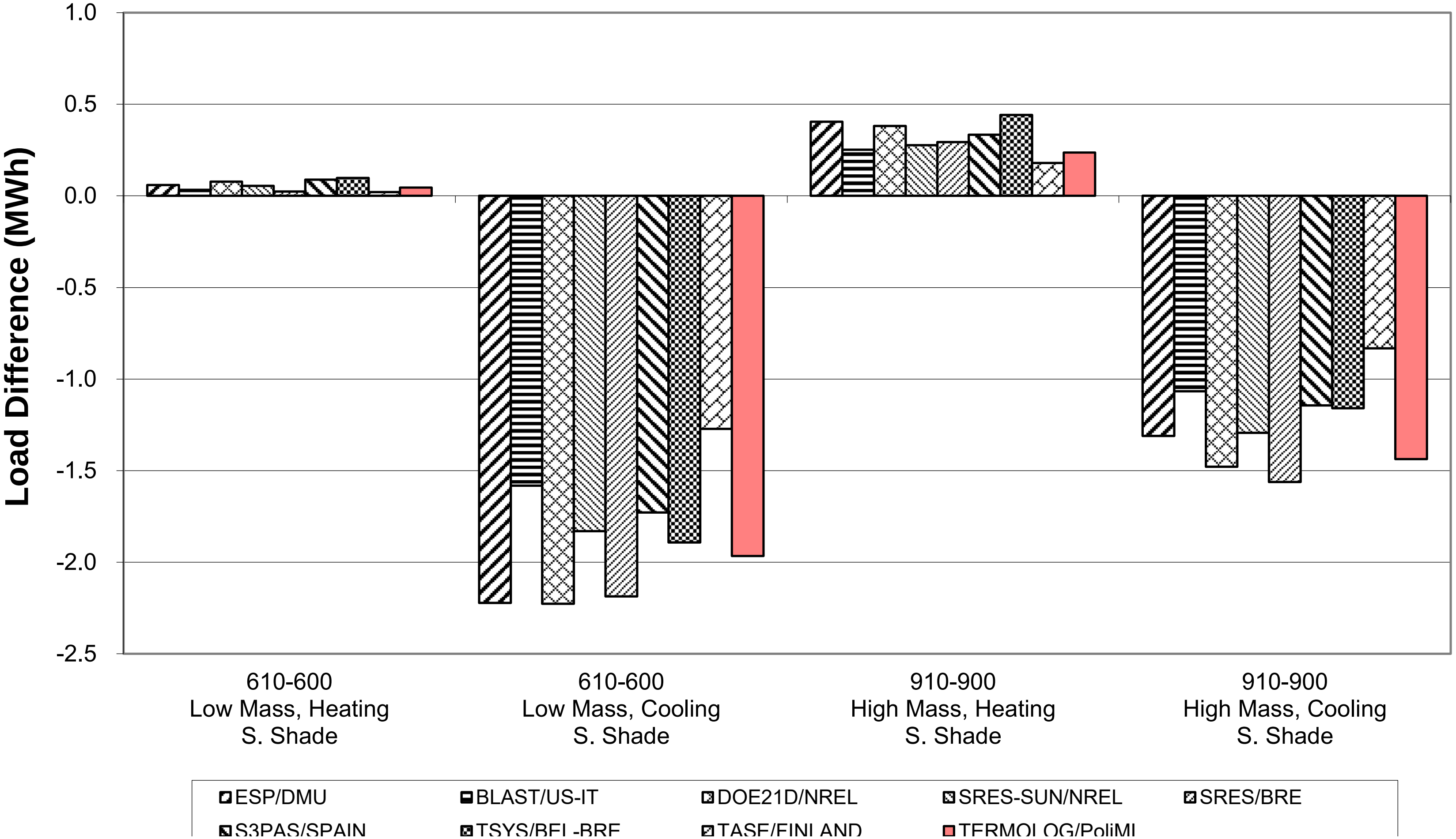
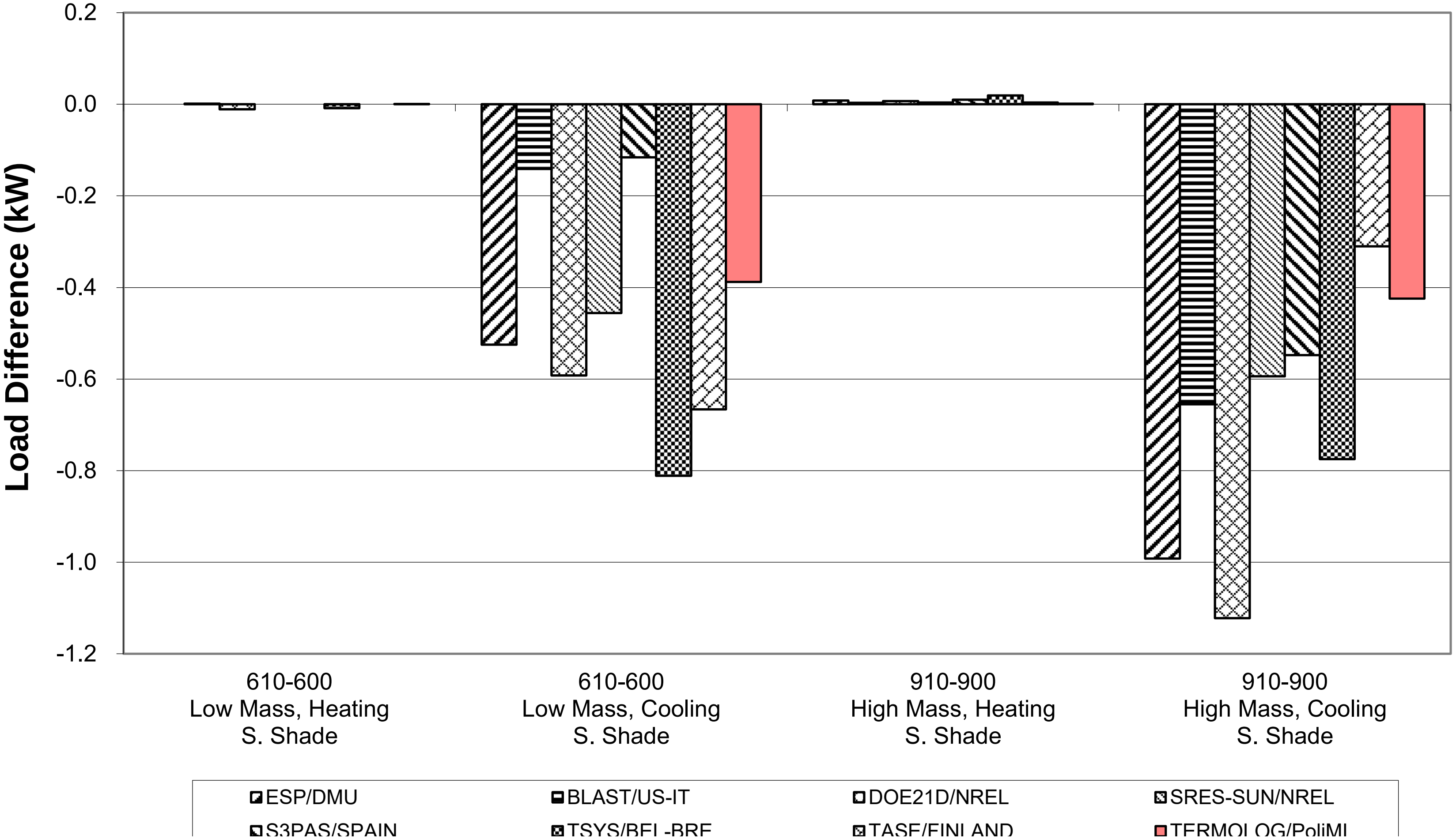
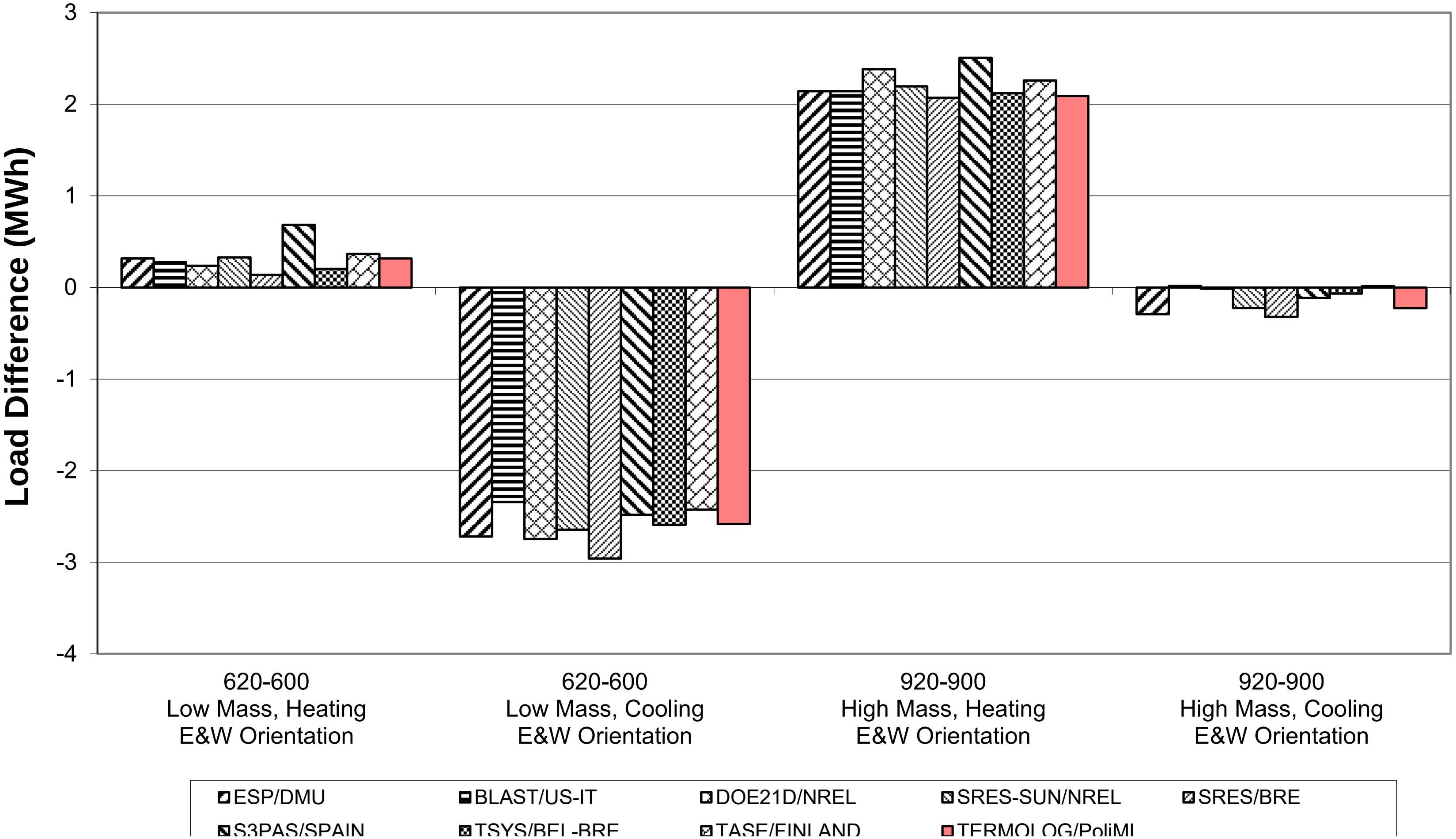


Figure B8-18. BESTEST BASIC
South Window Shading (Delta)
Peak Heating and Sensible Cooling



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-19. BESTEST BASIC
East & West Window (Delta)
Annual Heating and Sensible Cooling



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-20. BESTEST BASIC
East & West Window (Delta)
Peak Heating and Sensible Cooling

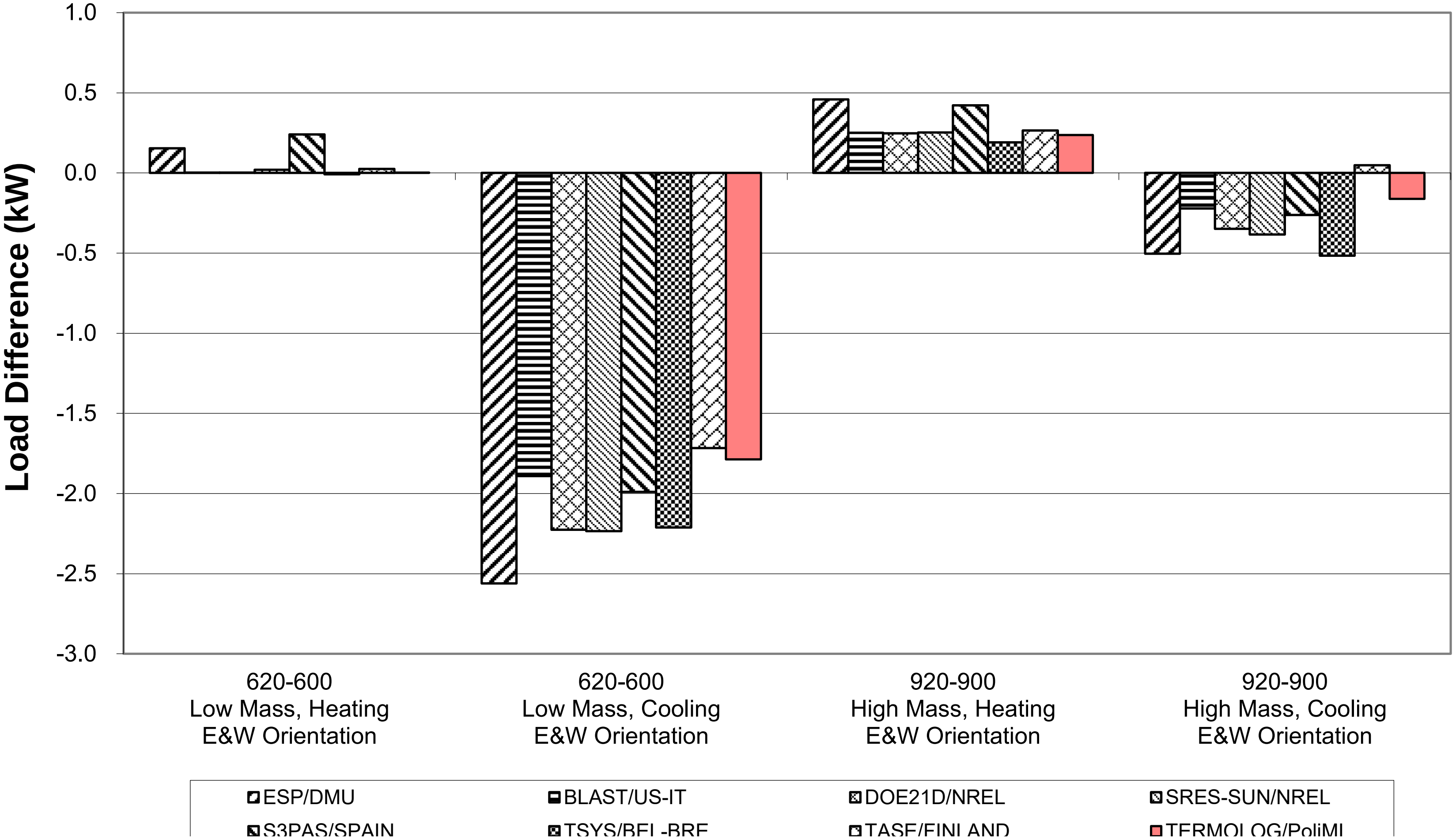
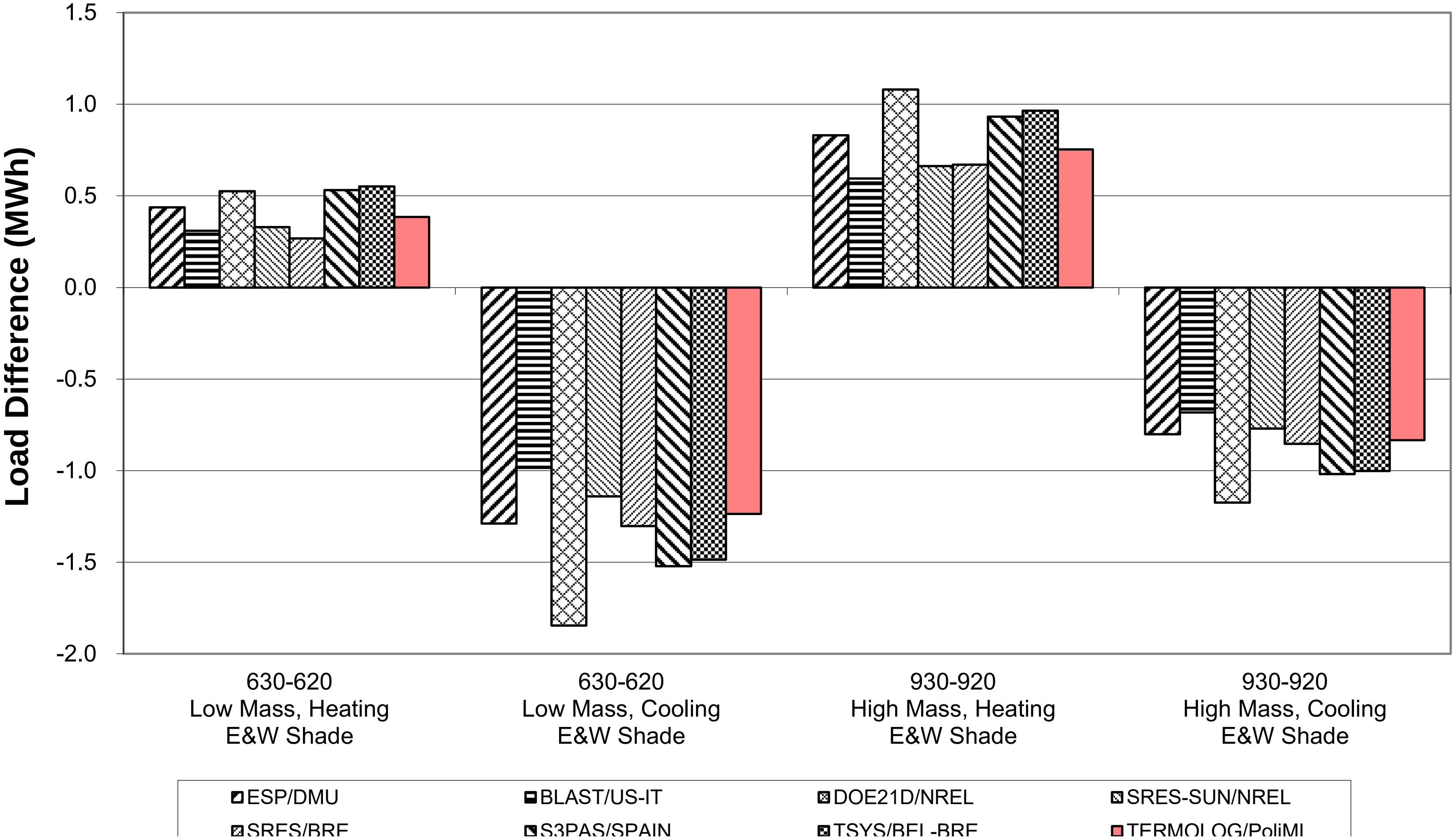


Figure B8-21. BESTEST BASIC East & West Shaded Window (Delta) Annual Heating and Sensible Cooling



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-22. BESTEST BASIC East & West Shaded Window (Delta) Peak Heating and Sensible Cooling

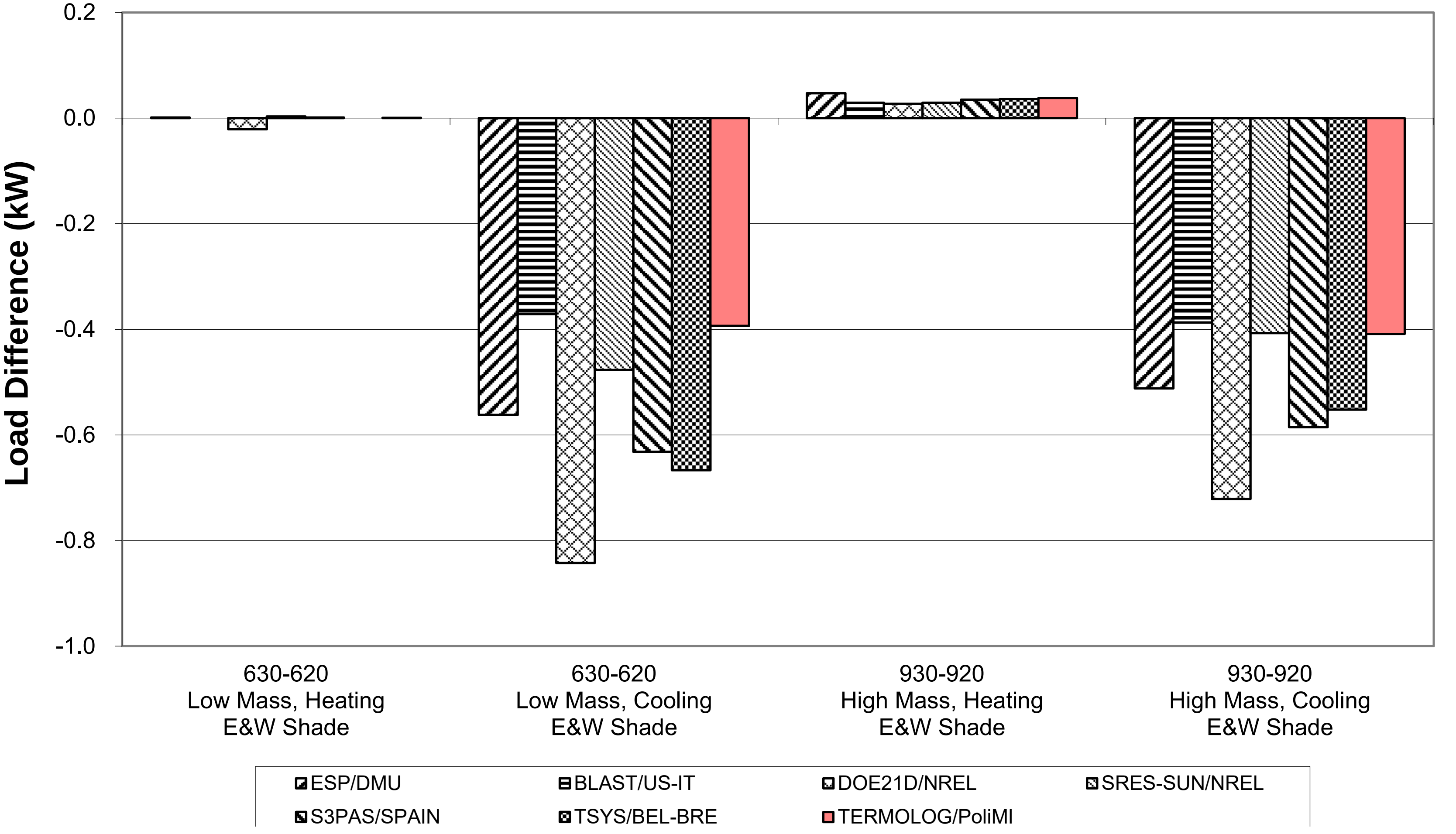
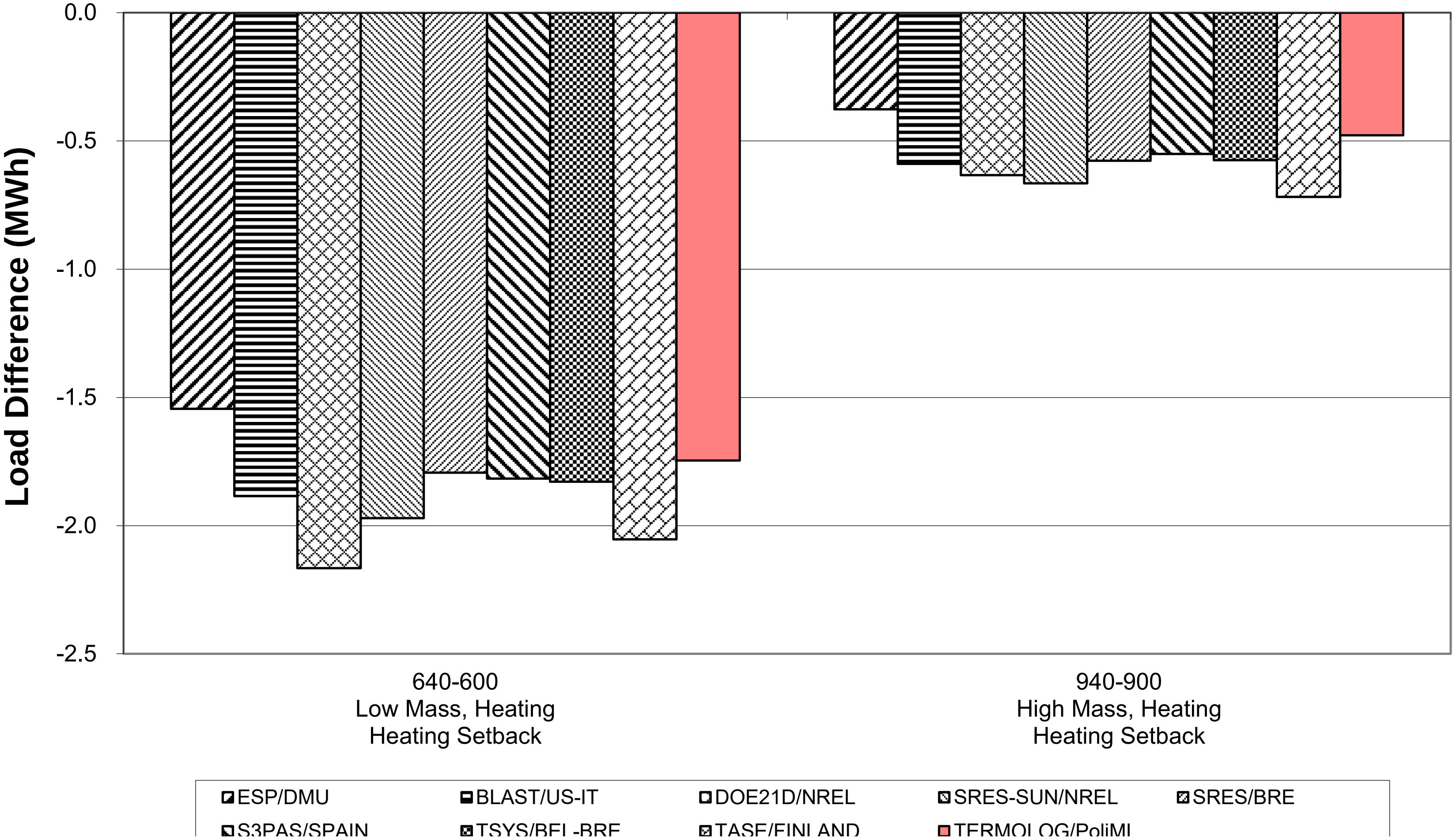


Figure B8-23. BESTEST BASIC Thermostat Setback (Delta) Annual Heating



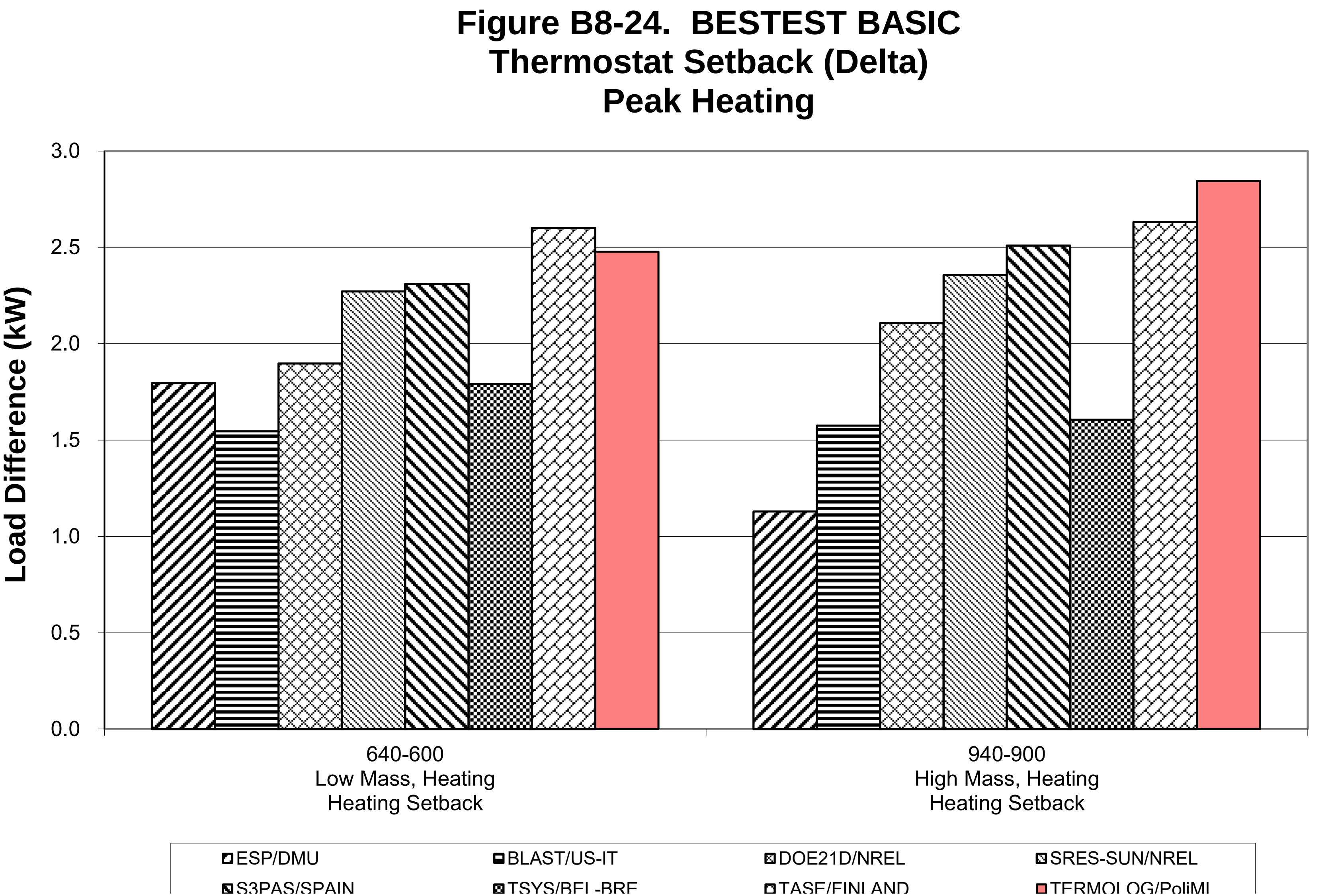


Figure B8-24. BESTEST BASIC
Thermostat Setback (Delta)
Peak Heating
Load Difference (kW)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
640-600
Low Mass, Heating
Heating Setback
940-900
High Mass, Heating
Heating Setback
ESP/DMU
BLAST/US-IT
DOE21D/NREL
SRES-SUN/NREL
S3PAS/SPAIN
TSYS/BEL-BRE
TASE/FINLAND
TERMOLOG/PoliMI

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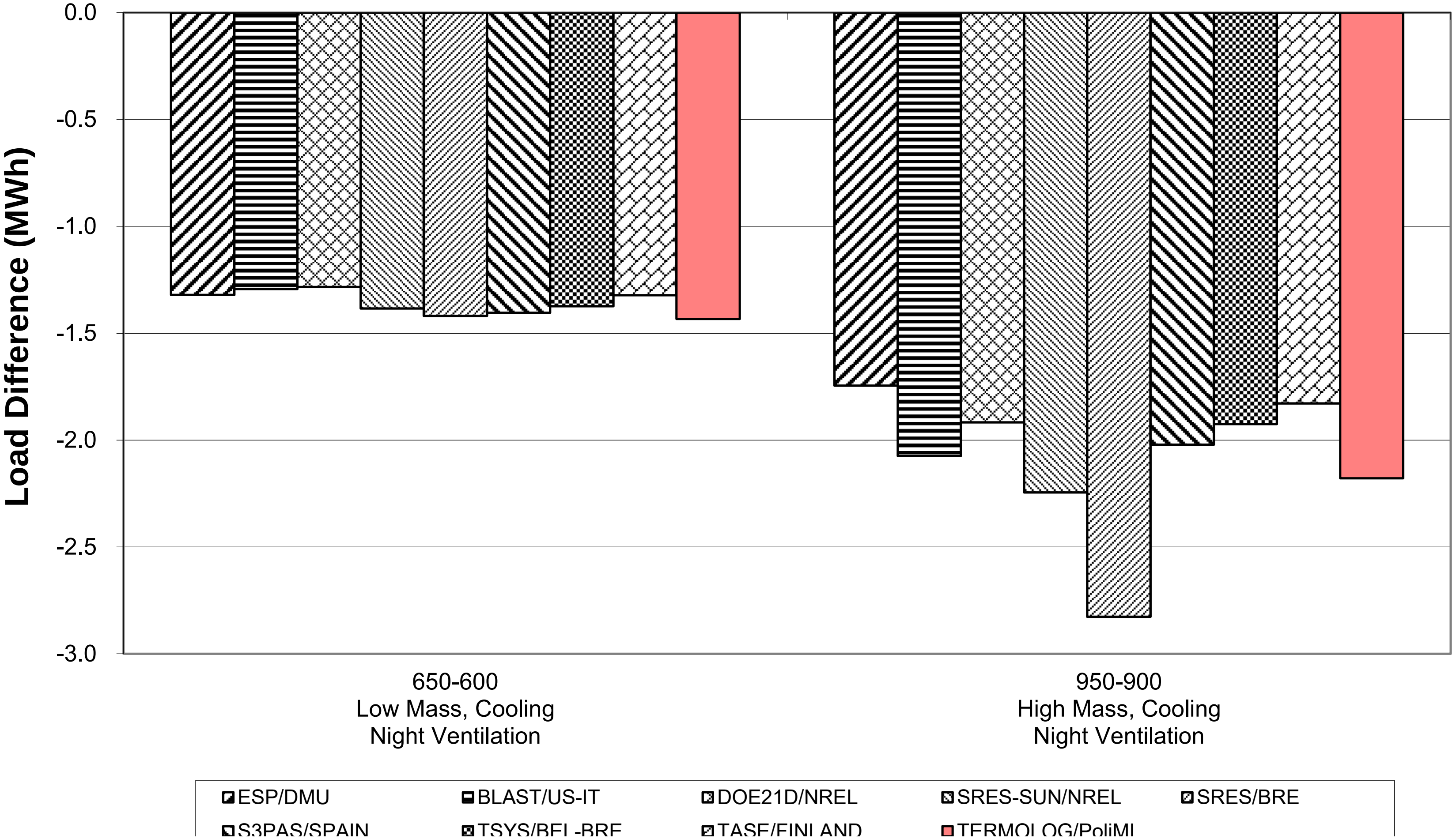
Figure B8-25. BESTEST BASIC
Vent Cooling (Delta)
Annual Sensible Cooling



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-26. BESTEST BASIC
Vent Cooling (Delta)
Peak Sensible Cooling

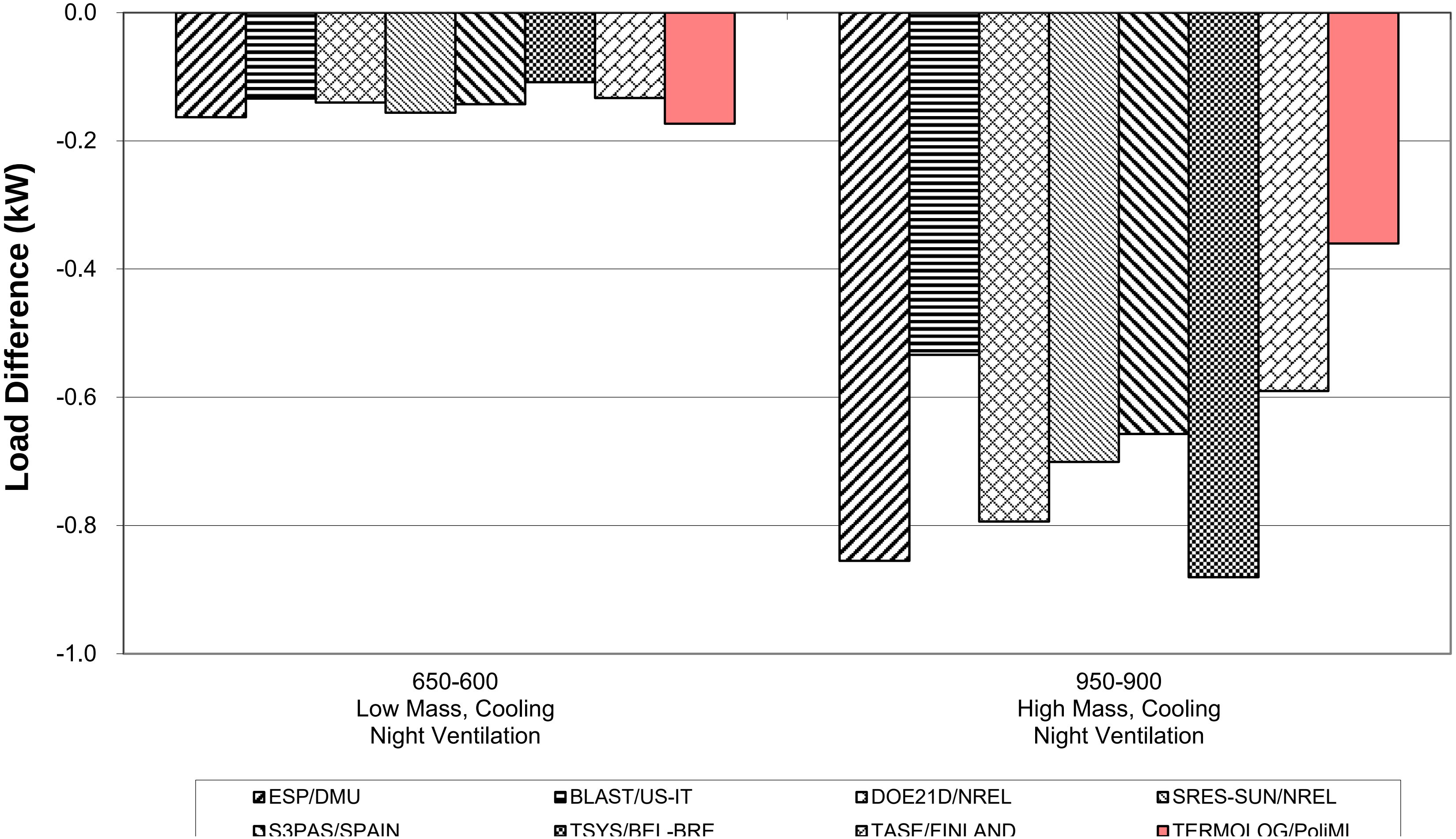
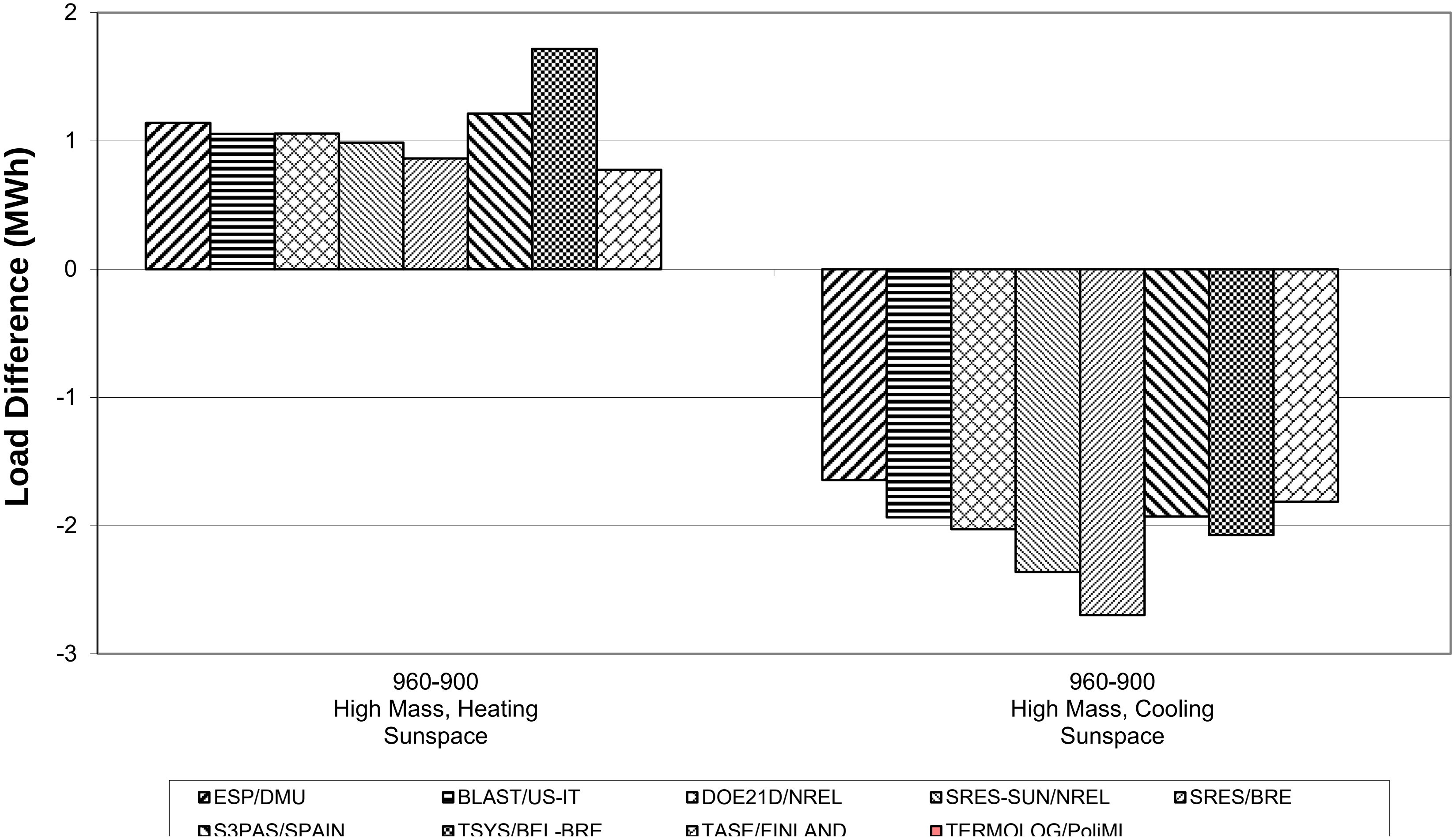
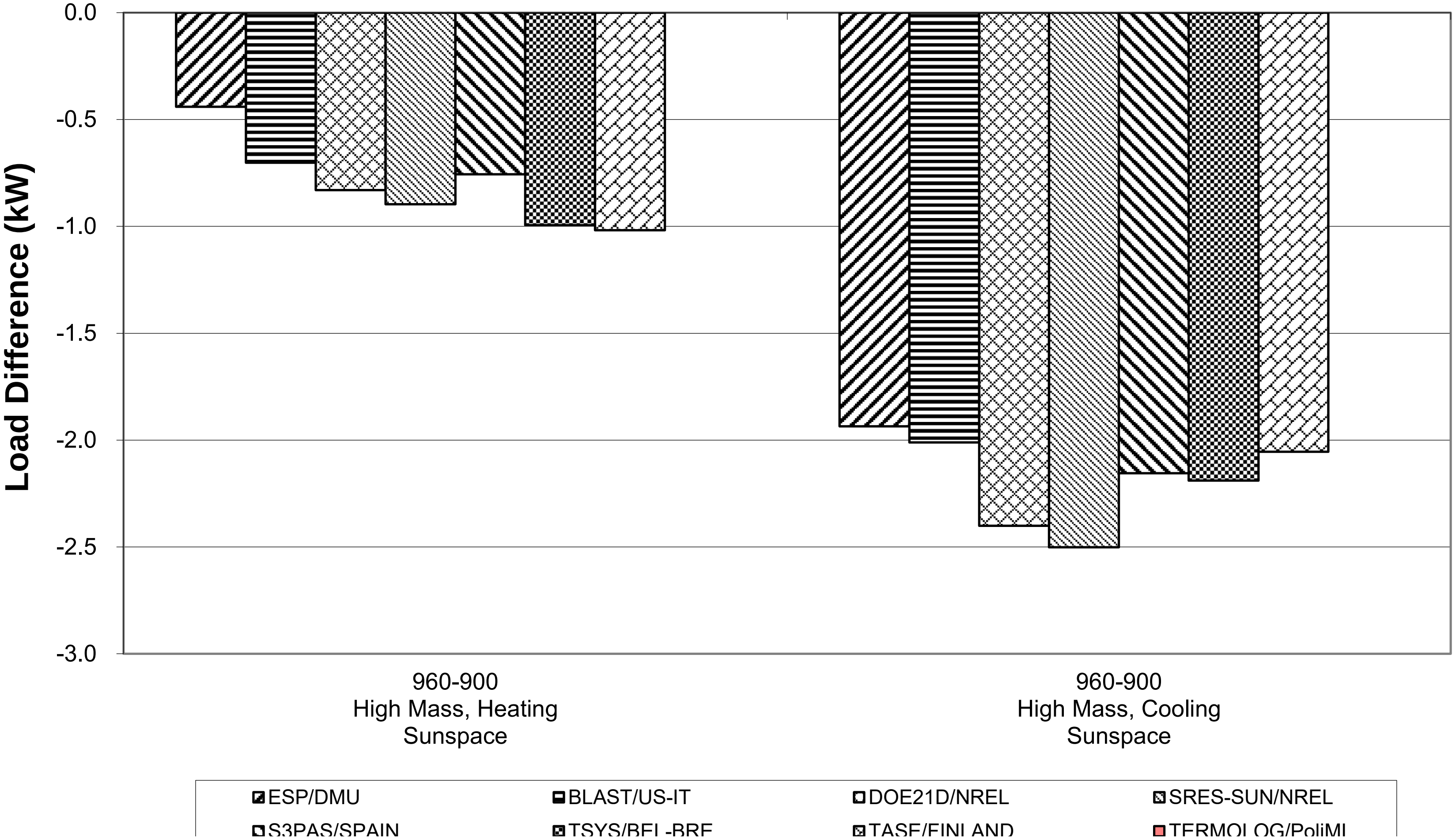


Figure B8-27. BESTEST BASIC Sunspace (Delta) Annual Heating and Sensible Cooling



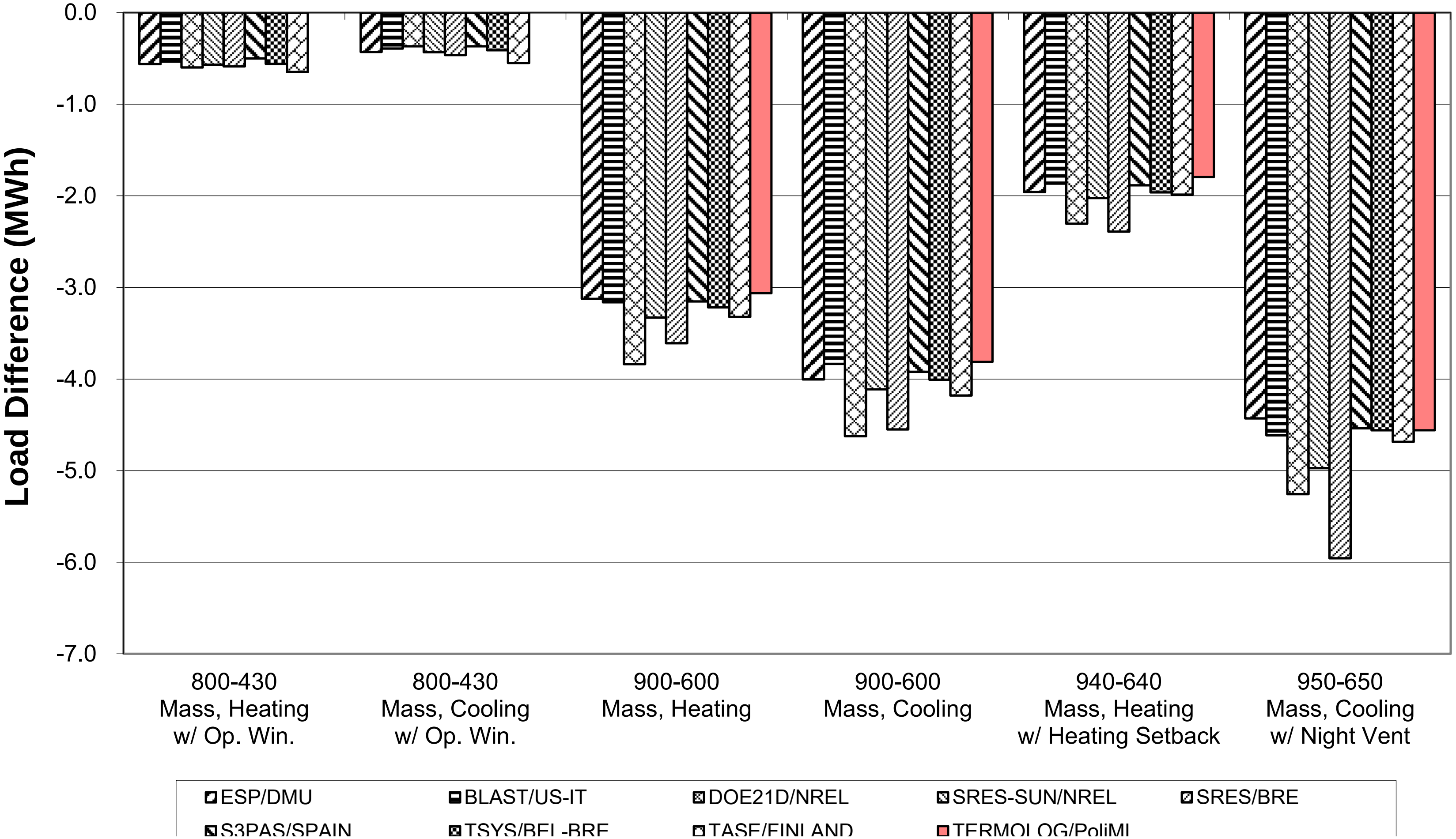
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-28. BESTEST BASIC Sunspace (Delta) Peak Heating and Sensible Cooling



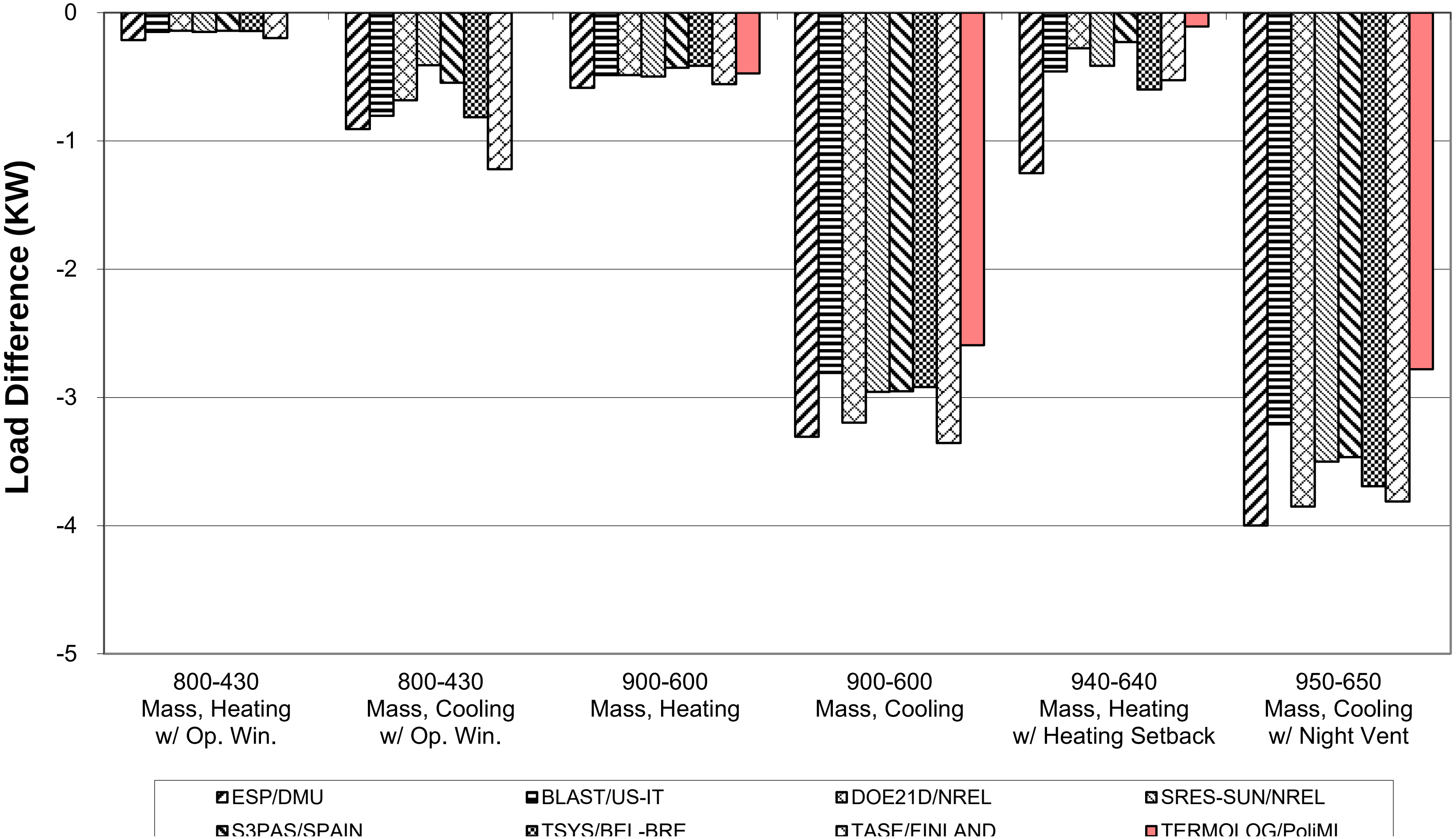
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-29. BESTEST BASIC AND IN-DEPTH
Mass Effect (Delta)
Annual Heating and Sensible Cooling



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-30. BESTEST BASIC AND IN-DEPTH
Mass Effect (Delta)
Peak Heating and Sensible Cooling



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-31. BESTEST IN-DEPTH
South Window (Delta)
Annual Heating and Sensible Cooling

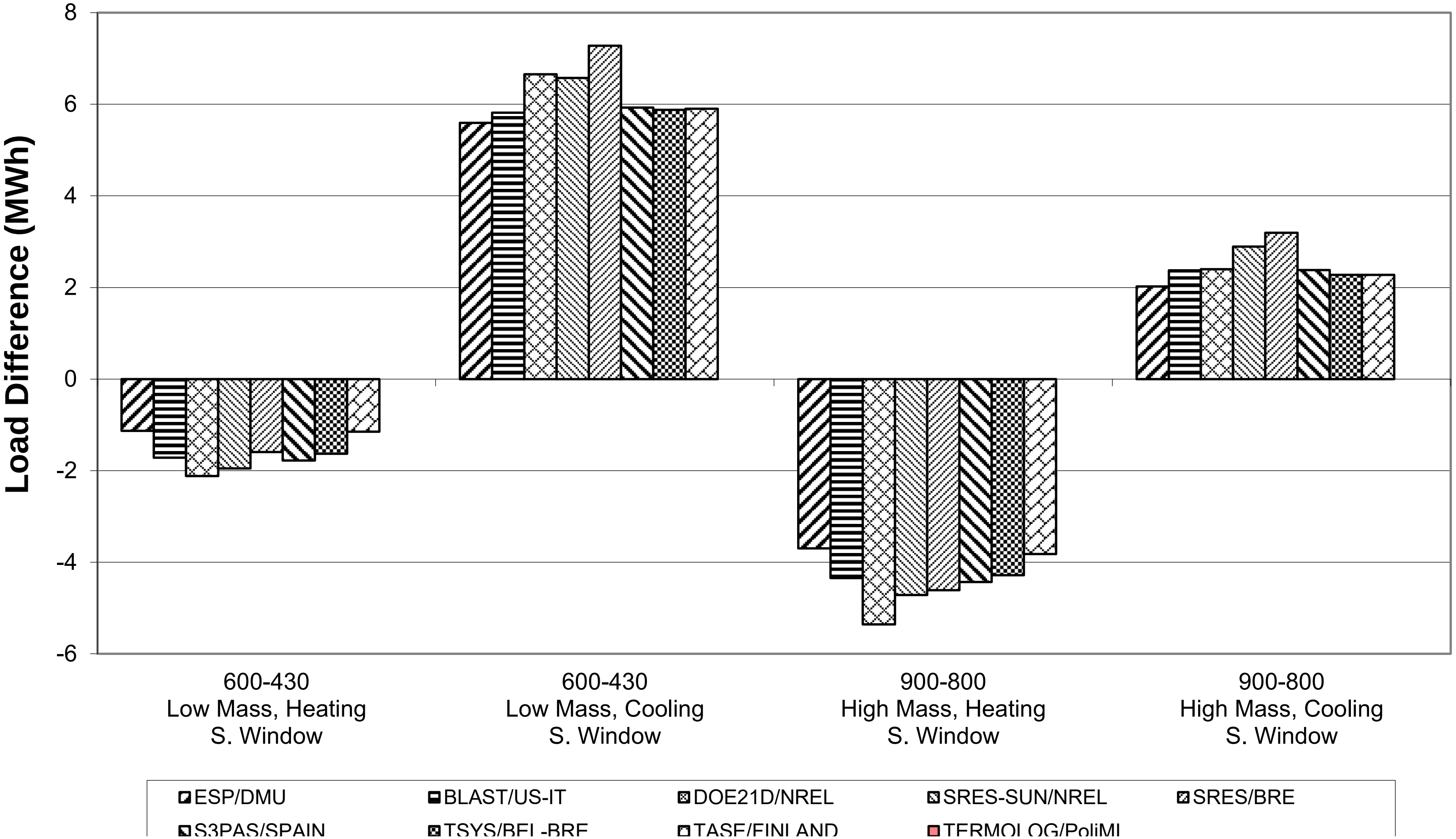
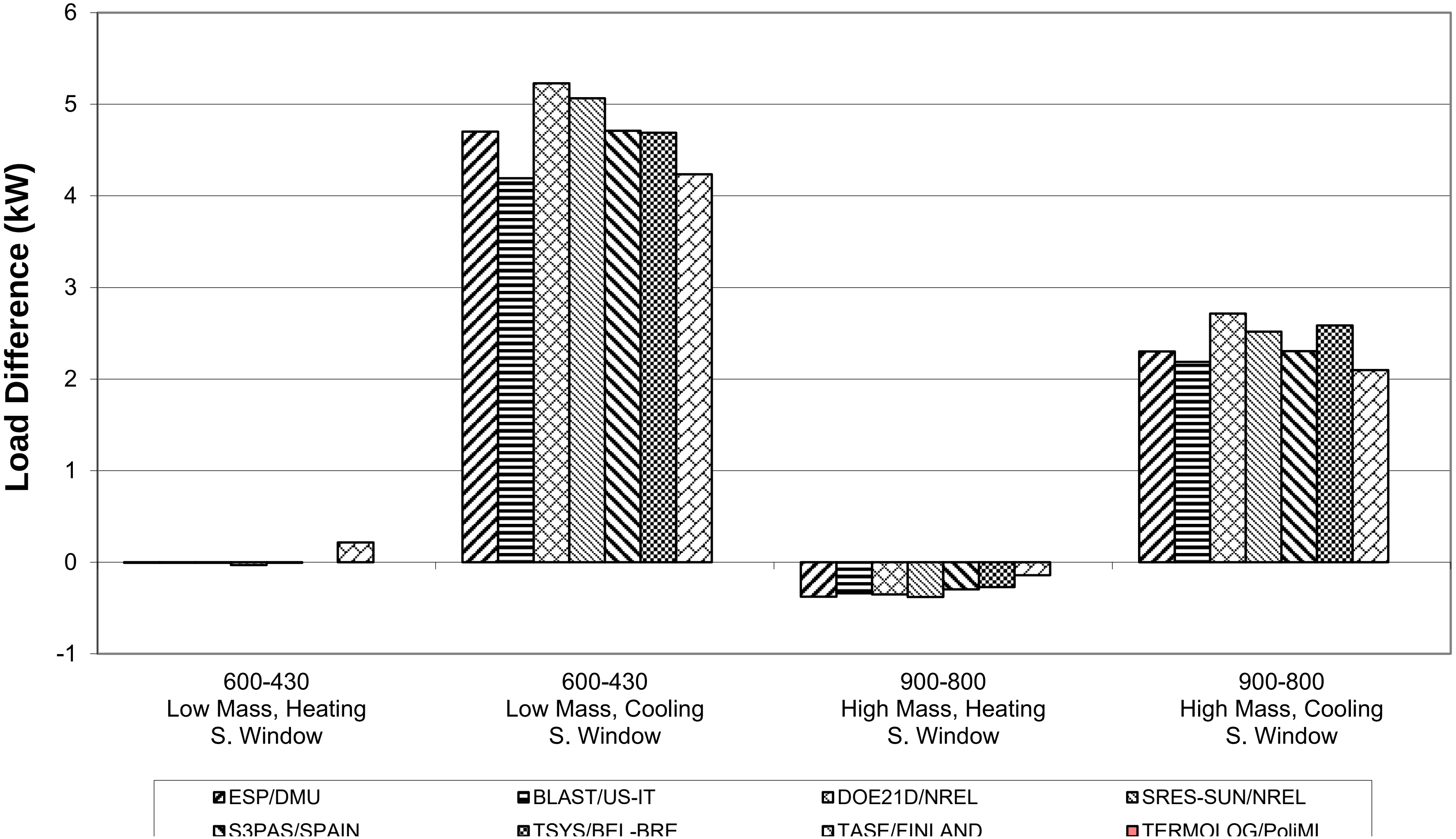


Figure B8-32. BESTEST IN-DEPTH
South Window (Delta)
Peak Heating and Sensible Cooling



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-33. BESTEST IN-DEPTH
Low Mass Annual Heating
Cases 195 to 250

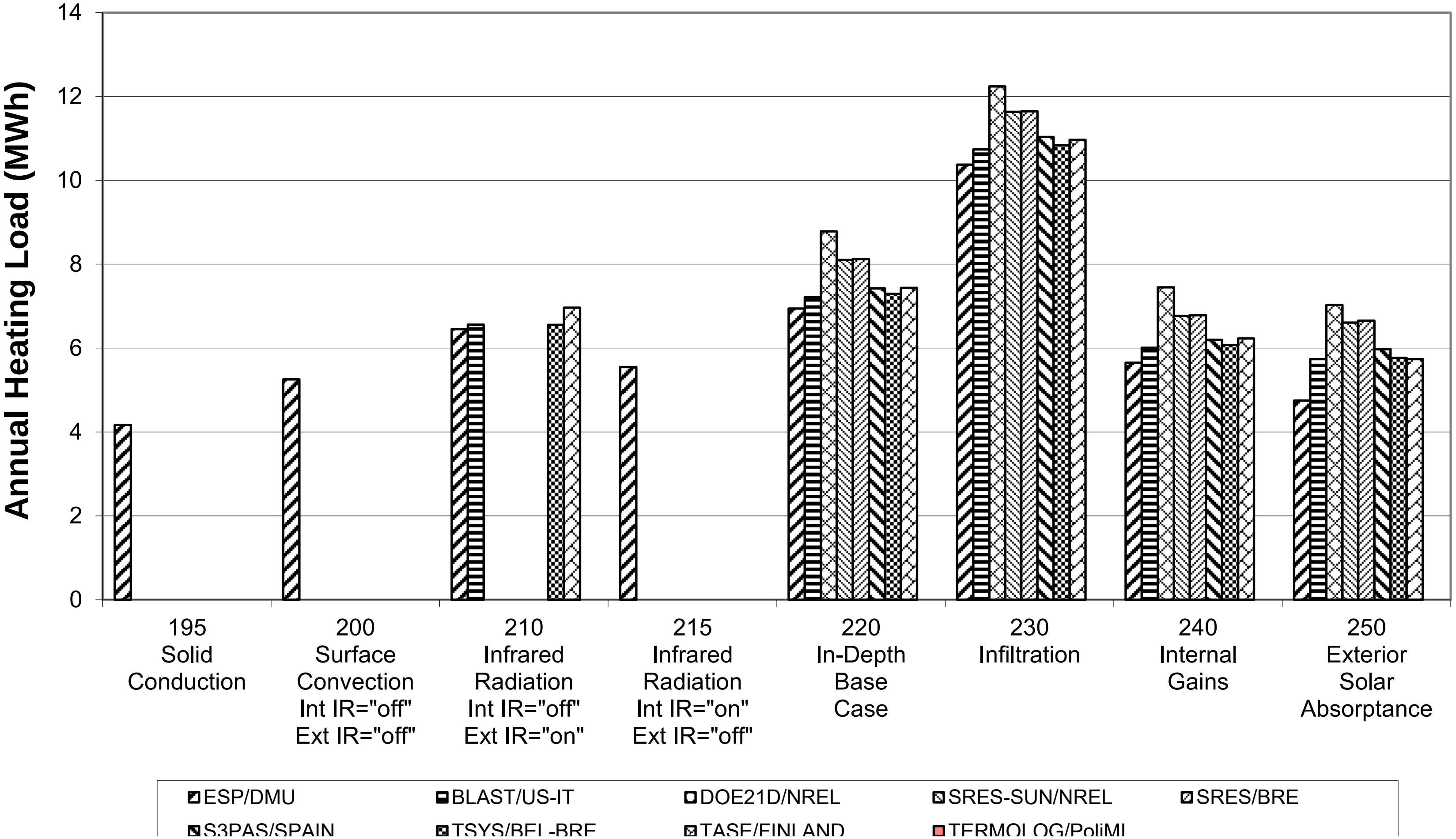
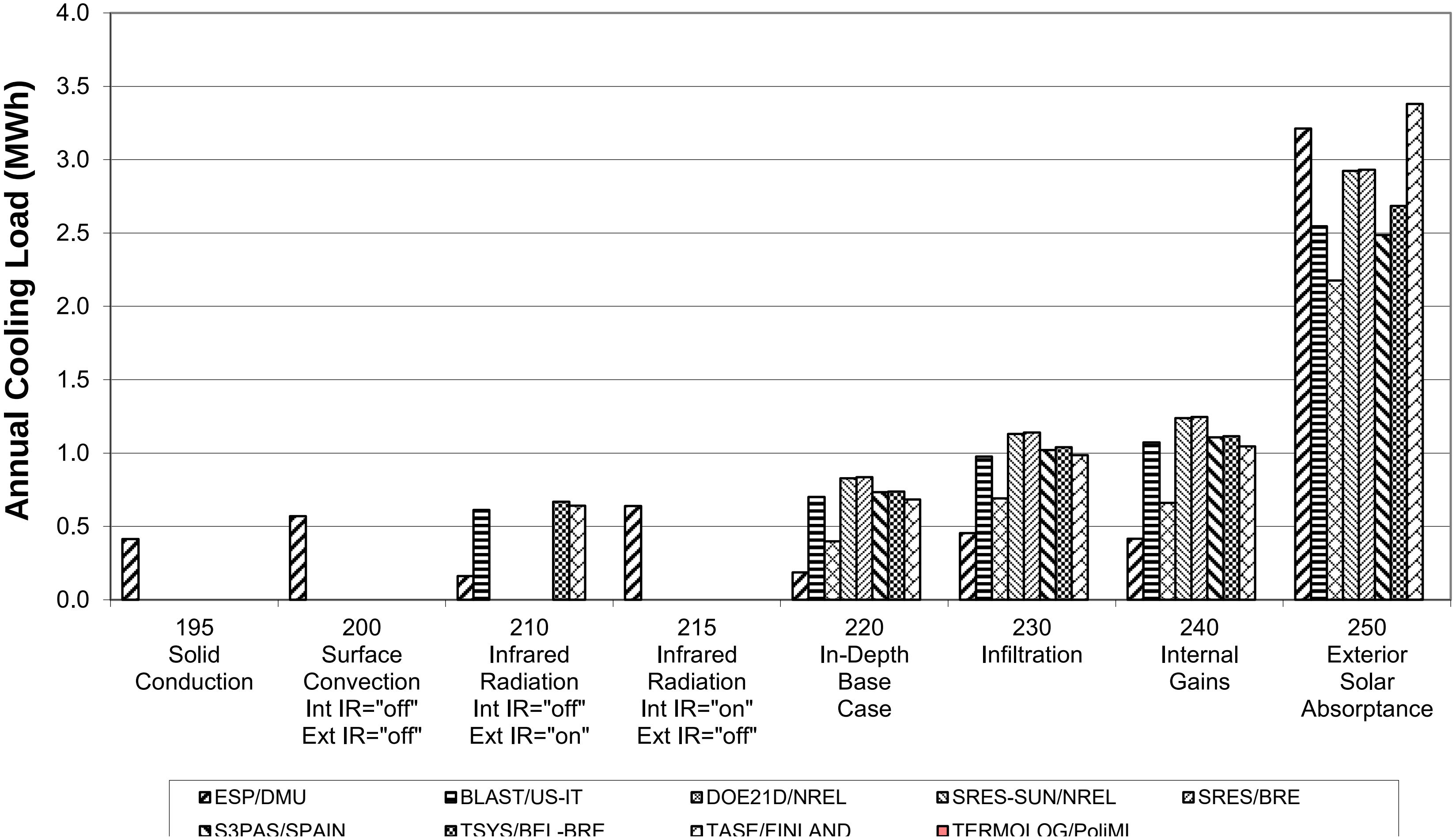
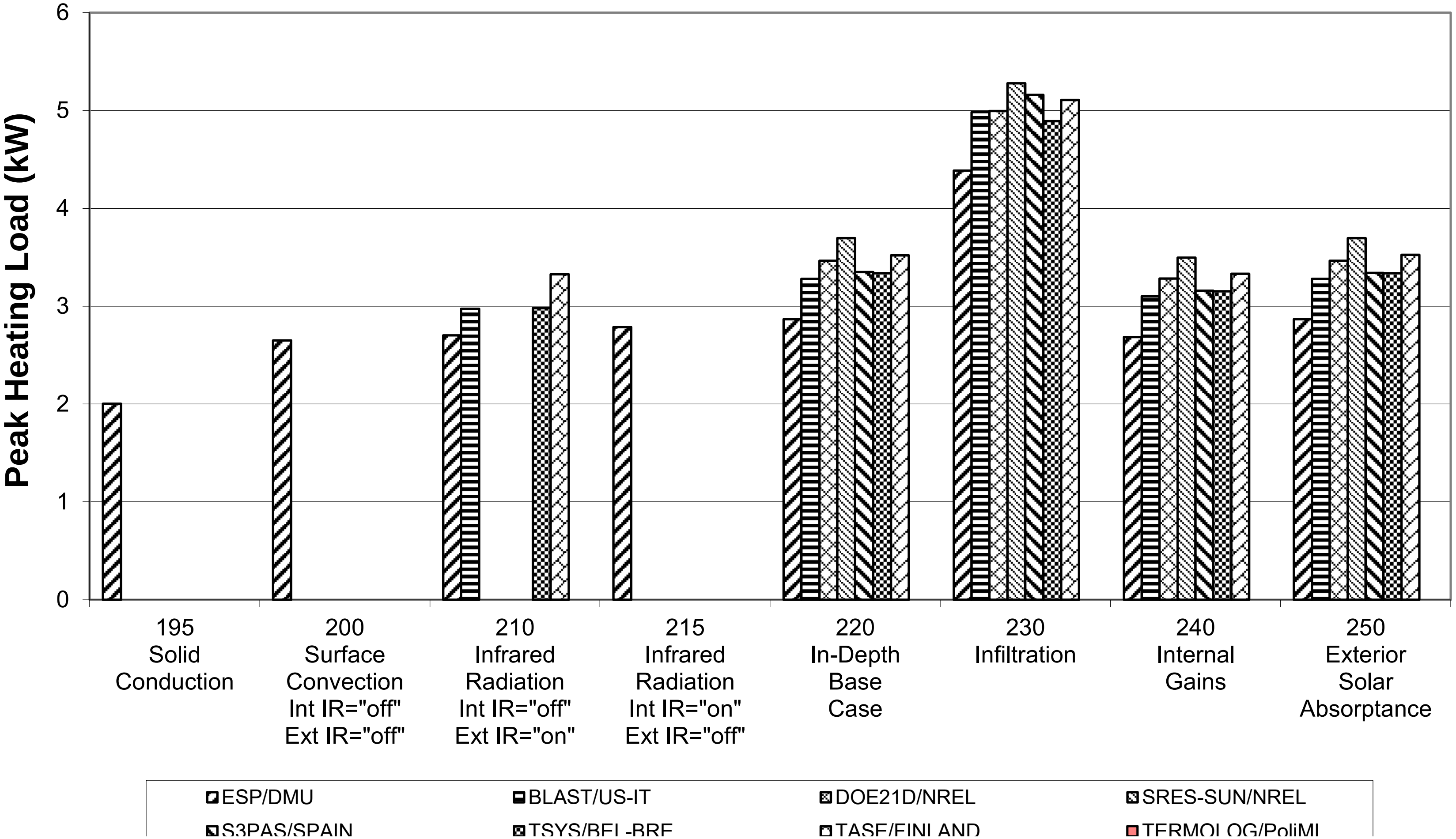


Figure B8-34. BESTEST IN-DEPTH Low Mass Annual Sensible Cooling Cases 195 to 250



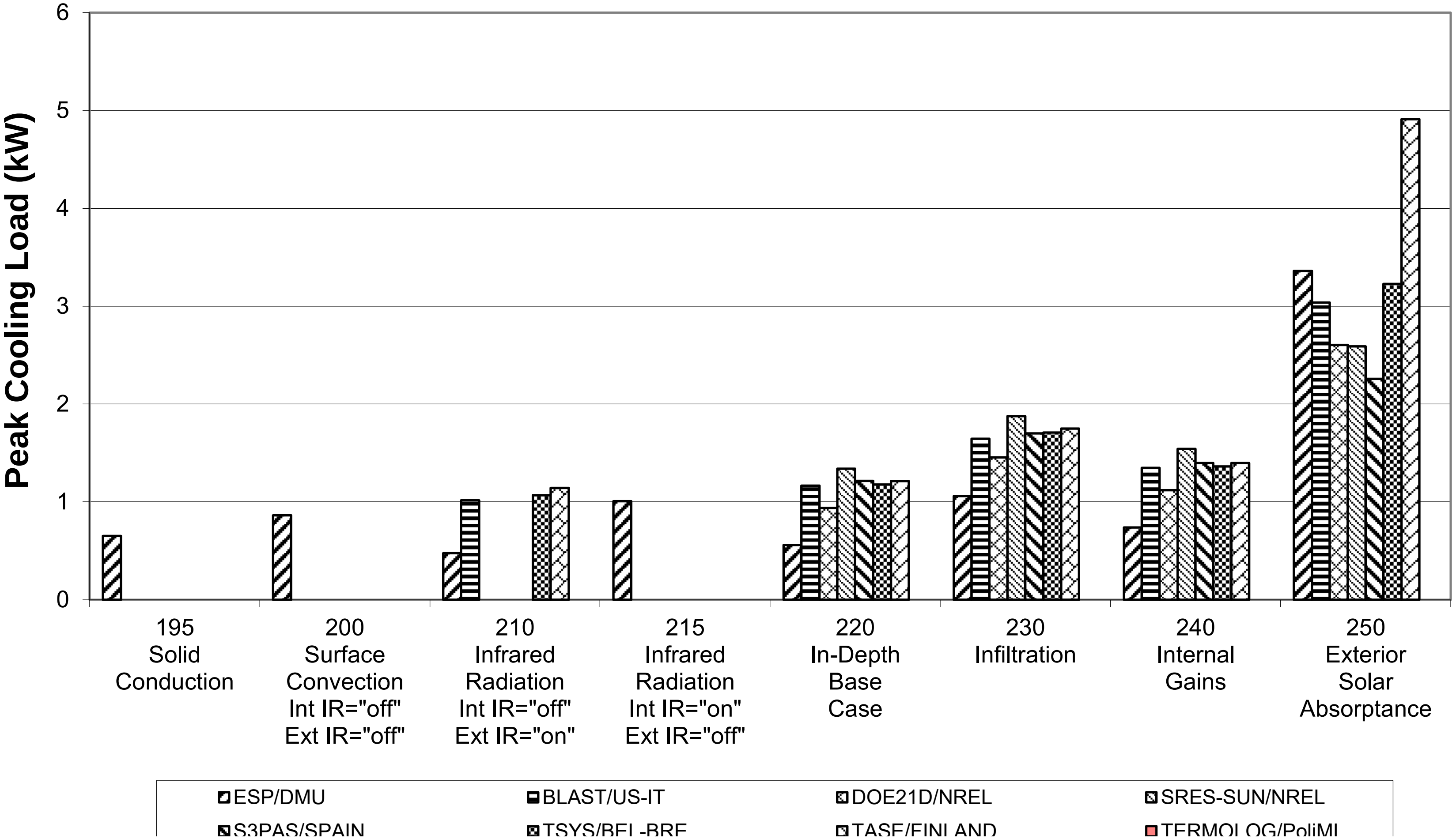
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-35. BESTEST IN-DEPTH
Low Mass Peak Heating
Cases 195 to 250



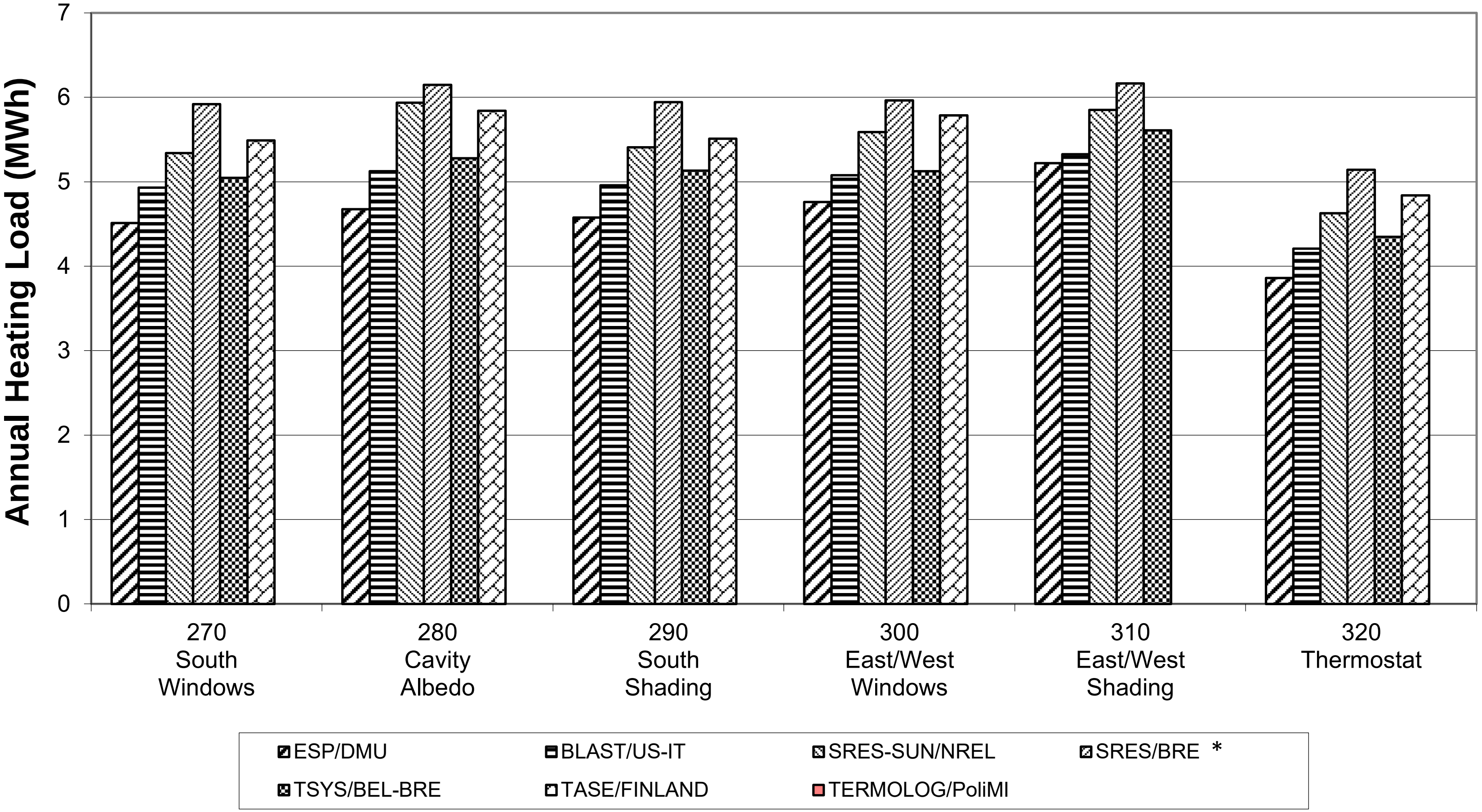
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-36. BESTEST IN-DEPTH Low Mass Peak Sensible Cooling Cases 195 to 250



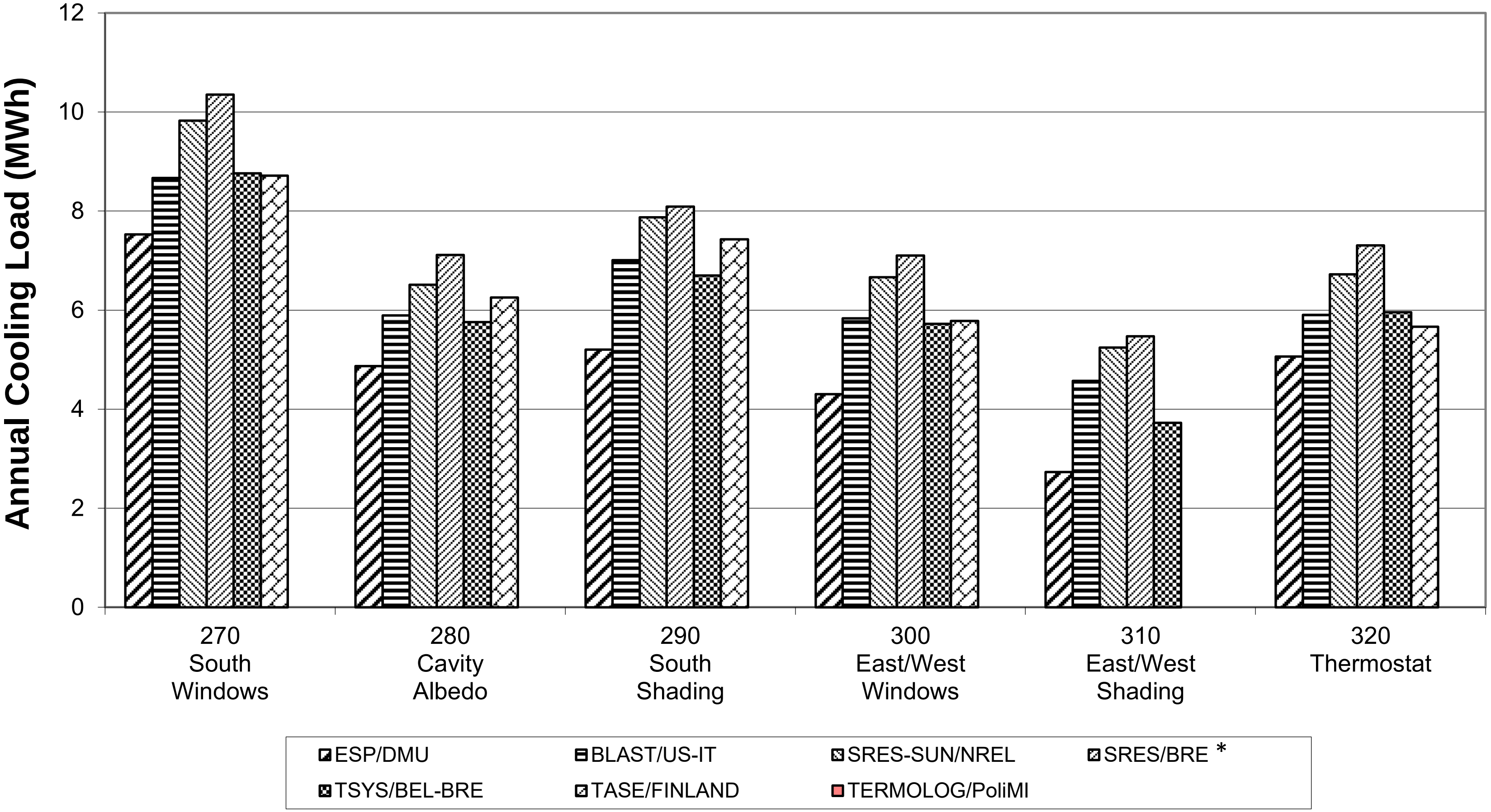
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-37. BESTEST IN-DEPTH Low Mass Annual Heating Cases 270 to 320



* SRES/BRE Cases 270, 290-320 have input error likely affecting results by <0.2 MWh/y (<3%)

Figure B8-38. BESTEST IN-DEPTH Low Mass Annual Sensible Cooling Cases 270 to 320



* SRES/BRE Cases 270, 290-320 have input error likely affecting results by <0.2 MWh/y (<3%)

ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
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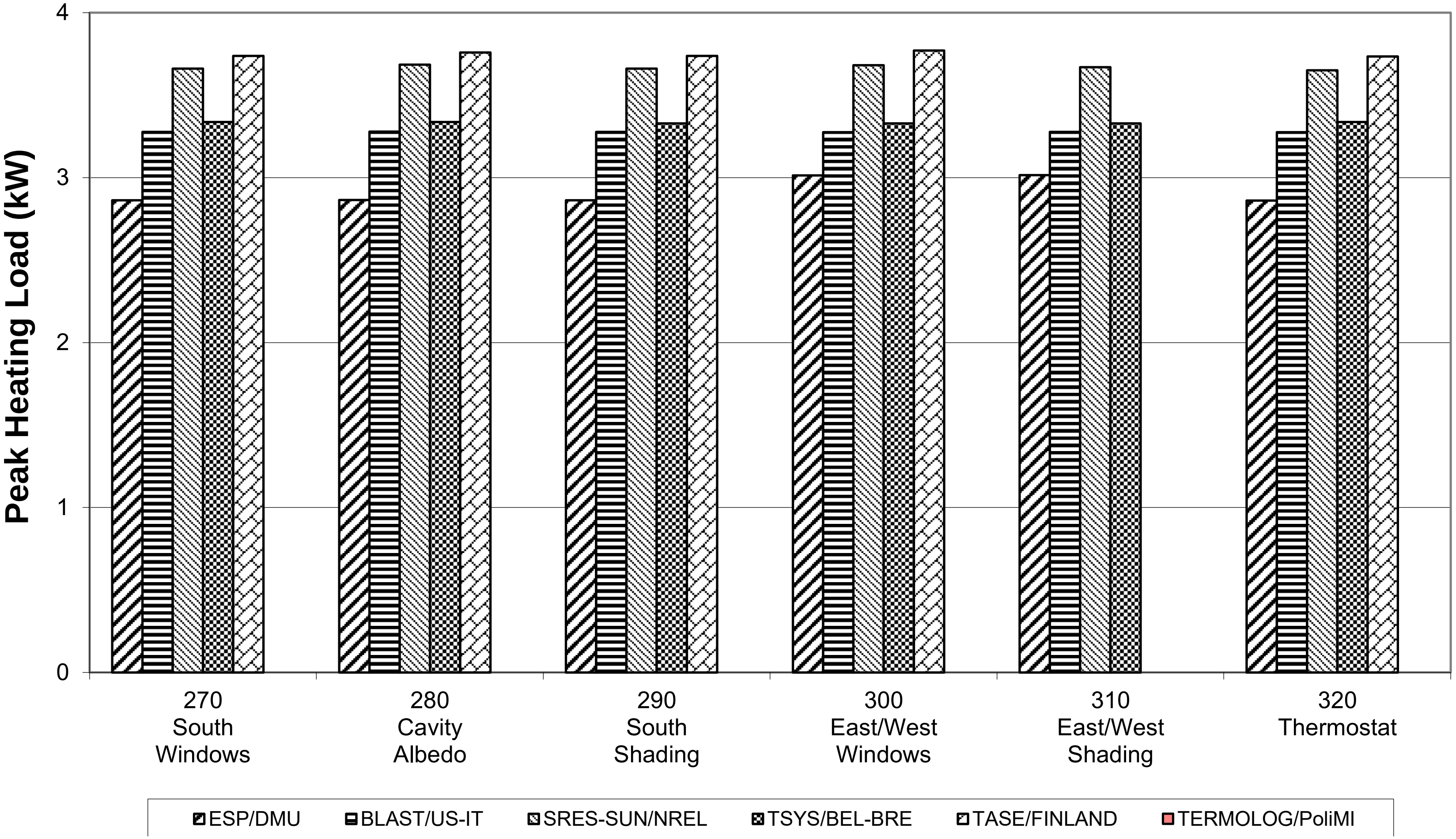
Figure B8-39. BESTEST IN-DEPTH
Low Mass Peak Heating
Cases 270 to 320



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-40. BESTEST IN-DEPTH Low Mass Peak Sensible Cooling Cases 270 to 320

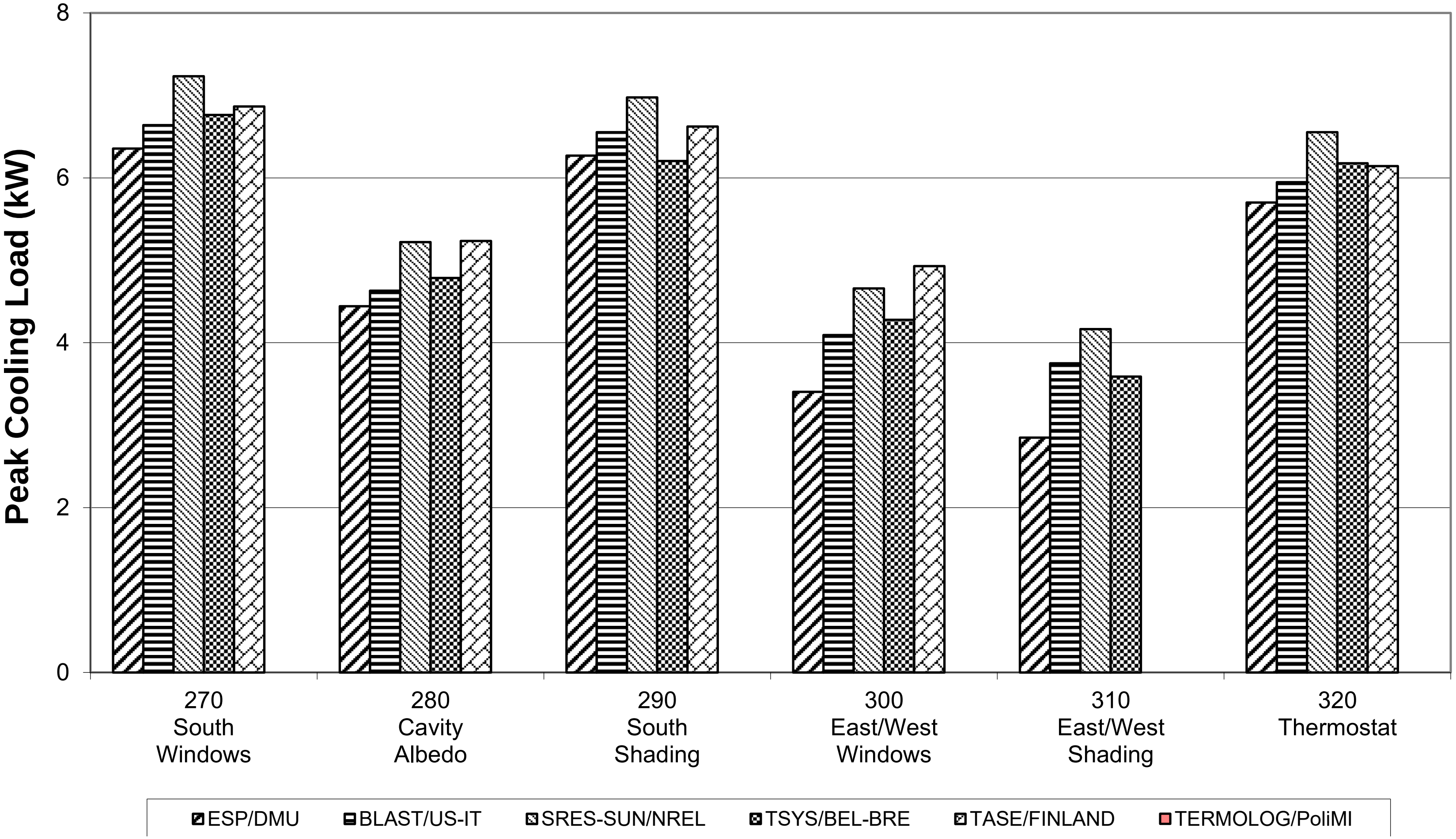
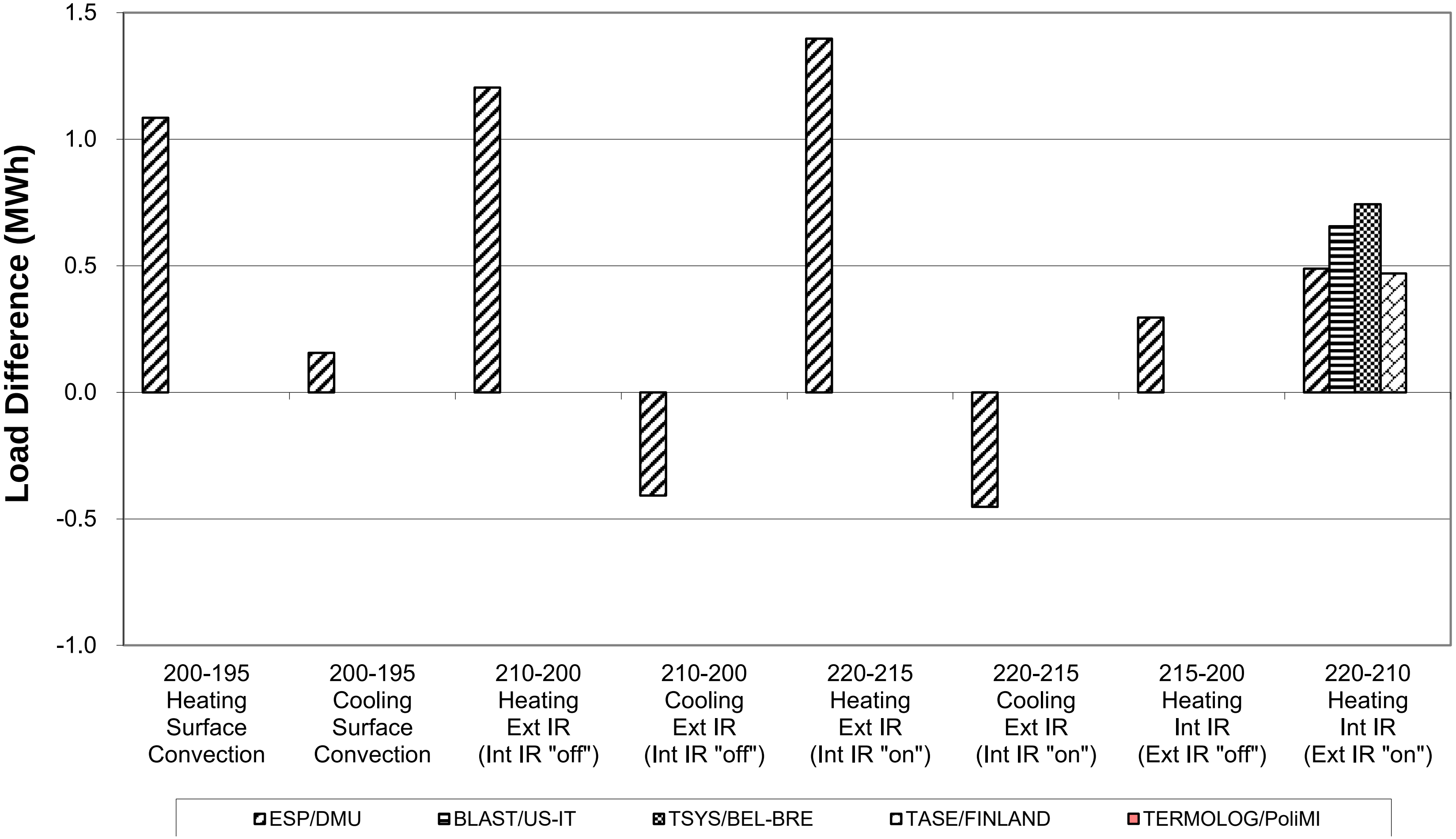
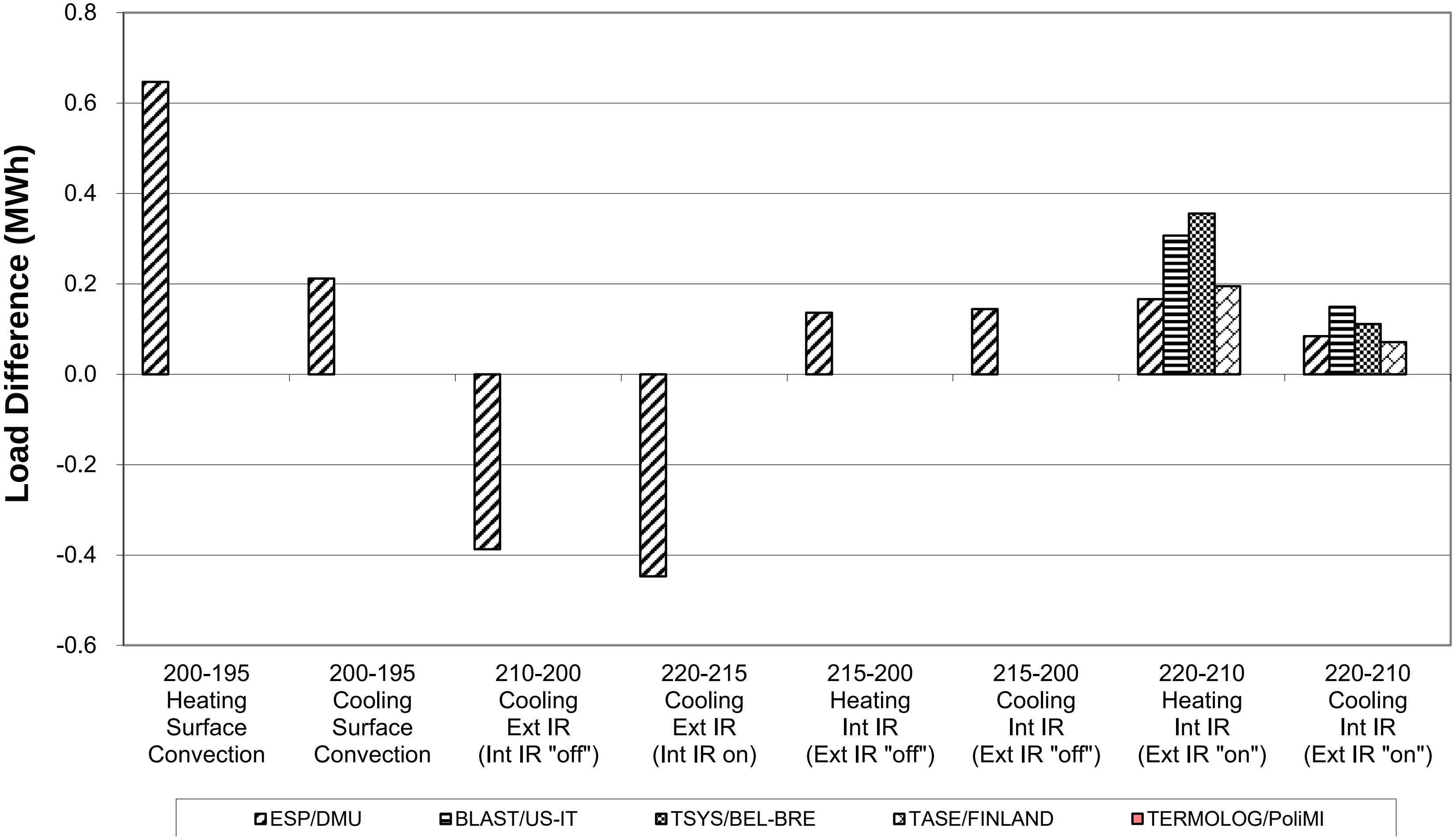


Figure B8-41. BESTEST IN-DEPTH
Cases 195 to 220 (Delta)
Annual Heating and Sensible Cooling



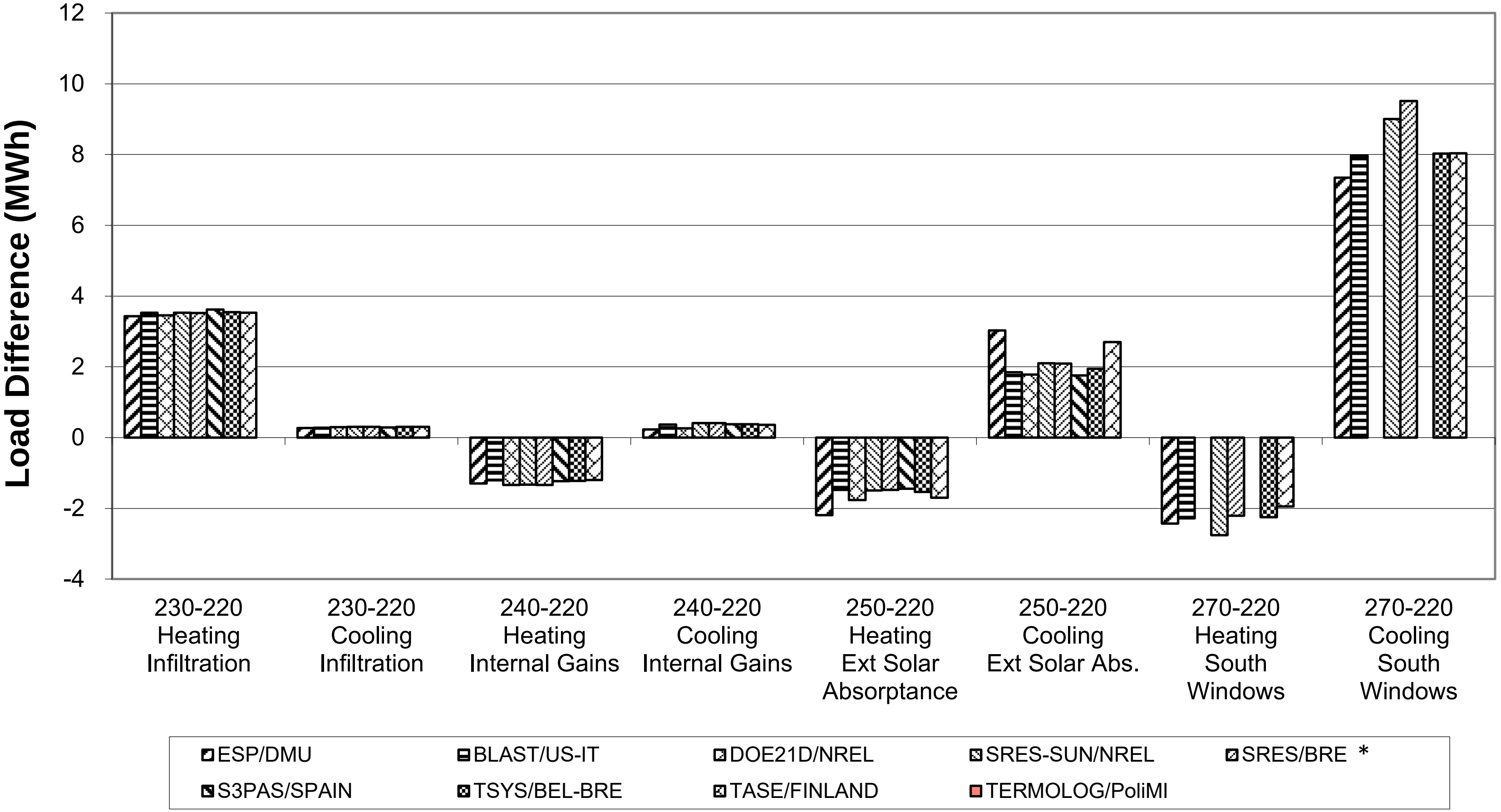
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-42. BESTEST IN-DEPTH
Cases 195 to 220 (Delta)
Peak Heating and Sensible Cooling



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-43. BESTEST IN-DEPTH Cases 220 to 270 (Delta) Annual Heating and Sensible Cooling



* SRES/BRE Case 270 has input error likely affecting 270-220 sensitivity results for heating by <0.2 MWh/y (<6%), and for cooling by <0.2 MWh/y (<3%)

Figure B8-44. BESTEST IN-DEPTH Cases 220 to 270 (Delta) Peak Heating and Sensible Cooling

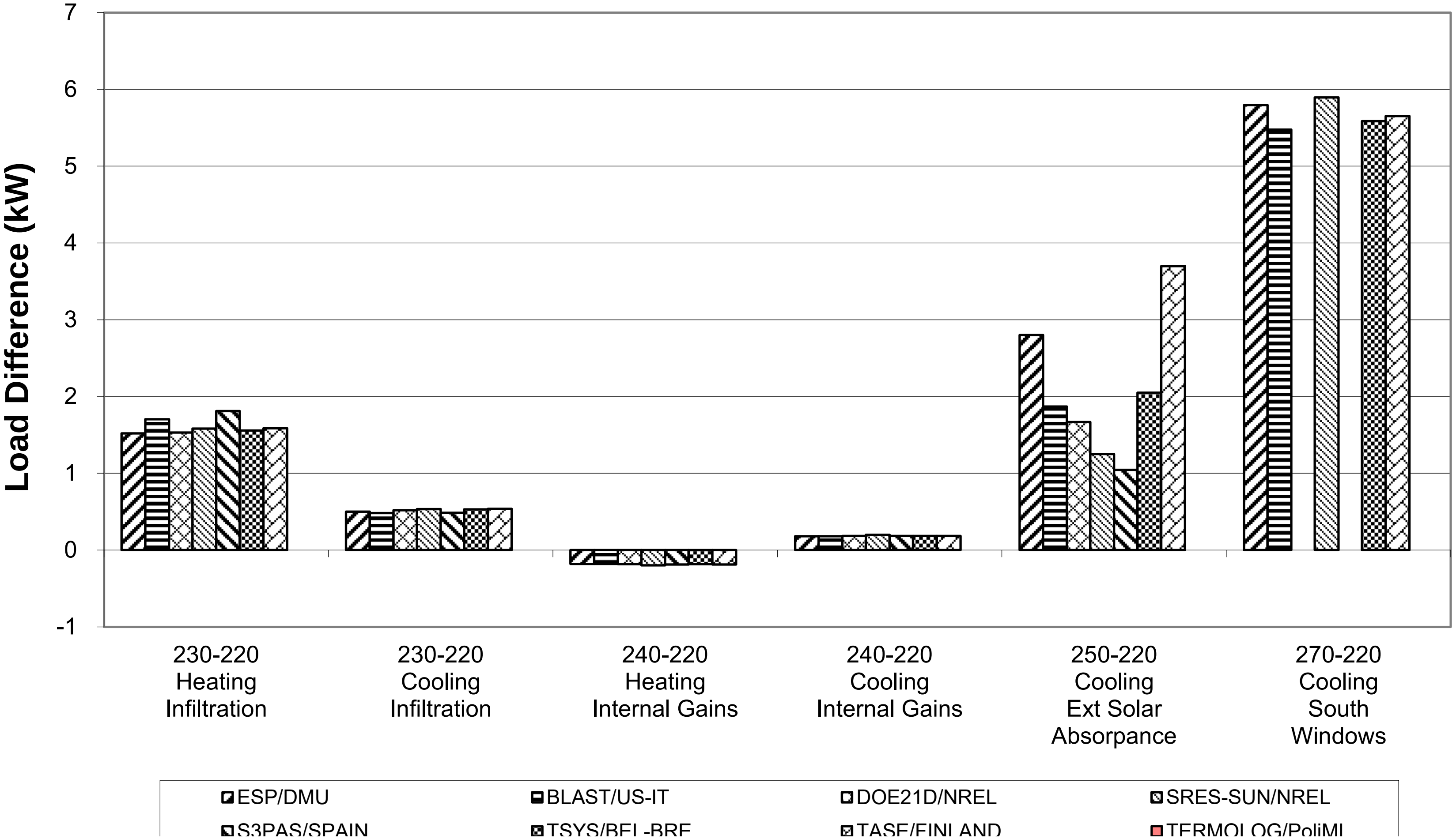
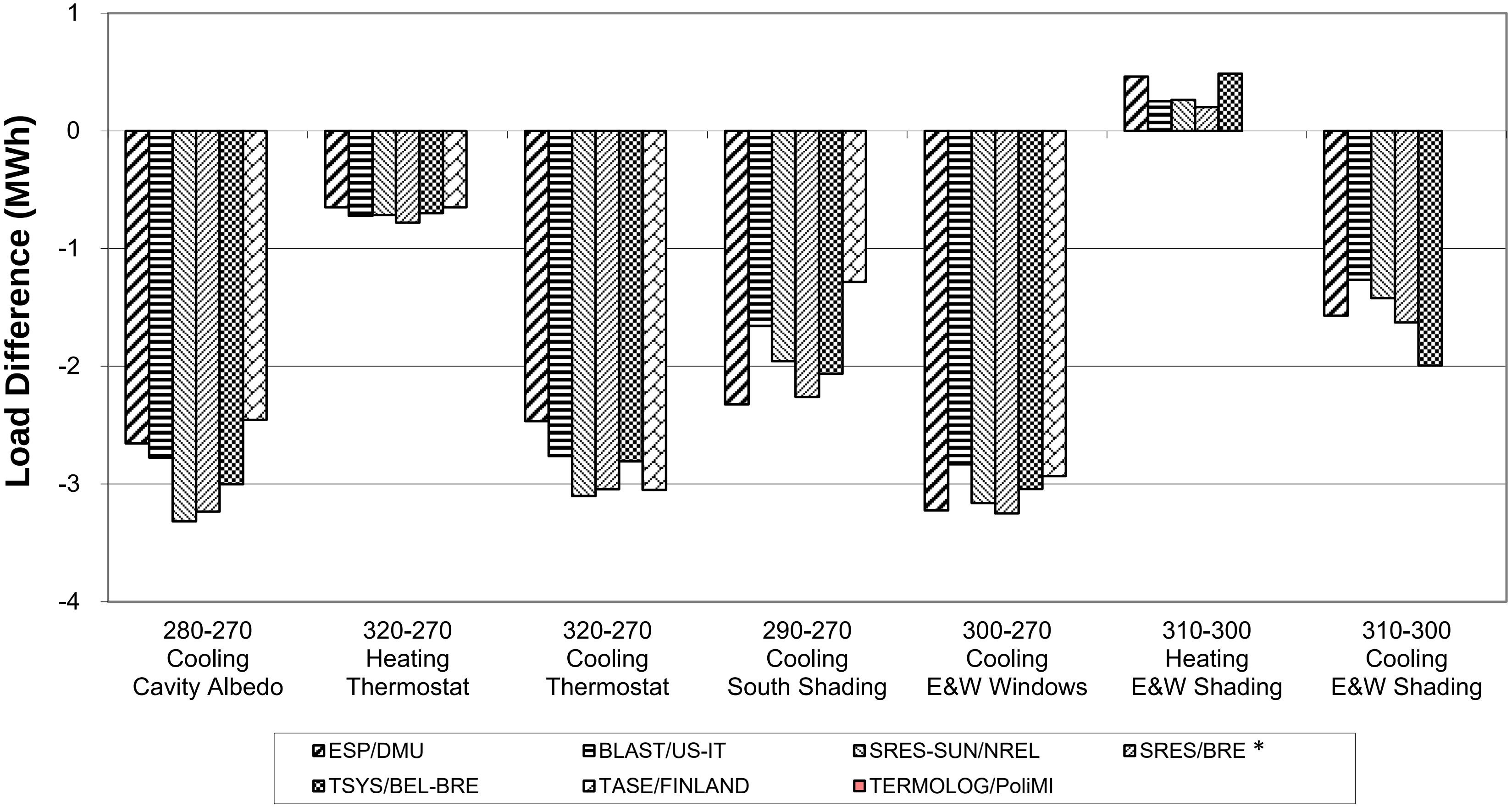
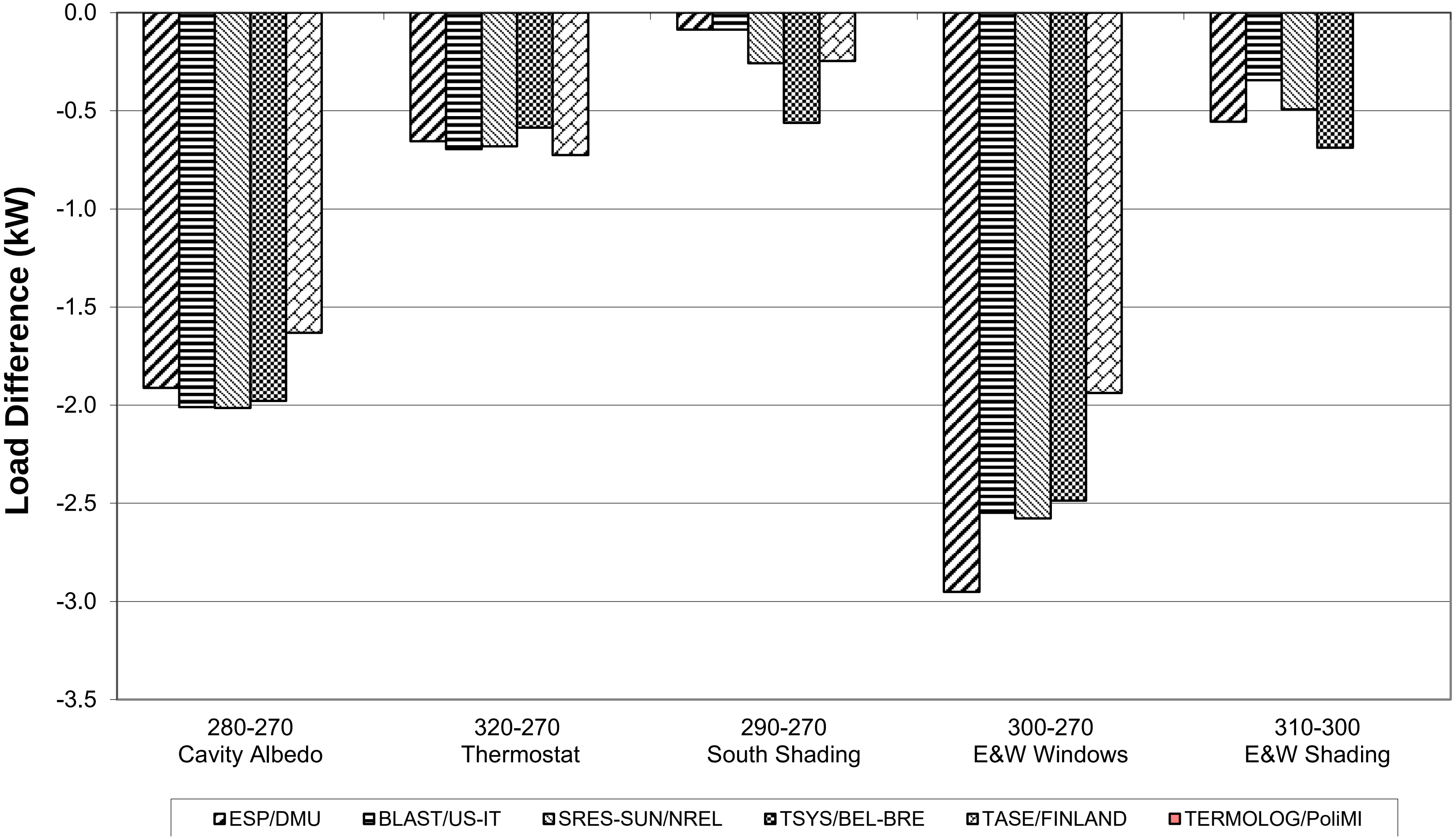


Figure B8-45. BESTEST IN-DEPTH
Cases 270 to 320 (Delta)
Annual Heating and Sensible Cooling



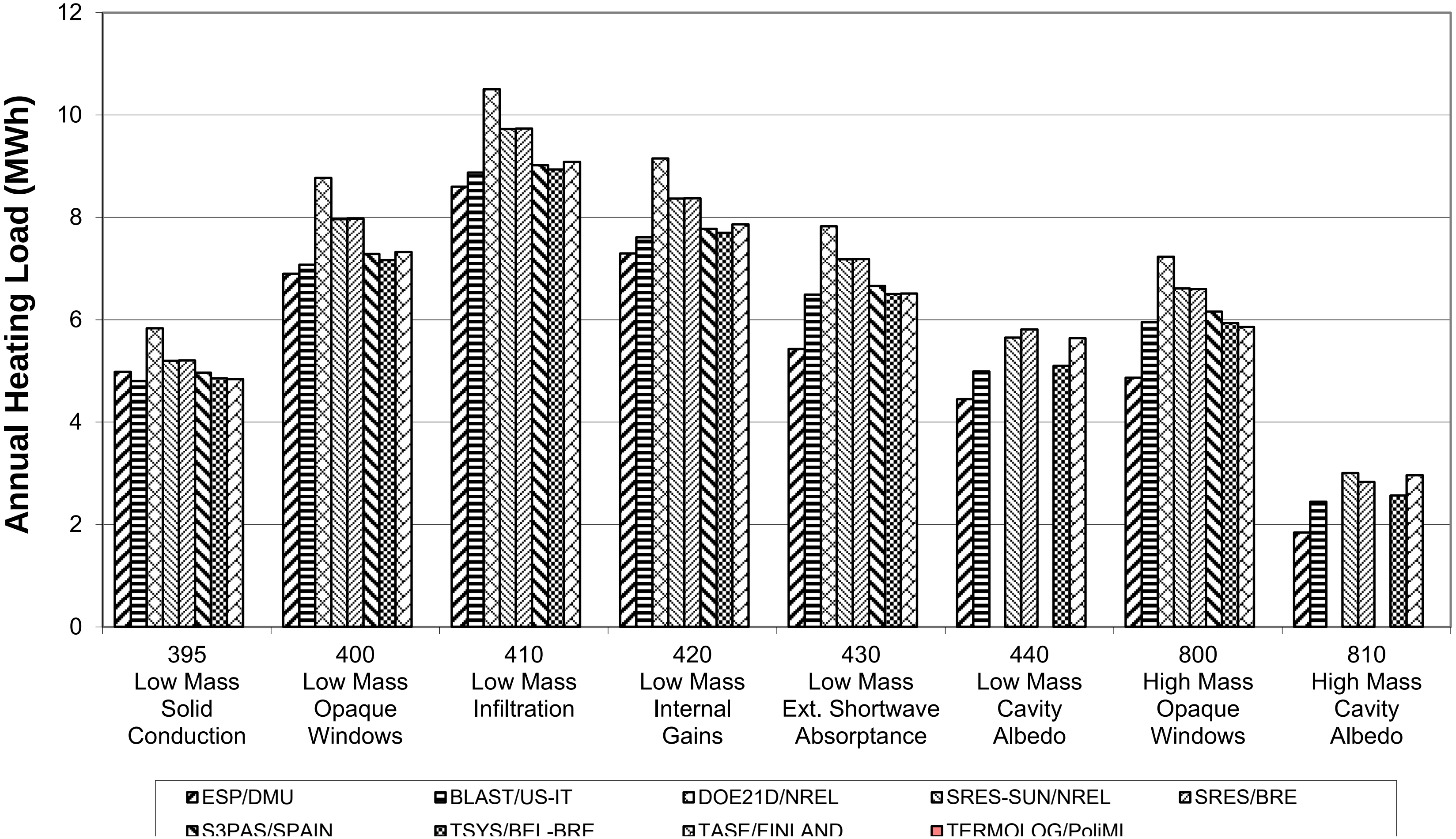
* SRES-BRE Cases 270, 290-320 have input error likely affecting sensitivity results for heating by <0.2 MWh/y (<6%), and for cooling by <0.2 MWh/y (<3%)

**Figure B8-46. BESTEST IN-DEPTH
Cases 270 to 320 (Delta)
Peak Sensible Cooling**



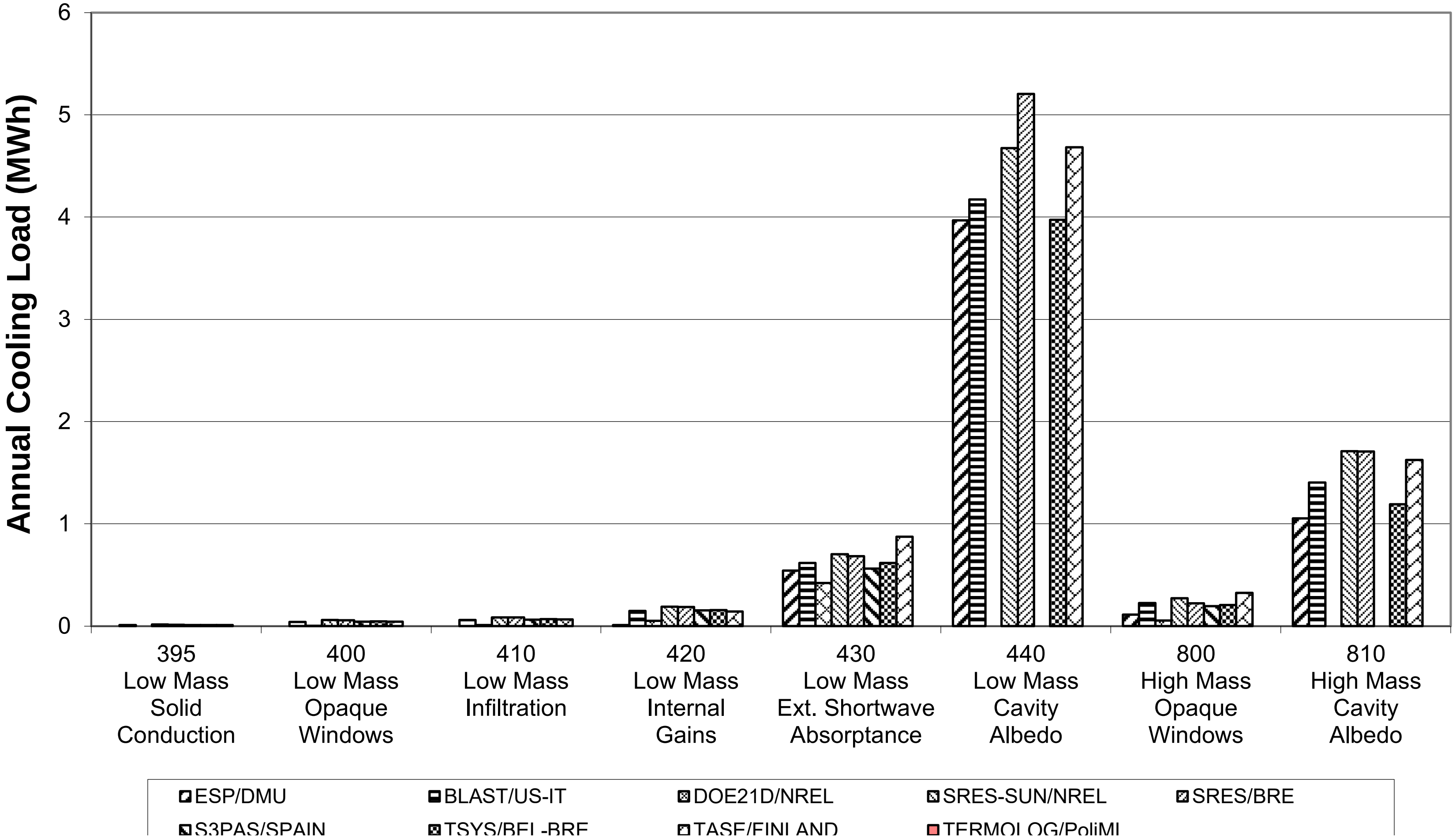
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-47. BESTEST IN-DEPTH
Annual Heating
Cases 395 to 440, 800, 810



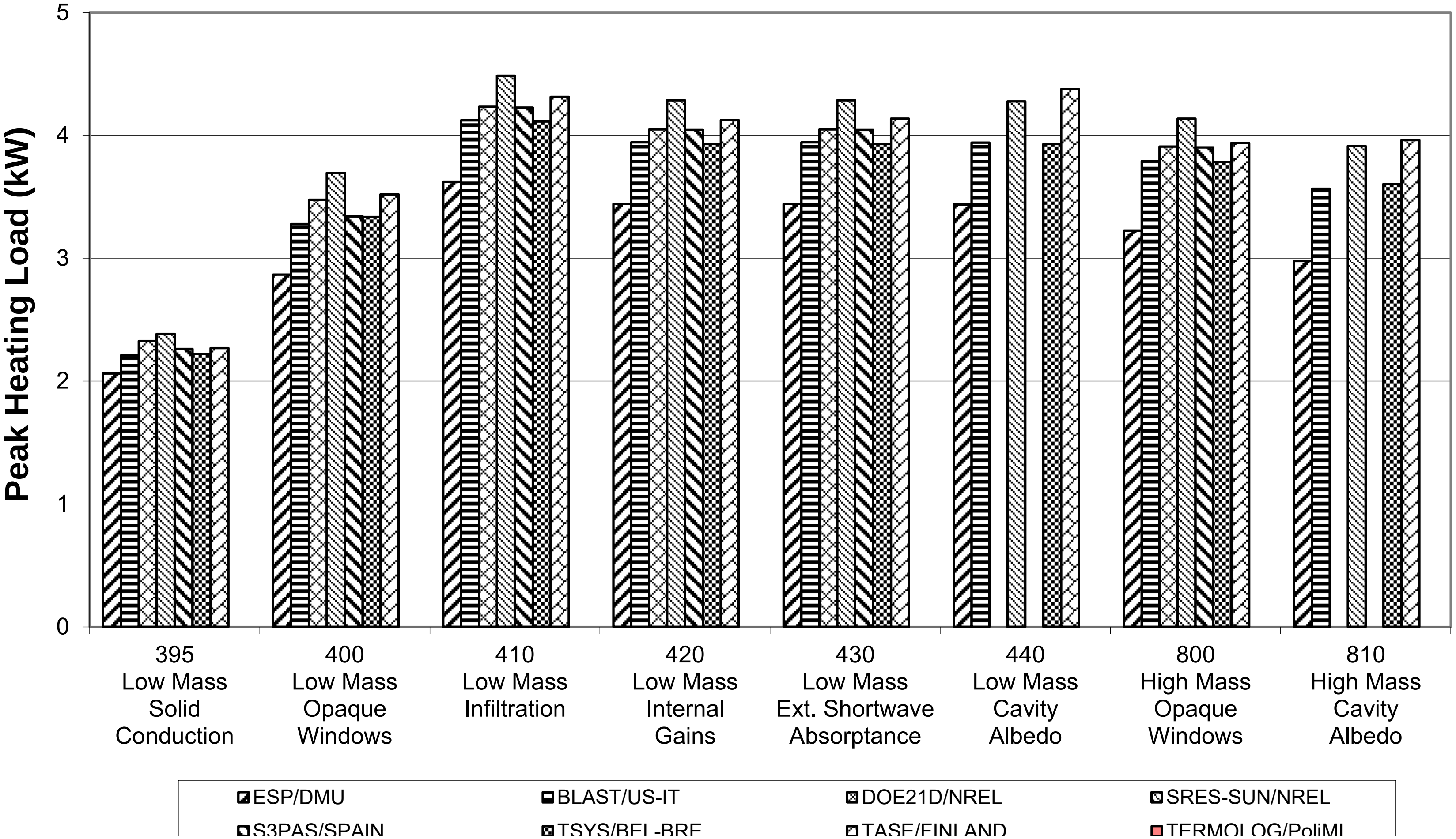
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-48. BESTEST IN-DEPTH Annual Sensible Cooling Cases 395 to 440, 800, 810



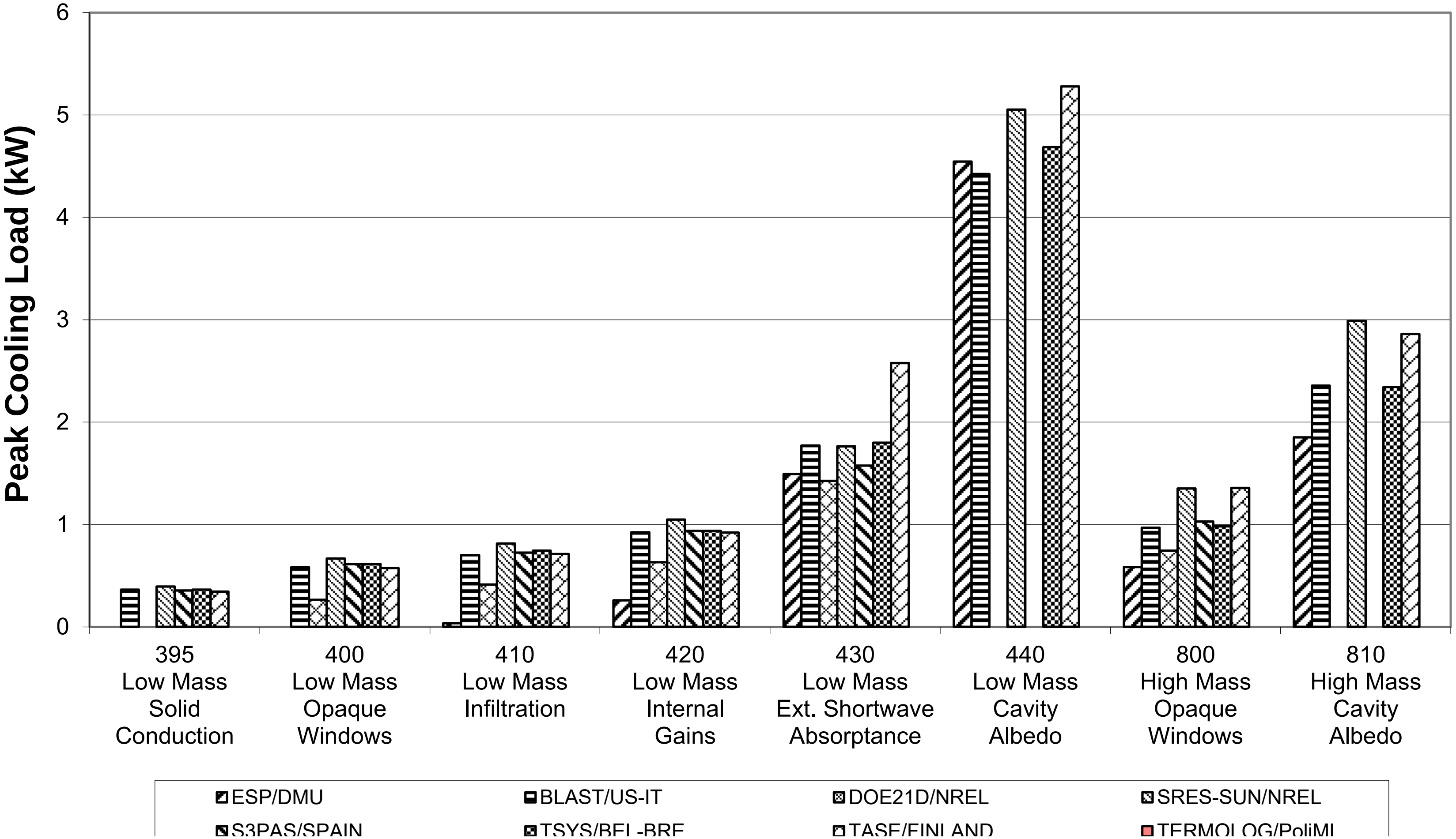
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-49. BESTEST IN-DEPTH
Peak Heating
Cases 395 to 440, 800, 810



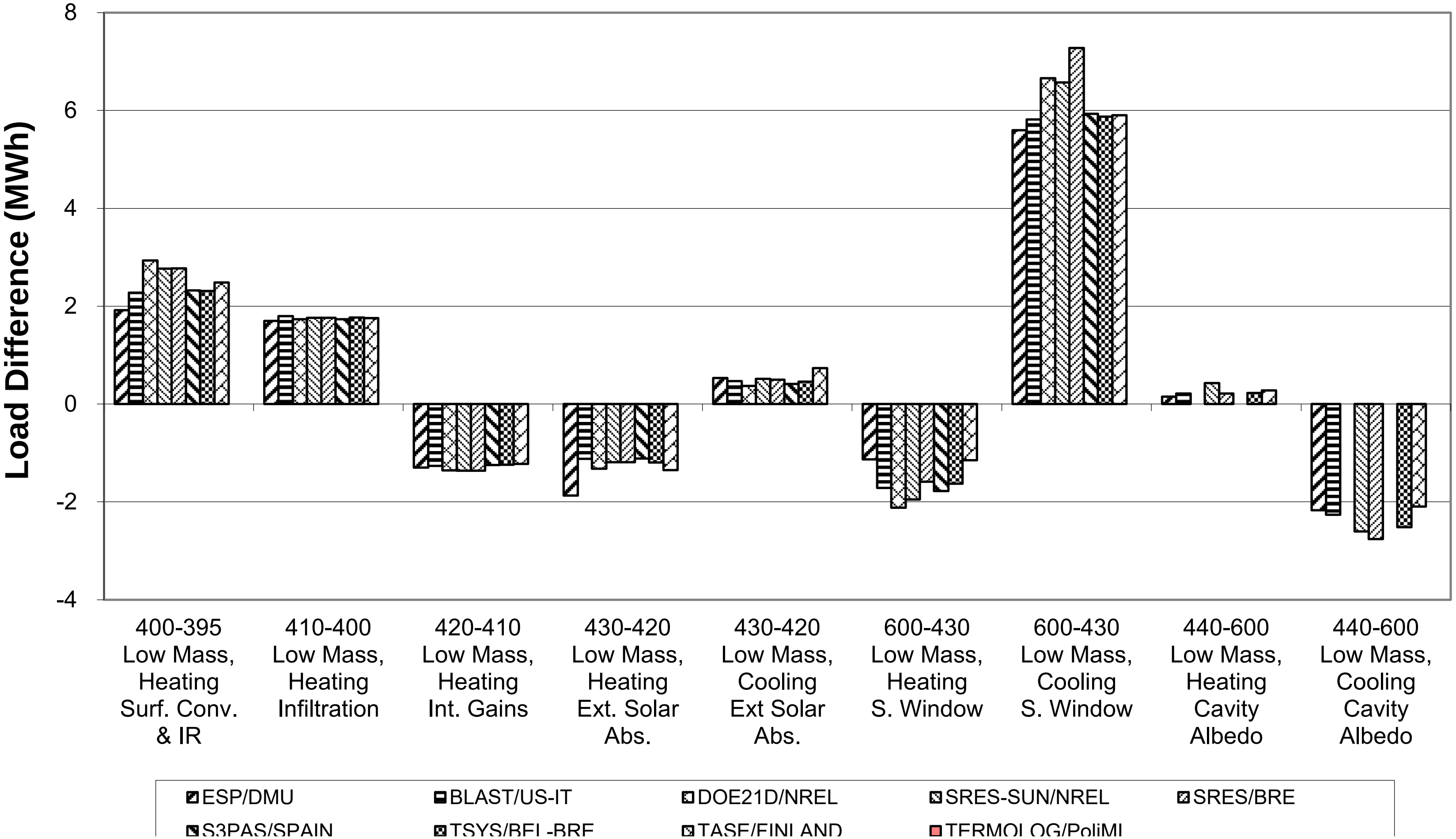
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-50. BESTEST IN-DEPTH
Peak Sensible Cooling
Cases 395 to 440, 800, 810



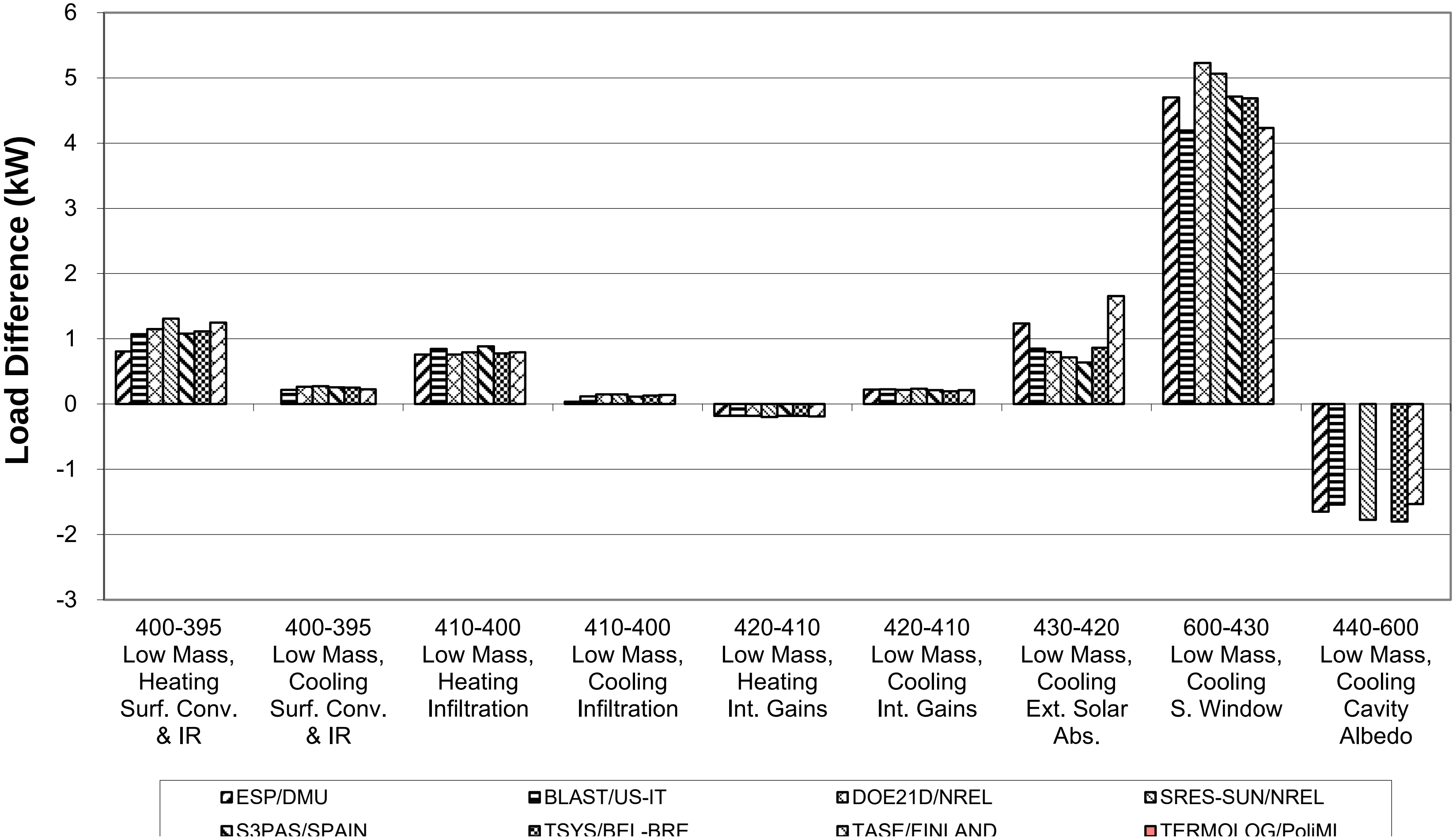
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-51. BESTEST IN-DEPTH
Cases 395 to 600 (Delta)
Annual Heating and Sensible Cooling



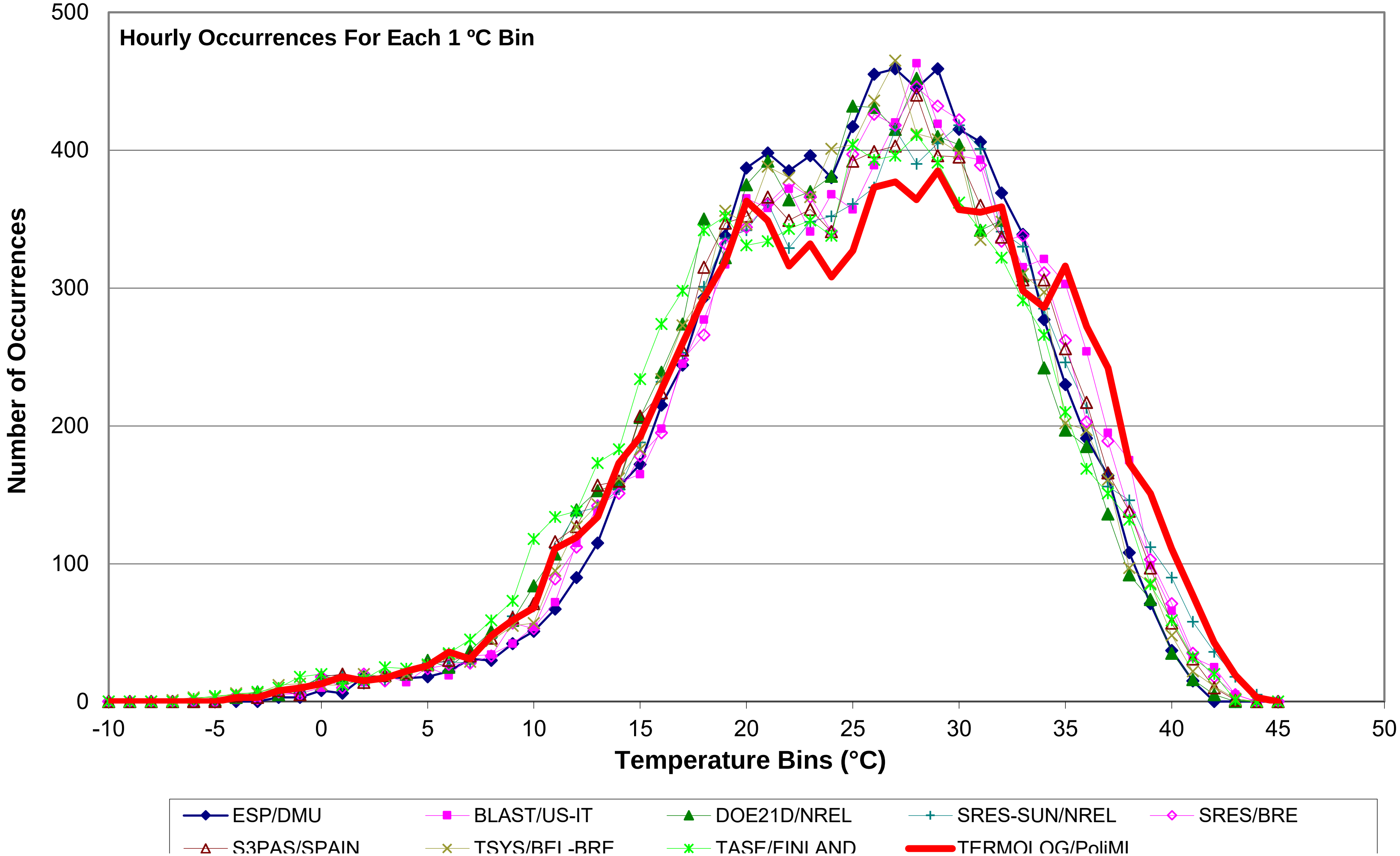
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-52. BESTEST IN-DEPTH Cases 395 to 600 (Delta) Peak Heating and Sensible Cooling



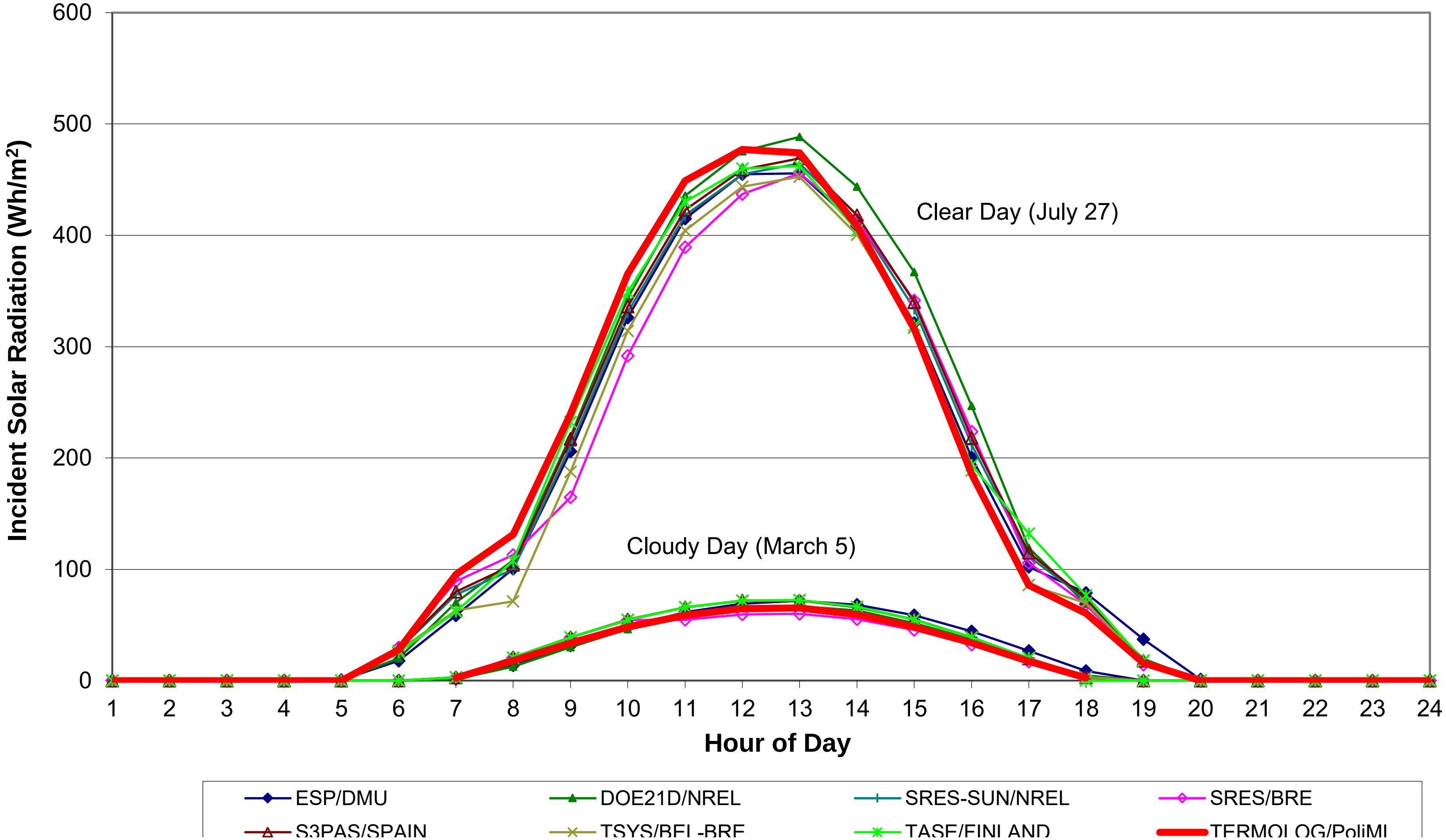
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-53. BESTEST Case 900FF Annual Hourly Temperature Frequency



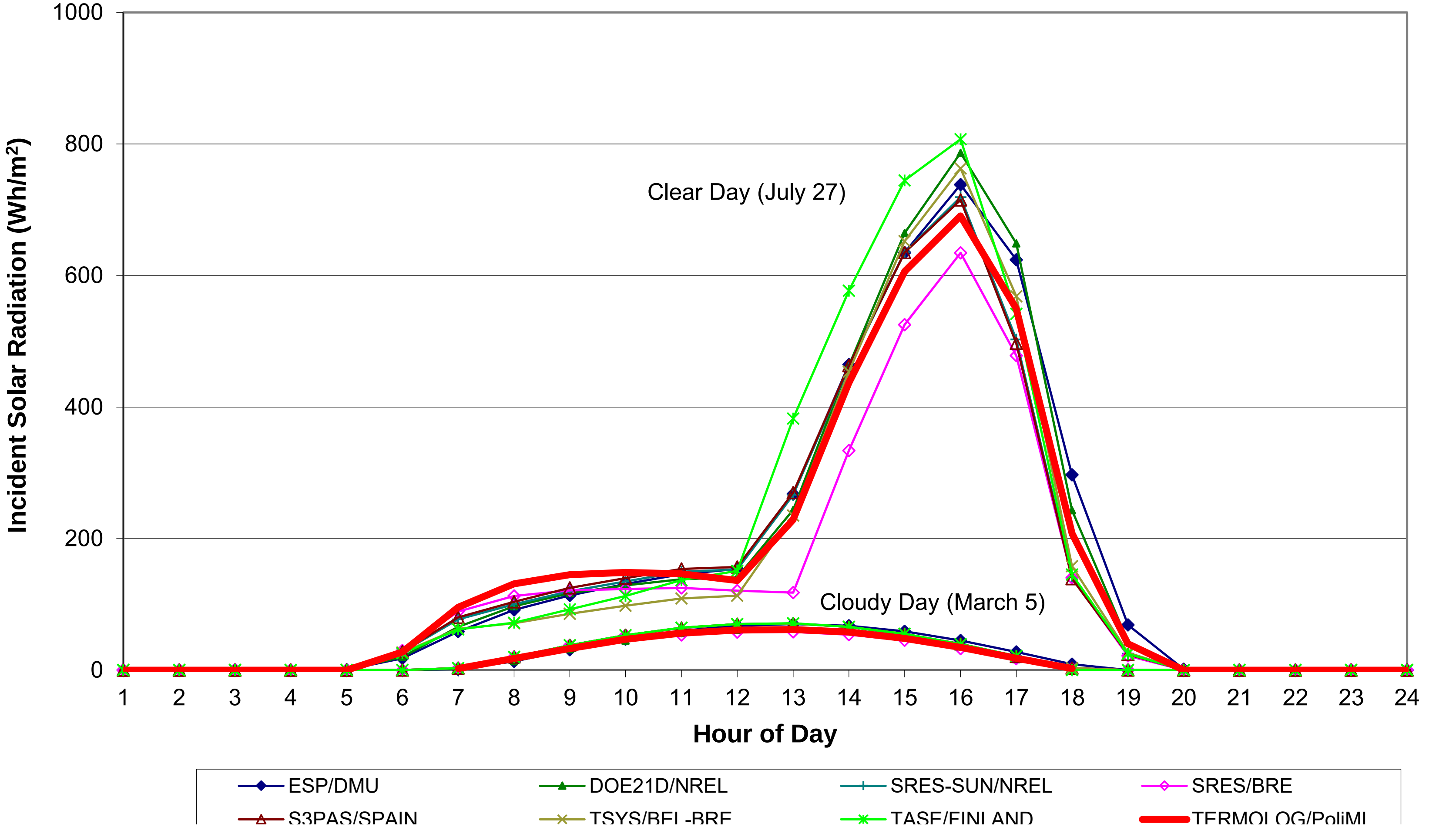
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-54. BESTEST Case 600
Cloudy & Clear Day Hourly Incident Solar
South Facing Surface



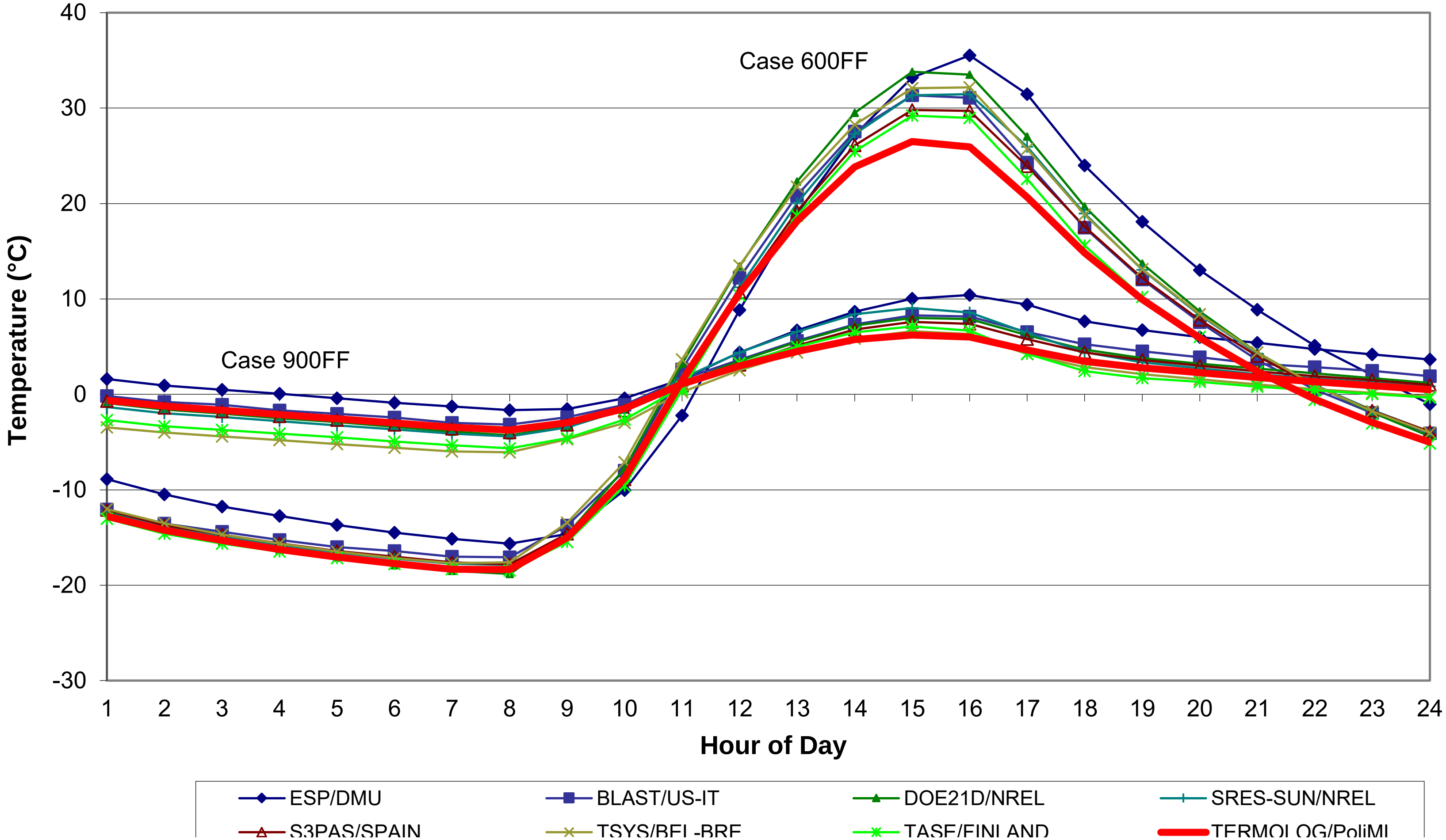
ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-55. BESTEST Case 600 Cloudy & Clear Day Hourly Incident Solar West Facing Surface



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-56. BESTEST
HOURLY FREE FLOAT TEMPERATURES
Clear Cold Day - Cases 600FF and 900FF



ASHRAE Standard 140-2017 Test Results Comparison for Section 5.2 - Building Thermal Envelope and Fabric Load Cases 195-960 & 600FF-950FF
TERMOLOG EpiX 8 build 2017.17 (TERMOLOG) vs. Annex B8, Section B8.1 Example Results, by Politecnico di Milano - ABC de

Figure B8-57. BESTEST
HOURLY FREE FLOAT TEMPERATURES
Clear Hot Day - Cases 650FF and 950FF