



Introducing the AMCA Fan Energy Waste Calculator

An AMCA International White Paper

United States Country Electricity cost per kwh: 0.1 USD

Diameter (inches): 15

Operating Speed (rpm): 2015

Testing Error (%): 20

Annual Operating Hours (hr): 2920

Energy Penalty (kwh)	Emissions Penalty (Metric Tons CO ₂)	Economic Penalty (USD)
469	0.03	47

AMCA International
30 West University Dr.
Arlington Heights, IL 60004 USA
www.amca.org

Introducing the AMCA Fan Energy Waste Calculator

ABSTRACT

To help participants in the AMCA Certified Ratings Program communicate the program's benefits to members and the industry at large, AMCA developed a web tool called the AMCA fan energy waste calculator. This calculator estimates the wasted electricity resulting from a fan operating with higher energy consumption than expected, based on its manufacturer's rating data. The implication is that it is far less likely for such energy waste to occur if the fan is AMCA-certified.

This white paper, in addition to describing how and why the calculator was developed, documents underlying assumptions, sources of data and examples of the calculator's insights.

AMCA's fan energy waste calculator determines the energy consumption of underperforming fans. In other words, it will calculate the energy used by a fan that does not deliver the rated airflow and/or air pressure at a given fan speed when that fan is tested according to internationally accepted standards.

The calculator's output includes

- annual wasted energy (in kilowatt hours)
- annual wasted energy budget (in any of the calculator's 34 pre-programmed countries' currencies, based on the country's average commercial electricity rate)
- annual unnecessary greenhouse emissions (in tons of carbon dioxide equivalent)

BACKGROUND

The creator of this calculator, the Air Movement and Control Association (AMCA) International, was founded in 1917 to promote the health, growth and integrity of the air-systems industry relevant to commercial, industrial and residential applications.

An important part of AMCA's mission is to certify the performance ratings of fans, fire/smoke/volumetric dampers, architectural louvers and other products that are within AMCA's scope. AMCA has been certifying products for almost 60 years. The reason the AMCA Certified Ratings Program exists is to ensure that manufacturers' published product-performance data are accurate and based on internationally accepted standards for performance-rating tests.

Certified performance data provides confidence to a variety of professionals, such as engineers, architectural system designers and specifiers, distributors, contractors and building operators. These professionals know that an important phase of design is matching product performance ratings to the requirements of the project. Often, one or more requirements are vital to the application. Perhaps delivered airflow and air pressure are a builder's main focus. Or maybe energy efficiency and noise reduction are essential considerations in a retrofit. And wind-driven rain penetration may be of the utmost importance in locations with extreme weather conditions.

Because options for product types, sizes and accoutrements often exist, both within a manufacturer's product lines and between those of different manufacturers, comparing manufacturers' ratings data also is vitally important. The only way to make such comparisons conclusive, however, is to have confidence that the ratings themselves are accurate. This is where independent evaluation through the AMCA Certified Ratings Program has its role.

AMCA FAN ENERGY WASTE CALCULATOR

But what is the benefit of the AMCA Certified Ratings Program? Does it provide a measurable benefit to its participants and the users of certified products? One way to answer that question is to think about the impact of using a non-certified product. What could be the energy, environmental and economic impacts if, say, a non-certified fan operated outside the performance expected by the manufacturer's rating?

To help answer this question, the AMCA fan energy waste calculator estimates just one parameter of fan operations: wasted energy. It shows the resulting cascade into higher energy costs and avertable greenhouse gas emissions. Other impacts, such as increased noise, reduced time between maintenance and reduced service life, are ignored in this analysis, but such impacts do exist and could be significant.

The AMCA fan energy waste calculator can be accessed only on the AMCA website under the "Resources" tab. To use the tool, the user selects the country where the fan would operate, which automatically loads the country's currency and average commercial electricity cost into the analysis. Use of inches or millimeters for the fan diameter also is automatically driven (Figure 1).

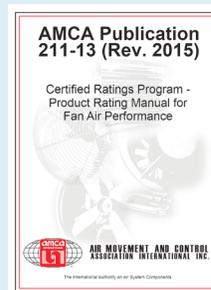
AMCA HEADQUARTERS LABORATORY AND TEST STANDARDS



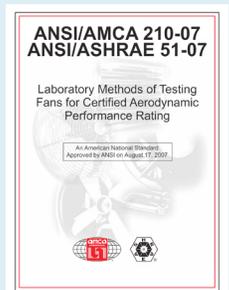
The AMCA headquarters laboratory is accredited by A2LA

Generally, fan testing for rating is conducted following standards published by AMCA, the International Standards Organization (ISO) and the Home Ventilation Institute (HVI). AMCA test standards are accredited by the American National Standards Institute (ANSI). Only test standards referenced in AMCA Publication 211¹ can be used for certification testing.

Data for the calculator were taken from centrifugal fans tested to ANSI/AMCA Standard 210, *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating*².



AMCA Publication 211



ANSI/AMCA Standard 210

United States ▼ Country Electricity cost per kwh: 0.1 USD

Figure 1. The selection of a country pre-loads the country's currency, average commercial electricity cost (country-specific currency per kWh), and fan-diameter engineering units. All images courtesy of AMCA International.

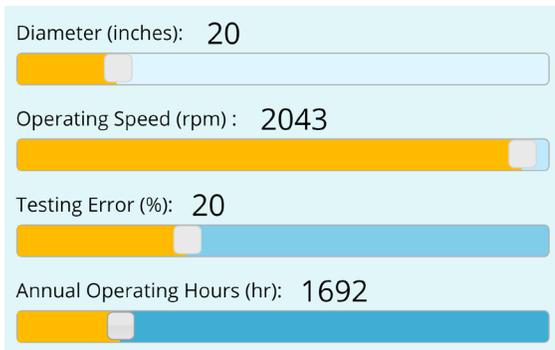


Figure 2a. Slides are used to specify the fan diameter, testing error, operating hours and operating speed. The results table is automatically updated to indicate total annual wasted energy, budget and greenhouse gas emissions.

Energy Penalty (kwh)	Emissions Penalty (Metric Tons CO ₂)	Economic Penalty (USD)
1343	0.09	134

Figure 2b. Fan waste calculator results panel showing readings from the slides and the results of the calculator.

Using four slider widgets, the user then specifies the fan’s diameter, annual fan operating hours, operating speed and the percentage by which the fan is operating outside the tolerance (testing error) of its rating. The widget automatically keeps the analysis within each parameter’s minimum and maximum to ensure the integrity of the results (Figure 2).

Table 1 provides the applicable minimum and maximum values for each of the slider widgets.

Slider parameter	Minimum	Maximum
Fan diameter (in./mm)	15/381	73/1854
Operating speed (rpm)	Depends on fan size	Depends on fan size
Testing error	6%	50%
Annual operating hours	1	8760

Table 1. Minimum and maximum selections for the calculator’s slide widgets.

DEVELOPMENT OF THE CALCULATOR

The calculator is based on centrifugal fans undergoing period check testing by staff at the AMCA headquarters laboratory in Arlington Heights, Illinois. Seventeen different sizes of centrifugal fans were studied, ranging in diameter from 380 mm to 1854 mm (15 in. to 73 in.).

In accordance with the AMCA Certified Ratings Program as articulated in AMCA Publication 211, *Certified Ratings Program Product Rating Manual for Air Movement Devices*, licensed products are subject to periodic check test schedules and fan-sample procedures.

The fact that check testing discovered underperforming fans testifies to the integrity and utility of the program — problematic ratings were discovered and, under the auspices of the program, the problems were fixed. Participants in the AMCA Certified Ratings Program must either (1) fix their production problems and have AMCA retest them, (2) re-rate their fan by publishing new performance data or (3) withdraw the products from the AMCA Certified Ratings Program.

Without initial certification and periodic check testing, the underperformance of non-certified fans may never be detected nor corrected.

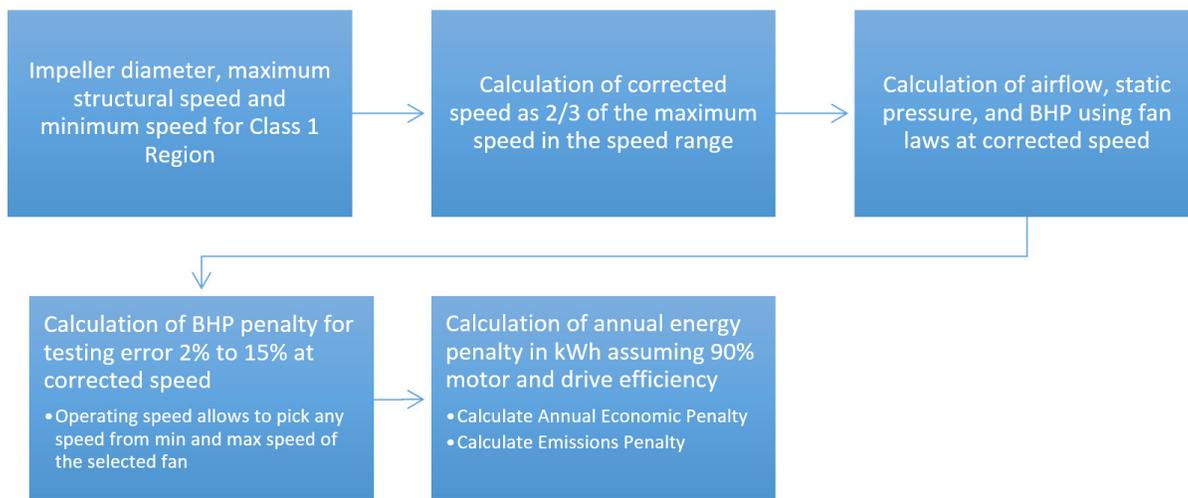


Figure 3. Flow diagram of fan energy waste calculator.

The calculation is shown in Figure 3 as a flow diagram.

“ Without initial certification and periodic check testing, the underperformance of non-certified fans may never be detected nor corrected. ”

ABOUT THE AMCA FAN ENERGY WASTE CALCULATOR’S PENALTY CALCULATIONS

ANNUAL ENERGY PENALTY

The fan energy waste calculator’s annual energy penalty is calculated as follows:

$$\text{Annual Energy Penalty in kWh} = 0.90 \cdot 0.95 \cdot 0.746 \cdot \text{Annual Operating Hours} \cdot \text{BHP}_{\text{catalog}} \cdot \left(\frac{\text{Speed}_{\text{oper}}}{\text{Speed}_{\text{catalog}}}\right)^3$$

Motor and drive efficiency of 90% and a testing error tolerance of 5% are assumed.

Depending on the size of the fan selected, the range of operating speed will change. The energy penalty at the operated speed is the third power of the speed. The higher the fan operational speed, the higher the energy penalty.

Since the fan power consumed is the fifth power of diameter, the energy penalty for the larger fan is much higher than the penalties for a fan with a smaller diameter run at the same operating speed. This increases system operating costs.

EMISSIONS PENALTY

The U.S. Environmental Agency’s greenhouse gas equivalencies calculator was used to calculate carbon dioxide emissions from electricity usage in kWh based on an emissions factor determined by the Emissions & Generation Resource Integrated Database (eGRID)³:

Emission Factor = $6.89551 \cdot 10^{-4}$ Metric Tons CO₂/kWh

For more information about the emissions factor, visit at the U.S. Environmental Protection Agency website.

Emissions penalty is calculated as follows:

Emissions Penalty in Metric Tons CO₂ = Emission Factor • Annual Energy Penalty

ANNUAL ECONOMIC PENALTY

Using energy cost in the currency of the country of interest per kWh, annual economic penalty is calculated as follows:

Economic Penalty = Annual Energy Penalty • Cost of Per Unit Energy

CONCLUSION

AMCA's new fan energy waste calculator helps users better grasp the costs of inefficiency. With a few simple clicks, it is now easier than ever to make a data-driven argument for the use of cost-effective, energy efficient, AMCA-certified fans. AMCA members can use the calculator to as an example of why they invest in having their products certified by AMCA. It can also be used by engineers, contractors and facility engineers to consider specifying that applicable products be certified by AMCA and ensuring that specified AMCA-certified products are installed.

EXAMPLES OF FAN ENERGY WASTE CALCULATOR RESULTS

USA: SMALL FAN (RUNNING ONLY DURING BUSINESS HOURS (2080 HOURS) AT 10% ERROR		
Inputs	Country	USA
	Electricity Cost	\$0.10 per kWh
	Fan Size	20 in.
	Operating Speed	1,752 rpm
	Annual Operating Hours	2080
Calculated Results	Annual Energy Penalty	521 kWh
	Emissions Penalty	0.04 metric tons
	Annual Energy Cost Penalty	\$52

USA: LARGE FAN RUNNING 10 HOURS PER DAY EVERY DAY OF YEAR (3650 HOURS) AT 10% ERROR		
Inputs	Country	USA
	Electricity Cost	\$0.10 per kWh
	Fan Size	49 in.
	Operating Speed	719 rpm
	Annual Operating Hours	3650
Calculated Results	Annual Energy Penalty	5809 kWh
	Emissions Penalty	0.40 metric tons
	Annual Energy Cost Penalty	\$581

CHINA: LARGE FAN RUNNING 10 HOURS PER DAY EVERY DAY OF YEAR (3650 HOURS) AT 15% ERROR		
Inputs	Country	China
	Electricity Cost	0.5 CNY per kWh
	Fan Size	1245 mm.
	Operating Speed	719 rpm
	Annual Operating Hours	3650
Calculated Results	Annual Energy Penalty	8713 kWh
	Emissions Penalty	0.60 metric tons
	Annual Energy Cost Penalty	4357 CNY

ITALY: LARGE FAN RUNNING 10 HOURS PER DAY EVERY DAY OF YEAR (3650 HOURS) AT 20% ERROR		
Inputs	Country	Italy
	Electricity Cost	0.19 EUR per kWh
	Fan Size	1676 mm.
	Operating Speed	540 rpm
	Annual Operating Hours	3650
Calculated Results	Annual Energy Penalty	20951 kWh
	Emissions Penalty	1.44 metric tons
	Annual Energy Cost Penalty	3981 EUR

REFERENCES

- 1 ANSI/AMCA Standard 210. *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating*. Arlington Heights: AMCA, 2007.
- 2 AMCA Publication 211. *Certified Ratings Program—Product Rating Manual for Fan Air Performance*. Arlington Heights: AMCA, 2015.
- 3 United States Environmental Protection Agency. “eGRID.” Accessed March 12, 2016.
<https://www.epa.gov/energy/egrid>

RESOURCES

AMCA International headquarters and laboratory
www.amca.org

Other AMCA white papers provide an overview of the AMCA Certified Ratings Program (CRP), guideline specifications for AMCA-certified products and a checklist for ensuring that intended to be AMCA-certified are actually installed. These white papers can be downloaded at no cost.

www.amca.org/whitepapers

CRP publications (no cost) and standards (cost)

www.amca.org/store



AMCA INTERNATIONAL

30 WEST UNIVERSITY DRIVE
ARLINGTON HEIGHTS, IL 60004-1893 USA
+1 847-394-0150
PUBLICATIONS@AMCA.ORG

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