Ceiling Fan Engineering Data and Life-cycle Cost Analysis

As part of its rulemaking analysis, DOE develops and makes public certain engineering and economic data. The data presented below are a portion of that analysis. DOE will make the entire analysis available to the public as the data are ready.

Throughout this document, the terms *low-volume ceiling fan* and *high-volume ceiling fan* are used, where volume refers to airflow volume. Low-volume ceiling fans are typically installed in residential applications, and high-volume ceiling fans in industrial applications.

Definitions:

Low-volume ceiling fan: a ceiling fan that is less than or equal to 7 feet in diameter, and that has a blade thickness greater than or equal to 3.2 mm at the edge, and that has a maximum tip speed less than or equal to the limit in Table 1.

High-volume ceiling fan: a ceiling fan that is greater than 7 feet in diameter, or that has a blade thickness of less than 3.2 mm at the edge, or that has a maximum tip speed that exceeds the threshold in Table 1.

Table 1: Low-volume ceiling fans, 7 feet in diameter or less

Thickness (t) of edges of blades		Maximum speed at tip of blades	
Mm	(inch)	m/s	(feet per minute)
$4.8 > t \geq 3.2$	$(3/16 > t \geq 1/8)$	12.2	(2400)
$t \geq 4.8$	$(t \geq 3/16)$	16.3	(3200)

High-volume small-diameter ceiling fan: a high-volume ceiling fan less than or equal to 7 feet in diameter.

High-volume large-diameter ceiling fan: a high-volume ceiling fan greater than 7 feet in diameter.

Engineering Analysis Results:

Efficiency has been determined by a weighted average of airflow efficiency at high and low fan speeds for low-volume ceiling fans. For high-volume ceiling fans, efficiency is airflow efficiency at high speed. MSP refers to the manufacturer selling price.

Table 2: Cost-Efficiency Curves for Low-Volume Standard Fans

	44-inch		52-inch		60-inch	
Efficiency Level	**Efficiency (CFM/W)**	**MSP (2013$)**	**Efficiency (CFM/W)**	**MSP (2013$)**	**Efficiency (CFM/W)**	**MSP (2013$)**
0	50	$45.54	49	$56.62	51	$83.85
1	66	$45.54	64	$56.62	68	$83.85
2	72	$45.54	74	$56.62	80	$83.85
3	79	$52.99	83	$66.66	93	$98.35
4	132	$70.11	139	$89.82	156	$131.86

Table 3: Cost-Efficiency Curves for Low-Volume Hugger Fans

	44-inch		52-inch	
Efficiency Level	**Efficiency (CFM/W)**	**MSP (2013$)**	**Efficiency (CFM/W)**	**MSP (2013$)**
0	37	$43.85	38	$52.19
1	49	$43.85	50	$52.19
2	51	$43.85	55	$52.19
3	56	$51.22	62	$61.12
4	93	$68.14	104	$81.70

Table 4: Cost-Efficiency Curves for High-Volume Large-Diameter Ceiling Fans

	8-ft		12-ft		20-ft	
Efficiency Level	**Efficiency (CFM/W)**	**MSP (2013$)**	**Efficiency (CFM/W)**	**MSP (2013$)**	**Efficiency (CFM/W)**	**MSP (2013$)**
0	44	$ 1,704	87	$ 1,812	171	$ 2,184
1	46	$ 1,700	90	$ 1,807	178	$ 2,175
2	74	$ 1,795	144	$ 1,949	285	$ 2,412
3	150	$ 3,614	293	$ 3,768	579	$ 4,231

Table 5: Cost-Efficiency Curves for High-Volume Small-Diameter Ceiling Fans

	36-inch		56-inch	
Efficiency Level	**Efficiency (CFM/W)**	**MSP (2013$)**	**Efficiency (CFM/W)**	**MSP (2013$)**
0	80	$ 28.02	231	$ 30.85
1	86	$ 31.88	247	$ 35.09
2	112	$ 33.04	323	$ 36.37
3	201	$ 58.55	583	$ 64.46

Life-cycle Cost (LCC) Analysis Results:

Table 6: LCC Results for Low-Volume Standard Ceiling Fans

Efficiency Level	**Average Life-Cycle Costs (2013$)***			**Life-Cycle Cost Savings****			
	Installed Cost	**Operating Cost**	**LCC**	**% of Purchases Showing**			**Avg. Savings (2013$)**
				Net Cost	**No Impact**	**Net Benefit**	
0	107	179	286	0%	100%	0%	0
1	107	132	239	0%	96%	4%	2
2	107	115	222	0%	92%	8%	3
3	120	102	222	22%	62%	15%	3
4	150	71	221	60%	4%	36%	4

*The average life-cycle costs for each efficiency level (EL) are calculated assuming that 100% of purchases are at that EL. This allows the LCCs for each EL to be compared under the same conditions.
** The average life-cycle cost savings for each EL are calculated relative to the average LCC of the market distribution of products in the base case (no standards case) in the compliance year. The calculation includes purchases with zero LCC savings (no impact).

Table 7: LCC Results for Low-Volume Hugger Ceiling Fans

Efficiency Level	**Average Life-Cycle Costs (2013$)***			**Life-Cycle Cost Savings****			
	Installed Cost	**Operating Cost**	**LCC**	**% of Purchases Showing**			**Avg. Savings (2013$)**
				Net Cost	**No Impact**	**Net Benefit**	
0	94	157	251	0%	100%	0%	0
1	94	115	209	0%	97%	3%	1
2	94	107	201	0%	92%	8%	2
3	105	96	201	22%	64%	14%	2
4	130	67	196	57%	4%	39%	6

*, ** See table notes from Table 6.

Table 8: LCC and PBP Results for High-Volume Small-Diameter Ceiling Fans

Efficiency Level	Average Life-Cycle Costs (2013$)*			Life-Cycle Cost Savings**			
	Installed Cost	Operating Cost	LCC	% of Purchases Showing			Avg. Savings (2013$)
				Net Cost	No Impact	Net Benefit	
0	68	202	269	0%	100%	0%	0
1	73	188	262	1%	75%	24%	2
2	75	144	219	0%	51%	49%	23
3	100	89	189	7%	13%	80%	49

*, ** See table notes from Table 6.

Table 9: LCC Results for High-Volume Large-Diameter Ceiling Fans

Efficiency Level	Average Life-Cycle Costs (2013$)*			Life-Cycle Cost Savings**			
	Installed Cost	Operating Cost	LCC	% of Purchases Showing			Avg. Savings (2013$)
				Net Cost	No Impact	Net Benefit	
0	3811	1920	5730	0%	100%	0%	0
1	3797	1846	5643	0%	91%	9%	8
2	4058	1156	5214	1%	57%	42%	194
3	5725	611	6336	94%	0%	6%	-928

*, ** See table notes from Table 6.

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Table 10: Payback Period Results and Average Lifetime for All Product Classes

Efficiency Level	Payback Period† for Low-Volume (years)		PBP† for High-Volume (years)		Average Lifetime for All Ceiling Fans (years)
	Standard	Hugger	Small-Diameter	Large-Diameter	
1	0.0	0.0	2.3	0.0	13.8
2	0.0	0.0	0.7	1.9	13.8
3	1.7	1.8	1.5	8.4	13.8
4	3.9	4.0			13.8

† The payback period is calculated with average (single-point) values and is relative to efficiency level 0.