



U.S. Department of Energy
**Energy Efficiency
and Renewable Energy**

Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

Building Technologies Program

Application of Building Energy Consumption Data in Low-Energy Building Research

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U. S. Department of Energy

April 2008

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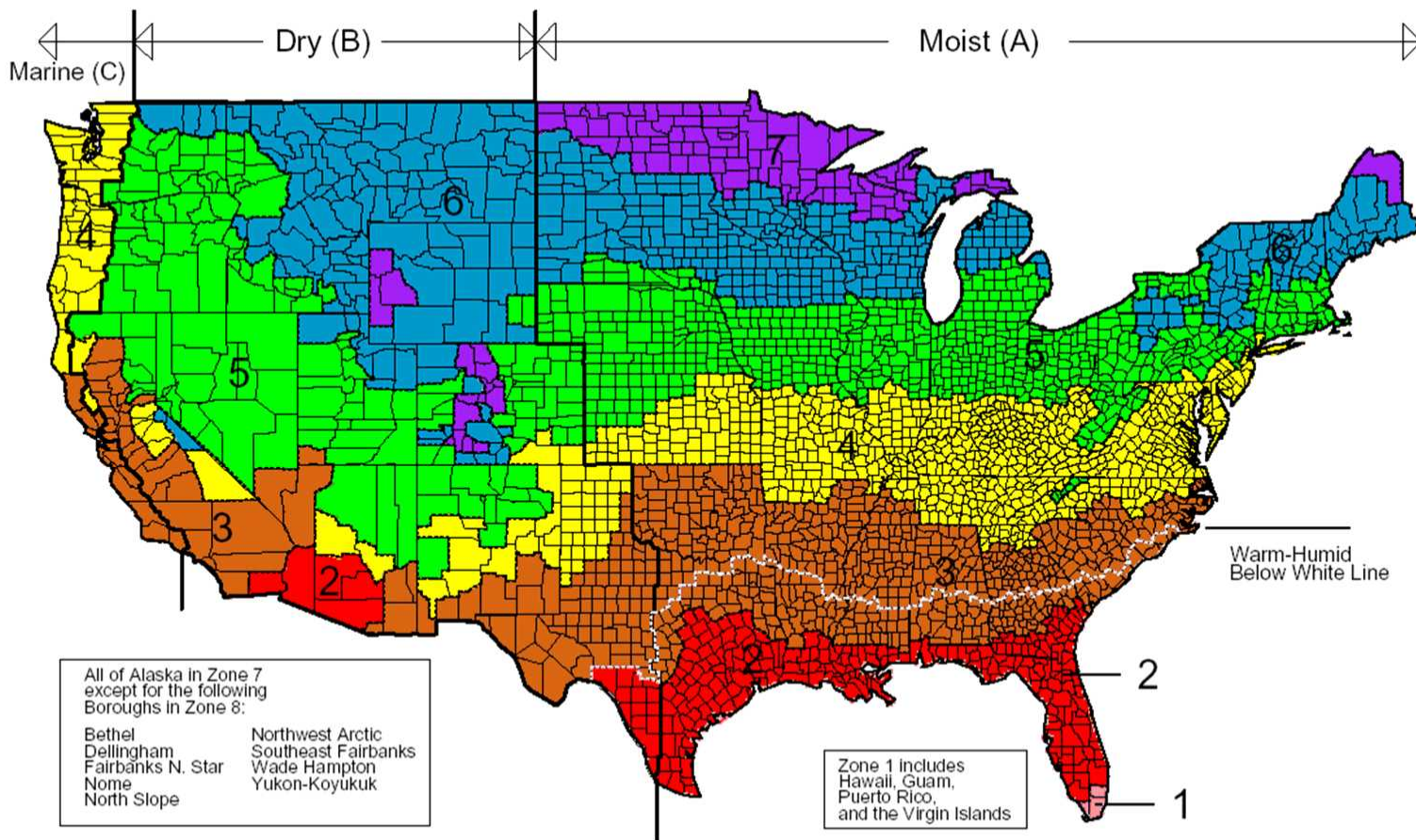
- **Energy Use Intensity**
 - *What is energy use per floor area?*
- **Floor-area weighting**
 - *What is average square foot vs. average building?*
- **End use**
 - *What equipment is using the energy?*
- **Climate zone distributions**
 - *How are buildings distributed in climate zones per ASHRAE Standard 169-2006?*



- Mechanical equipment detail
 - *What systems and component types are being used?*
- Schedules
 - *How does occupancy and operation vary over time?*
- Utility pricing structures
 - *What are demand, energy, and service charges really like?*



ASHRAE Standard 169 Climate Zones



March 24, 2003



Using EIA's CBECS Data

- *Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector*
<http://www.nrel.gov/docs/fy08osti/41957.pdf>
- *Methodology for Analyzing the Technical Potential for Energy Performance Across the Commercial Sector*
<http://www.nrel.gov/docs/fy08osti/41956.pdf>
- **Scenario Analysis Using EnergyPlus Models for 4,820 Samples**
 - Forward modeling allows modeling “what if” scenarios
 - Annual, 15-minute modeling with historical weather files for 2003
 - Detail developed from probability, literature, engineering design, codes, and standards.

April 2008



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Innovation for Our Energy Future

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Office of Energy Efficiency & Renewable Energy

Methodology for Modeling Building Energy Performance across the Commercial Sector

B. Griffith, N. Long, P. Torcellini, and R. Judkoff
National Renewable Energy Laboratory

D. Crawley and J. Ryan
U.S. Department of Energy

Technical Report
NREL/TP-550-41956
March 2008



NREL National Renewable Energy Laboratory

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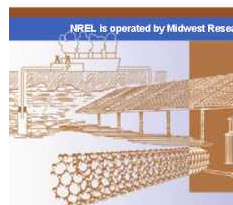
A national laboratory of the U.S. Department of Energy
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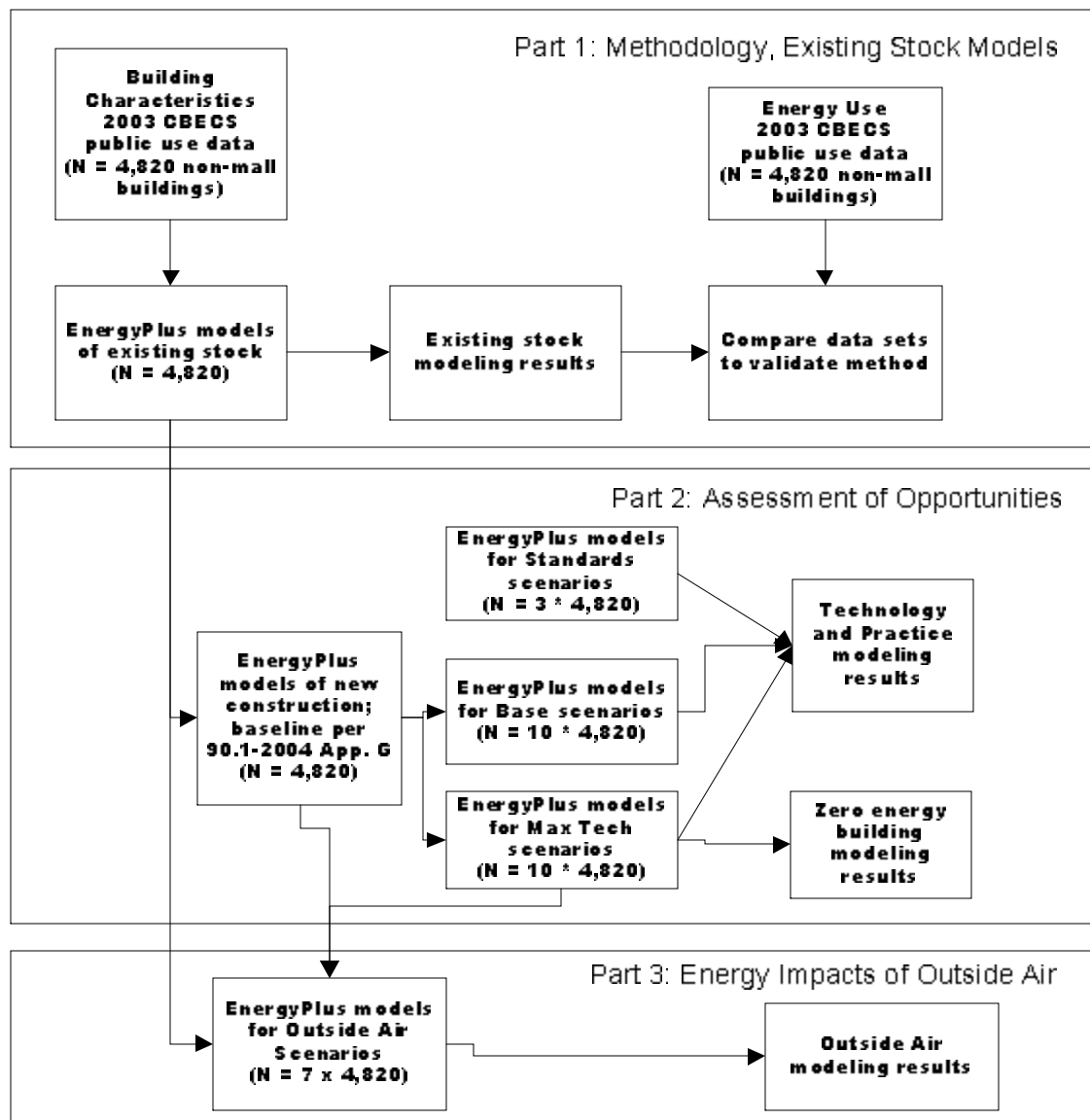
Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector

B. Griffith, N. Long, P. Torcellini, and R. Judkoff
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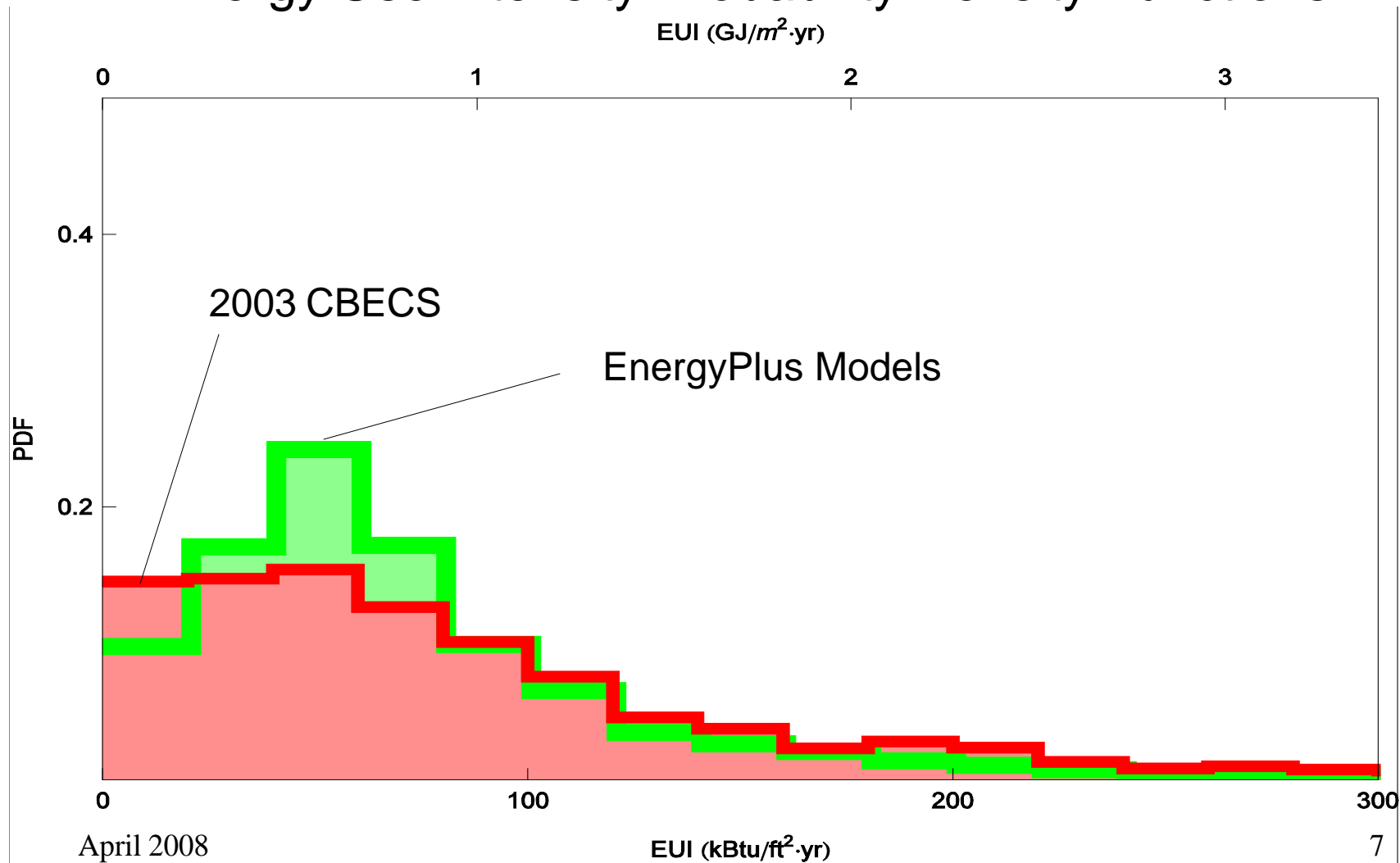
Technical Report
NREL/TP-550-41957
December 2007





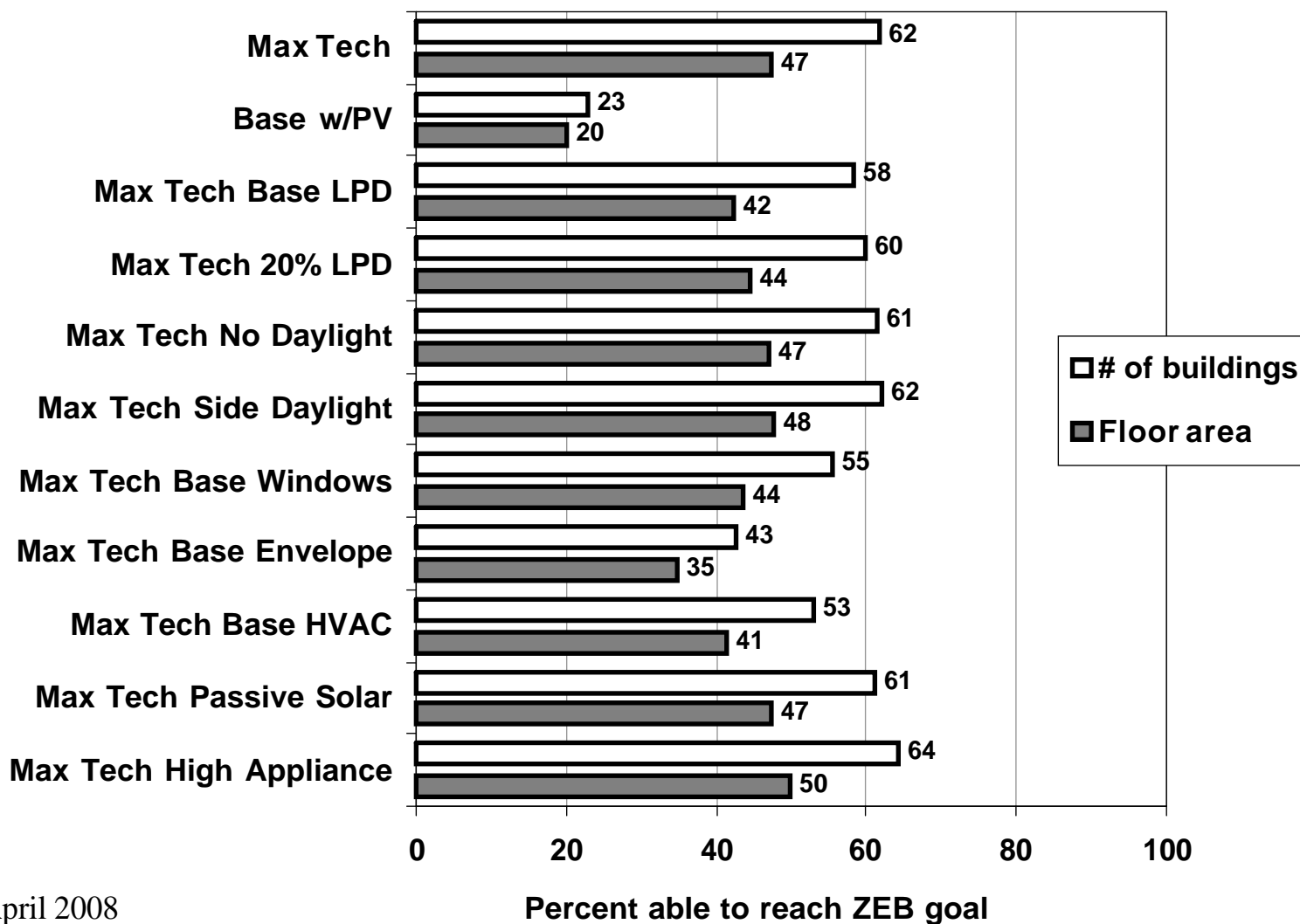


Energy Use Intensity Probability Density Functions



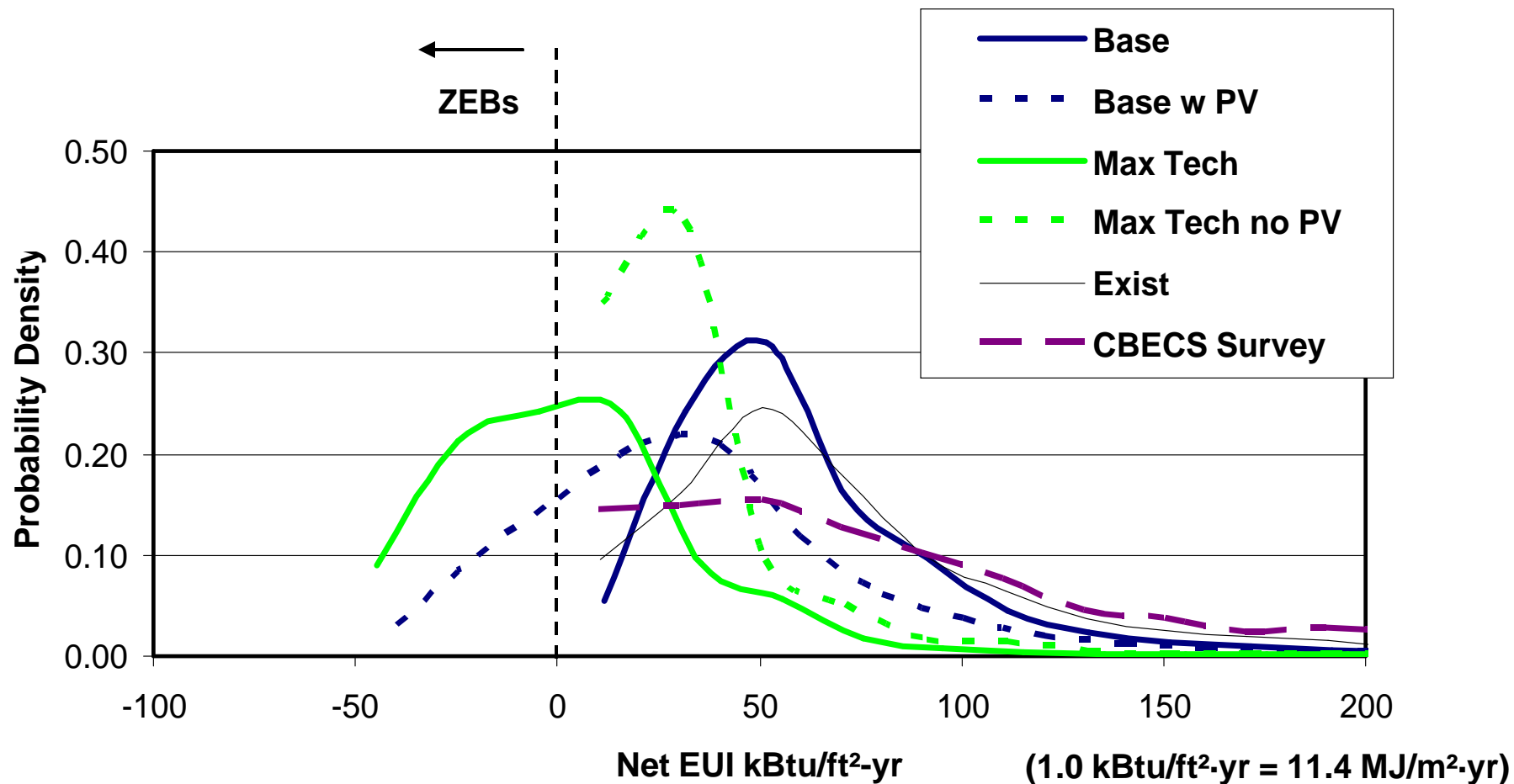


Percent of Commercial Sector That Can Reach ZEB



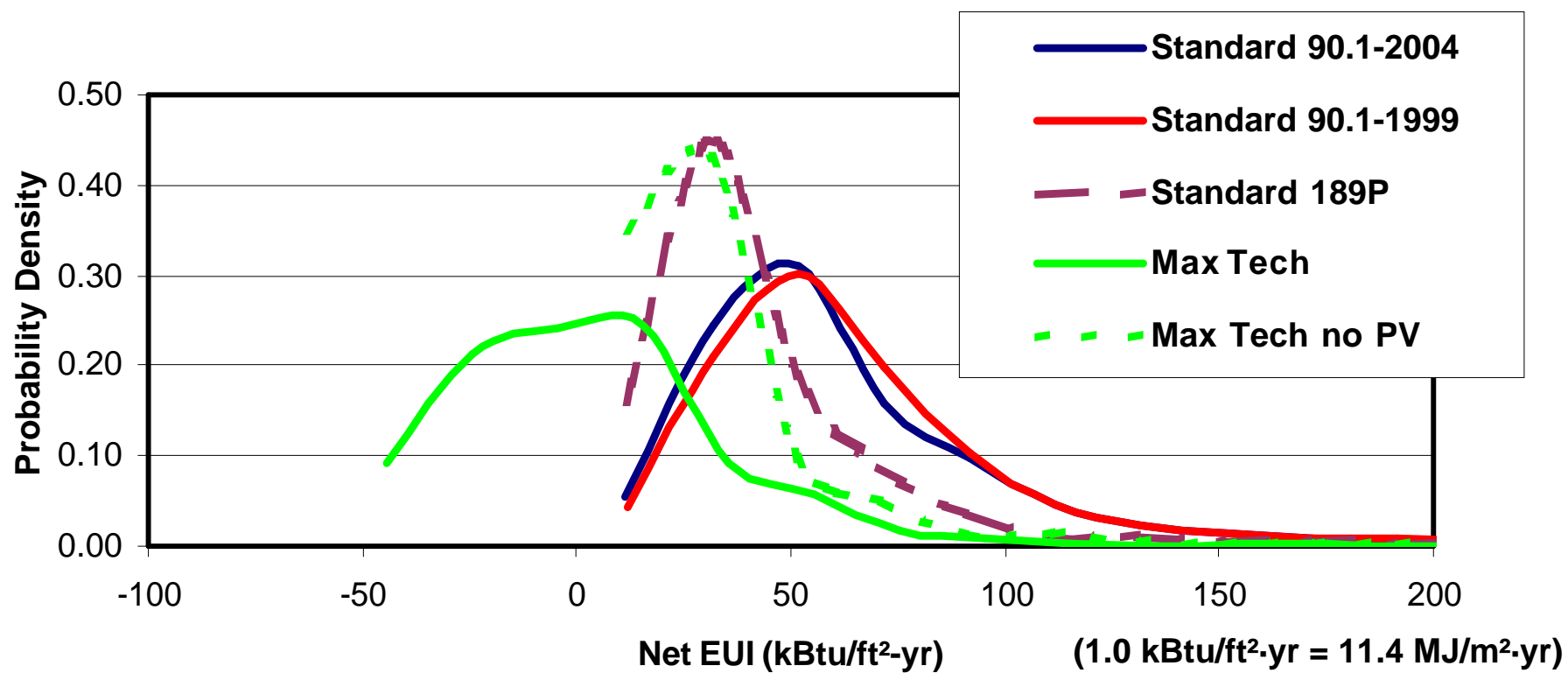


Net-EUI Distributions from ZEB Assessment





Net-EUI Distributions for ASHRAE Standards





Target EUIs for 30% Savings

Table 1. Target Energy Use Intensities¹ for 30% savings relative to ANSI/ASHRAE/IESNA Standard 90.1-2004² by Subsector and Climate Zone³: IP Units kBtu/ft²-yr

Subsectors	Climate Zones															
	All	1A	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	6A	6B	7	8
All	49	56	47	51	54	40	44	49	39	39	52	45	53	51	52	52
Office/professional	40	39	42	45	37	32	31	42	41	37	42	33	43	43	47	47
Nonrefrigerated warehouse	29	19	21	21	26	21	21	29	35	21	33	35	35	33	32	32
Education	36	36	34	40	29	29	38	42	24	30	37	31	42	45	45	45
Retail (except malls)	47	47	46	46	44	38	38	48	40	40	51	50	53	64	70	70
Public assembly	43	46	46	46	50	37	37	38	33	54	48	35	46	36	49	49
Service	58	58	55	55	42	44	44	55	36	36	64	53	72	60	76	76
Religious worship	31	28	28	28	20	21	21	31	41	41	36	24	40	27	31	31
Lodging	38	45	36	36	37	28	28	40	43	43	39	36	42	45	44	44
Food services	248	248	248	248	266	262	262	257	257	257	235	198	239	239	248	248
Inpatient health care	77	75	75	75	83	69	68	74	74	74	81	74	79	81	81	81
Public order and safety	47	38	38	38	47	47	47	42	42	42	55	54	51	61	61	61
Food sales	127	140	140	140	133	105	105	132	132	132	121	127	146	146	127	127
Outpatient health care	53	53	56	56	45	55	55	46	46	46	63	53	57	55	75	75
Vacant	21	21	16	16	21	14	14	29	29	29	15	15	28	28	28	28
Other	40	51	51	51	40	40	40	40	40	40	43	43	44	44	44	44
Skilled nursing	92	92	92	92	79	72	72	102	102	102	99	74	93	93	93	93
Laboratory	226	226	226	226	226	258	258	191	191	191	219	219	226	226	226	226
Refrigerated warehouse	60	60	60	60	60	60	60	62	60	60	60	60	60	60	60	60

¹ EUIs are site (delivered) energy use for the whole building.

² 30% Targets were developed from modeling results for Standard 90.1-2004 multiplied by 0.7 (listed in Table 2).

³ Climate zones are defined in ANSI/ASHRAE Standard 169-2006.

- Developed targets by climate zone and principal building activity
- Cited in DOE order 430.2B (Feb. 27, 2008) for federal buildings

http://buildings.energy.gov/highperformance/pdfs/energy_use_intensity_targets.pdf



Suggested improvements:

- Detailed modeling as part of methodology
- Applying ASHRAE Standard 169-2006 climate zones
- Taking into account:
 - Mechanical ventilation systems and operation
 - Monthly demand and energy use
 - Building shape and orientation
 - Utility tariffs
 - Sub-metering of end uses



Conclusions

- Sector data such as CBECS are critical to BTP's planning, analysis, and research
- Working with EIA to expand data to support analysis with more variables