ENERGY STAR Market & Industry Scoping Report
Residential Humidifiers
October 2012

U.S. Environmental Protection Agency (EPA) consistently looks for new opportunities to expand ENERGY STAR to new product categories that will deliver significant benefits to consumers and the environment in the form of energy and dollar savings plus greenhouse gas reductions. A key step in this evaluation is the development of a scoping report that provides a snapshot of the product market, energy use, and savings potential associated with an ENERGY STAR program for the scoped product type. EPA uses scoping findings to prioritize product specification development work. While scoping reports are drafted primarily for internal evaluation purposes, and are not intended to be exhaustive but rather a guidepost for the ENERGY STAR program, EPA makes the reports available with the interest of benefiting other efficiency programs evaluating similar opportunities. For more information about the ENERGY STAR specification development process, go to: www.energystar.gov/productdevelopment.

1. *Executive Summary and Recommendation*

This report examines the U.S. market and national energy savings potential of residential humidifiers, which include portable and whole-house devices. Humidifiers have two main purposes in a residence: (1) to increase or maintain the amount of humidity in a given area and/or, (2) to ease the symptoms of an illness. According to manufacturers, energy consumption is generally not a purchase consideration for consumers.

To ascertain a clear picture of the residential humidifier market, manufacturers of portable and whole-house humidifiers were engaged to gather information about humidifier shipments, energy consumption, product characteristics, test methods, the present state of the industry, and their interest in an ENERGY STAR specification for residential humidifiers. Each humidifier manufacturer expressed guarded optimism for a new ENERGY STAR program for residential humidifiers. One portable humidifier manufacturer pointed out that consumers make purchase decisions based on the price point, the immediate need (illness or lack of humidification), and/or the size of the room that needs greater humidification. Any skepticism from manufacturers is derived from consumers' perceived lack of interest in energy savings from a humidifier. All manufacturers contacted were in favor of an ENERGY STAR specification for humidifiers as long as the process is collaborative.

In the U.S., humidifiers use approximately 0.11% of the total electricity consumed by households each year.[1] The portable humidifier category is composed of three subcategories, each with their own benefits and characteristics: ultrasonic, cool mist, and warm mist. Whole-house humidifiers consist of bypass, fan-powered, and steam technologies. According to manufacturers, in 2011 the annual shipments of portable humidifiers is estimated at 8,000,000

[1] EIA (2008). 2005 Residential Energy Consumption Survey. Table US-3, Total Consumption by Fuels Used, 2005, Physical Units (PDF) (4 pp, 50K, About PDF). EPA (2009). eGRID2007 Version 1.1. U.S. Environmental Protection Agency, Washington, DC.

and whole-house humidifiers is estimated at 350,000, resulting in an annual market share of 96% portable and 4% whole house humidifiers of the entire residential humidifier market.[2] As these devices are not covered by DOE, energy consumption reporting is inconsistent and there is no industry-accepted test method to determine efficacy. As a result, this report consists of energy savings calculations based on estimated market penetration, technology type, and manufacturer-provided power ratings. There is very little, if any, correlation between humidification capacity (in square feet) and watt rating.

A numerical value for the uncertainty of the national savings estimate cannot be ascertained because the variables contained in the calculations are derived from estimates provided by the manufacturers. For example, the estimated 8 million annual shipments of portable humidifiers and 350,000 annual shipments of whole-house humidifiers are a collective estimate among humidifier manufacturers.[3] Also, the wattage ratings published by manufacturers are not verified or validated by a third party.

Table 1 below illustrates the average energy and cost savings of efficient portable humidifiers. Estimated savings in this table are based on a comparison of hypothetical humidifiers that consume energy at the 25th quartile of the market to a baseline of energy consumption at the 75th quartile of the market. The baseline for the inefficient product assumes a watt rating of 44.5 for ultrasonic, 81 for cool mist, and 220 for warm mist.

Table 1: Estimated Household Savings of Portable Humidifiers

	Ultrasonic	Cool Mist	Warm Mist
Kwh Savings Per Year	11.8 kwh	36.2 kwh	80.1 kwh
$ Savings Per Year[4]	$1.36	$4.17	$9.22
Kwh Savings per Lifetime (4 yrs)	47 kwh	145 kwh	320 kwh
$ Savings per Lifetime (4 yrs)	$5.44	$16.68	$36.88
National kwh Savings (4 yrs)[5]	155.9 Mwh[6]	1,197 Mwh[7]	1,587 Mwh[8]
National $ Savings (4 yrs) [9]	$17.9 Million[10]	$137.7 Million[11]	$182.7 Million[12]

[2] Conversations with manufacturers and 2009 RECS data.

[3] Ibid.

[4] $0.1151 per kwh.

[5] 96% of 17.2 million households - 2009 RECS data – Weighted based upon the following estimated market penetration: 50% Cool Mist, 30% Warm Mist, and 20% Ultrasonic.

[6] 3,302,400 estimated homes.

[7] 8,256,000 estimated homes.

[8] 4,953,600 estimated homes.

[9] 96% of 17.2 million households - 2009 RECS data – Weighted based upon the following estimated market penetration: 50% Cool Mist, 30% Warm Mist, and 20% Ultrasonic.

[10] 3,302,400 estimated homes.

[11] 8,256,000 estimated homes.

Table 2 below illustrates the average energy and cost savings of efficient whole-house humidifiers. Estimated savings are based on a comparison of hypothetical humidifiers that consume energy at the 25th quartile of the market to a baseline of energy consumption at the 75th quartile of the market. The baseline for the inefficient product assumes a watt rating 108 for fan powered, and 1,916 for steam. Note that an energy savings estimate is not calculated for bypass humidifiers. Unlike fan powered, and steam models, there is little differentiation among bypass humidifier models as all models have similar wattage ratings.

Table 2: Estimated Household Savings of Whole-House Humidifiers

	Bypass[13]	Fan Powered	Steam
Kwh Savings Per Year	N/A	15.2 kwh	426.7 kwh
$ Savings Per Year	N/A	$1.75	$49.11
Kwh Savings per Lifetime (10 yrs)	N/A	151 kwh	4267 kwh
$ Savings per Lifetime (10 yrs)	N/A	$17.47	$491.11
National kwh Savings (10 yrs)[14]	N/A	31.3 Mwh[15]	293.5 Mwh[16]
National $ Savings (10 yrs)[17]	N/A	$3.6 Million[18]	$33.7 Million[19]

Based on the savings in Tables 1 and 2, by purchasing energy efficient humidifiers, consumers can collectively save an estimated 3.4 terawatts of electricity in the US over the course of the lifetimes of all portable and whole-house residential humidifiers.[20] That amounts to a national estimated lifetime savings of $391,340,000.[21]

---

[12] 4,953,600 estimated homes.

[13] Bypass humidifiers have extremely similar capacities and watt ratings. Therefore, the national savings estimate can't be estimated.

[14] 4% of 17.2 million households - 2009 RECS data – Weighted based upon the following estimated market penetration: 60% bypass, 30% Fan Powered, and 10% Steam.

[15] 206,400 estimated homes.

[16] 68,800 estimated homes.

[17] Ibid.

[18] 206,400 estimated homes.

[19] 68,800 estimated homes.

[20] Conversations with manufacturers and 2009 RECS data. Assumes a lifetime installed base of 35.5 million homes (32 million portable over 4 years and 3,500,000 whole-house over 10 years).

[21] Conversations with manufacturers, 2009 RECS data, ten year whole-house lifetime, 4 year portable lifetime, and $0.1151/kwh.

Note that while warm mist portable humidifiers are useful for easing the symptoms of illnesses, there are no significant use case differences between portable Cool Mist and Ultrasonic models. Given the fact that Cool Mist models consume, on average about 136% more energy than ultrasonic models, EPA may wish to explore associated technology-based savings opportunities. Thus, while ultrasonic and cool mist technologies differ in energy consumption, they are effectively interchangeable technologies from a functional perspective.

Similarly, while all whole house humidifier models perform an essentially identical humidification function, steam models consume, on average, 14,835% more energy than bypass models and 1,637% more than fan-powered models.

2. *Product & Technology Overview*

For the purposes of this scoping report, a humidifier is defined as a device intended to introduce moisture within a dwelling to maintain or increase humidity levels. Common variations of humidifiers in the residential space are as follows:

Portable

A portable humidifier is intended to increase the humidity in one room, multiple rooms, or, in rare circumstances, a small home (up to 2,500 square feet). In portable applications, a humidistat (small rotary or digital controller) is built-in to the device to allow the user to either select a relative humidity target or to select a “low”, “medium”, or “high” setting. Portable humidifiers have a water tank, and come equipped with a standby mode which activates only when it runs out of water. Product safety is the major purpose of the standby feature. Certain portable humidifiers have hybrid ultrasonic and warm mist functionality, which can be switched back and forth manually by the user. All portable units plug directly into a 120V outlet and use at least one of the three following major types of humidification technologies:

Warm Mist – Water is heated by an element within a reservoir and is released into the surrounding area in vapor form.	
Cool Mist – A fan blows water towards a diffuser or wick which may create a fine mist.	
Ultrasonic – A piezo-electric device is placed inside a basin of water. The high-frequency vibrations create water vapor without the need for heating and a fan propels the vapor outward.	

Whole-House

Unlike a portable humidifier, a whole-house humidifier is usually installed by a HVAC professional in the ductwork of a forced warm air HVAC system. These products may use the HVAC system fan to deliver humidified air throughout the house using the existing ductwork. Generally, whole-house humidifiers are chosen based upon the size of the home and can effectively humidify up to 6,000 square feet. Maintenance of these devices includes filter replacement approximately once every six months. Whole-house humidifiers usually connect directly to a water source and provide a desired amount of humidity using a manually-controlled humidistat. The humidistat is typically powered by 24 VAC. Whole-house humidifiers may be powered either from 230, 120, or 24 VAC power sources. Whole-house units are typically installed by a contractor, who makes size and type recommendations to the homeowner, largely based on the square footage of the home. The following types of built-in humidifiers are being installed today:

Bypass – Flow-through humidifiers utilize a pad that is periodically sprayed with water and then exposed to the airflow in the HVAC system.	
Fan Powered – A reservoir of water is exposed to the air flowing through the HVAC system. These devices also use their own fan if the HVAC system is inactive.	
Steam – A container of water is heated using a heating element and a fine mist of water is sprayed directly into the air flowing through the HVAC system. Such systems are used in humid areas of the country.	

An average steam humidifier uses over 14 times the energy of a bypass humidifier for 1-hour of usage. In rare circumstances, a steam mist humidifier may require 208V power.

Product Components

The basic components of a humidifier are described in Table 3.

Table 3: Humidifier Main Product Components

Portable	
Component	**Description**
Distribution Tray	A reservoir-like container that holds a reserve of water that is intended to be dispersed into conditioned space.
Evaporative Wick	The evaporative wick is soaked with water and moisture is added to the conditioned space.
Electric Motor	A small motor is used to vaporize, boil, or disperse water mechanically.
Fan	The fan is used to propel moisture from the wick or distribution tray into the conditioned space.
Whole-House	
Component	**Description**
Drain	In most models, unused water in a distribution tray will be flushed down a drain to impede mold growth.
Distribution Tray	An open container of water which allows the water contained therein to evaporate as air passes through.
Fan	Non-bypass models can use an internal fan to increase airflow over an evaporative wick or a distributive tray to aid in evaporation.
Evaporative Wick	In models with a fan, a wick is soaked with water and moisture is added to the conditioned space.
Steam Generator	In steam-producing models, electrodes are placed into a cylinder of water that increases its temperature to produce steam.

3. *Market Assessment and Usage Assumptions*

U.S. Market Analysis and Usage Patterns

Major manufacturers of portable humidifiers include Crane, Jarden, Essick, Sunpentown (SPT), and Air-O-Swiss. On an annual basis, roughly 8,000,000[22] portable humidifiers are sold into the U.S. market. Generally speaking, the U.S. market breakdown of ultrasonic, cool mist, and warm mist humidifiers comprise approximately 20%, 50% and 30% of the market, respectively.[23] As a percentage of the entire humidifier market, portable devices encompass approximately 96% of the total number of humidifiers sold and 92% of the total annual energy consumed by all humidifiers.[24]

Major manufacturers of whole-house manufacturers include Aprilaire, Honeywell,, and GeneralAire. On an annual basis, approximately 350,000[25] whole-house humidifiers are sold into the residential market. The market breakdown of bypass, fan powered, and steam humidifiers composes approximately 60%, 30%, and 10% of the market, respectively.[26] As a percentage of the entire humidifier market, whole-house devices comprise approximately 4% of

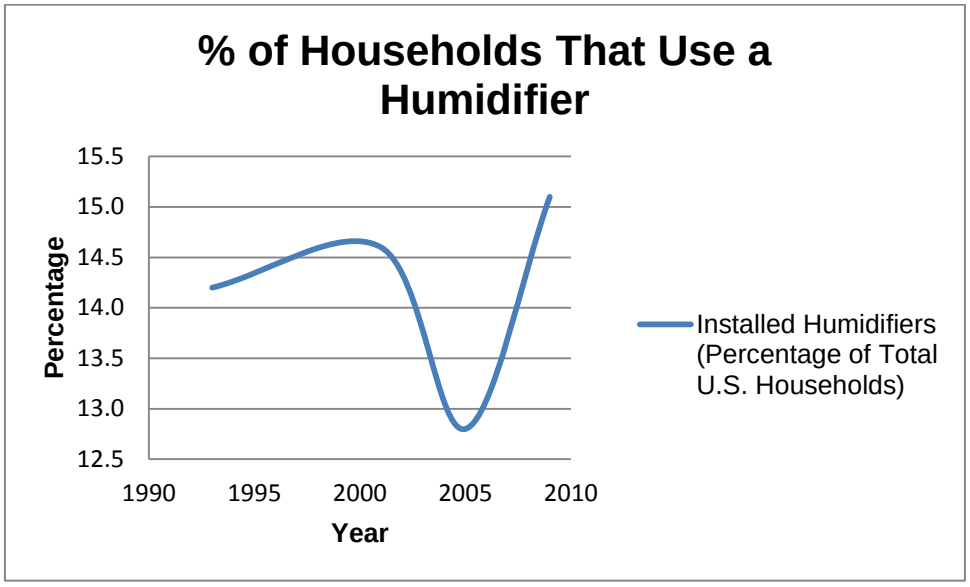
[22] Determined in conversations with manufacturers.
[23] Ibid
[24] Calculated based on weighted energy consumption of 8,000,000 portable units and 350,000 HVAC units.
[25] Manufacturer-reported annual shipments.
[26] Determined in conversations with manufacturers.

the total number of humidifiers sold and 8% of the total annual energy consumed by all humidifiers.[27]

Existing Stock of Humidifiers

From 1993 to 2009, the residential humidifier market penetration as a percentage of total households in the U.S. has only marginally increased. In 1993, 14.2% of households claimed to use a humidifier, whereas market penetration only increased to 15.1% in 2009 (Figure 1). In that same timespan (Figure 2), the total amount of humidifiers used in U.S. households increased by slightly over 25%.[28]

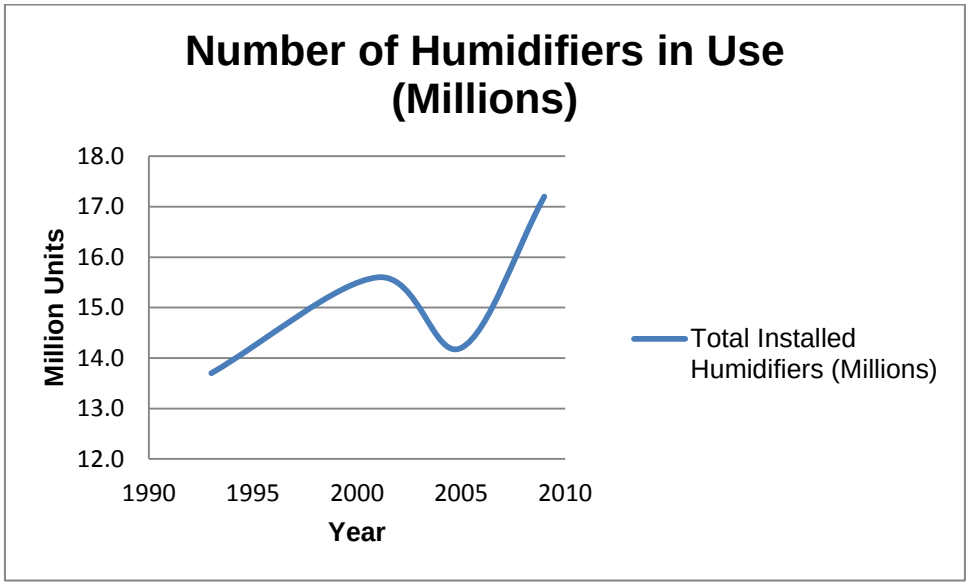
Figure 1. Humidifier Usage as a Percentage



[29]

[27] DOE– EIA. Residential Energy Consumption Survey 2005-2009 Public Use Data Files.
[28] DOE– EIA. Residential Energy Consumption Survey 1993-2009 – Excluding 1997 Data (not collected)
[29] Ibid.

Figure 2. Humidifier Market Size



[30]

Usage Patterns

Based on usage patterns from 2005-2009, shown below in Table 4, approximately 88% of homeowners that own a humidifier use them 1-6 months of the year.[31] The Energy Information Administration's (EIA) Residential Energy Consumption Survey (RECS) does not differentiate between whole-house and portable humidifiers on its survey request form, and therefore this report assumes these usage patterns apply to all residential humidifiers in the U.S.[32]

Table 4: Household Humidifier Usage Patterns[33]

Humidifier Monthly Usage Patterns	2005		2009	
	U.S. Households (millions)	Percentage of All Households	U.S. Households (millions)	Percentage of All Households
Use a Humidifier at Some Point During the Year	14.2	13%	17.2	15%
- 1 to 3 Months Each Year	7.1	6%	9.2	8%
- 4 to 6 Months Each Year	5.6	5%	5.7	5%
- 7 to 9 Months Each Year	.4	<1%	.9	1%
- 10 to 11 months	N/A	N/A	.2	<1%
- Turned on All Year Long	1.1	1%	1.2	1%
Do Not Use a Humidifier At Home	96.9	87%	96.5	85%

[30] Ibid.
[31] DOE– EIA. Residential Energy Consumption Survey 2005-2009 Public Use Data Files.
[32] Ibid
[33] Ibid

This scoping report assumes that the average humidifier owner will use a humidifier no more than 2,500 hours per year (approximately 29% of the year).[34] Of the 17.2 million households in the U.S that use a humidifier, 9.2 million use it for at least one month per year, and based on average monthly usage, the weighted annual average hourly usage of a humidifier is approximately 843 hours per year.

Humidifier Lifetime

The average lifetime of portable humidifiers is generally estimated in the range of 3-5[35] years. Regular maintenance and cleaning these devices can have a large impact on their performance and lifespan. If cool mist or ultrasonic portable devices are not cleaned regularly (every 2-3 weeks), mold and other bacteria can grow, which can enter into the vaporized water and eventually into the conditioned space. In warm mist applications, the water is heated to create steam, which kills most bacteria. Calcium and lime build up over time and can cause a decrease in the amount of steam delivered or change the trajectory of the heated vapor. This mineral buildup can be removed with a vinegar-based solution. Manufacturers recommend that maintenance measures should be taken on a weekly basis for such products.

Whole-house humidifiers generally require much less maintenance than portable devices and have much longer lifetimes. For example, the basin of a bypass humidifier can be easily replaced by a resourceful homeowner or an HVAC professional. Ducted/HVAC-installed parts are usually easily replaceable. On an annual basis, a homeowner should clean the evaporation pad and its housing with a vinegar-based solution.

The average lifetime of whole-house humidifiers is generally estimated in the range of 10[36] years. Anecdotally, a whole-house humidifier can outlast the HVAC system to which it is connected and be placed into an entirely new system if proper annual maintenance is observed.[37]

Pricing

Within the humidifier market, there is generally no tradeoff in initial price point for guaranteed energy savings. Features such as a heating element increase the device's energy consumption and price point. High efficiency technologies, such as ultrasonic humidifiers usually cost less than their less efficient counterparts, such as cool mist humidifiers. Given that, consumer payback scenarios in this report cannot compare efficiency vs. cost-per-unit annual payback. As of the completion of this report, no utilities in the U.S. have incentivized humidifiers. However, in Ontario, Canada, significant rebates are available for certain bypass or fan powered whole-house models due to their water savings potential.[38] Table 5 below shows the average price for portable and whole-house humidifiers in the U.S. retail market.

[34] Ibid
[35] Ibid
[36] Ibid
[37] Determined in conversations with manufacturers.
[38] http://www.waterfortomorrow.ca/en/athome/humidifierrebates.asp

Table 5: Average Price Points of Residential Humidifiers

Portable	Ultrasonic	**$121**
	Cool Mist	**$70**
	Warm Mist	**$135**
Whole House	Bypass	**$148**
	Fan Powered	**$189**
	Steam	**$640**

4. *Humidifier Test Procedures and Standards*

U.S. Federal Energy Conservation Standards

As of the completion of this scoping report, there are no federal minimum energy standards or test methods available for portable or whole-house humidifiers. Industry organizations such as Air-Conditioning, Heating, and Refrigeration Institute (AHRI), the American National Standards Institute (ANSI), the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), and the Association of Home Appliance Manufacturers (AHAM) have developed voluntary standards to quantify humidifier performance based on humidification capacity. There are no known required test methods that must be used prior to making water output capacity claims on packaging or brochures in the residential humidifier market. Though AHAM and AHRI carry out certification programs for many other types of residential appliances and/or HVAC equipment, neither organization has implemented a certification program for residential humidifiers.

Method of Test for Residential Central-System Humidifiers – ANSI/ASHRAE 164.1 - 2008[39]

ANSI/ASHRAE standard 164.1 delineates the proper test setup, air pressure, and relative humidity levels which allow the humidification capacity of a residential whole-house humidifier to be properly measured.

Portable Household Humidifiers – AHAM HU-1-2006 (Revised 2011) [40]

AHAM's HU-1 standard contains water output capacity calculations for evaporative and non-evaporative models, a humidifier-sizing method, numerous definitions, and a standardized setup for testing portable humidifiers. Notably, this test method does not take into consideration the watt rating of the device being tested. HU-1 is the only known residential portable humidifier standard and it is not required to be used by manufacturers prior to testing.

[39] ANSI/ASHRAE Standard 164.1, Method of Test for Central System Humidifiers for Residential Applications
[40] Portable Household Humidifiers – AHAM HU-1-2006 (Revised 2011)

ANSI/AHRI Standard 620 - Performance Rating Of Self-Contained Humidifiers For Residential Applications (2004) [41]

ANSI/AHRI Standard 620 establishes definitions, proper data claims, test setup and humidification method of test for self-contained whole-house humidifiers.

ANSI/AHRI Standard 610 - Performance Rating Of Central System Humidifiers (2004) [42]

ANSI/AHRI Standard 620 establishes definitions, proper data claims, energy consumption calculations, test setup and method of test for self-contained whole-house humidifiers. Unlike standard 620, standard 610 contains a calculation to quantify the combined energy consumption of the HVAC system and humidifier.

5. *Energy Assessment*

Portable and whole-house humidifiers enter a standby mode only when the device runs out of water or when the desired humidity level has been achieved. This report necessarily assumes that all technologies have similar run times across different technologies, as the DOE RECS does not discern between types of products in the survey. Portable humidifiers that do not have a humidistat will run continuously until they run out of water. AHAM HU-1 2006 reflects this characteristic in the scope of its recommended use guidelines: "The measured output of a portable humidifier is based upon continuous operation at standard rating conditions. With normal variations of indoor and outdoor conditions, the humidistat-controlled humidifier will not run continuously, at maximum output, unless the controls are set to do so." Further, portable humidifiers are rated for capacity and square footage in retailer and manufacturer websites.

Whole-house humidifiers function when a command is sent from a humidistat. Upon evaluation of the watt ratings of different whole-house technologies, there is a great disparity in energy consumption between the most and least consumptive devices. As the industry does not report watt ratings for standby mode, estimated savings only consist of On Mode power in this report. Within both portable and whole-house estimates, energy consumption comparisons can only be made against interchangeable technology types.

Tables 6 and 7 below illustrate the average energy consumption and cost of one household depending upon the type of humidifier in use. These estimates are weighted by each subcategory's estimated market penetration based on annual sales as provided by manufacturers.

[41] ANSI/AHRI Standard 620 - Performance Rating Of Self-Contained Humidifiers For Residential Applications
[42] ANSI/AHRI Standard 610 - Performance Rating Of Central System Humidifiers

Table 6: Average Annual Portable Humidifier Energy Use Per Household[43]

Type	Watt Rating in Operating Mode	Kilowatt Rating in Operating Mode	Total Annual Energy Consumed per Household (kWh)	Total Annual Operating Cost per Household ($)[44]	Total Lifetime National Energy Consumed per household (kWh)[45]	Total Lifetime National Operating Cost per Household ($)[46]	Total Annual National Energy Consumed (MkWh)	Total Annual National Operating Cost per Household ($Million)
Ultrasonic	36.06	0.03606	30.41	$3.50	121.63	$14.00	100.4	$11.5
Cool Mist	85.46	0.08546	72.06	$8.29	288.26	$33.16	594.9	$68.4
Warm Mist	193.55	0.19355	163.21	$18.79	652.84	$75.16	808.4	$93.0
Weighted Total (or Average)	-	-	**91.08**	**$10.48**	**364.32**	**$41.92**	**1,503.8**	**$173.0**

Table 7: Average Annual Whole-House Humidifier Energy Use Per Household[47]

Type	Watts in Operating Mode	Kilowatts in Operating Mode	Total Annual Energy Consumed per Household (kWh)	Total Annual Operating Cost per Household[48] ($)	Total Lifetime National Energy Consumed per Household (kWh)[49]	Total Lifetime National Operating Cost per Household ($)[50]	Total Annual National Energy Consumed per Household (MkWh)	Total Annual National Operating Cost per Household ($Million)
Bypass	11.63	0.01163	9.81	$1.13	98	$11	4.0	$0.5
Fan Powered	100	0.1	84.33	$9.71	843	$97	17.4	$2
Steam	1,737	1.73733	1465.00	$168.62	14650	$1,686	100.8	$11.7
Weighted Total (or Average)	-	-	**177.68**	**$20.45**	**1777**	**$204.50**	**122.2**	**$14.1**

Savings Opportunities

This report assumes the average household uses 12,773 kwh per year.[51] At a conversion rate of $0.1151 per kwh, the average U.S. household pays approximately $1,470 in electricity costs

43 Figures weighted based upon market penetration and average annual hourly usage (843.25 hours per year).
44 Cost of electricity = $0.1151/kWh
45 Lifetime assumed to be 4 years.
46 Ibid
47 Figures weighted based upon market penetration and average annual hourly usage (843.25 hours per year).
48 Cost of electricity = $0.1151/kWh
49 Lifetime assumed to be 10 years.
50 Ibid
51 Note: This figure is based on the annual electricity consumed by an average single family household.

per year. To acquire the most realistic picture of the energy savings potential for humidifiers, dissimilar products are not compared to one another. For example, whole-house humidifiers, which have a large water output capacity and are installed in the HVAC system of a home are not compared to any kind of portable humidifier. Similarly, the main purpose of a warm mist portable humidifier may be to disperse warm humidity and medicine within a flu patient's room. Cool mist and ultrasonic humidifiers are generally not used for this purpose.

Given that, Tables 11 and 15 illustrate the savings potential of switching from one inefficient humidifier technology to a more efficient technology. In both cases, the compared products are interchangeable and serve nearly identical purposes.

Portable Savings Opportunities

The estimated savings figures in this report compare hypothetical humidifiers that consume energy at the 75th quartile of the market to comparable hypothetical humidifiers that consume energy at the 25th quartile of the market. The baseline for the inefficient product assumes a watt rating of 44.5 for ultrasonic, 81 for cool mist, and 220 for warm mist. Tables 8 and 9 illustrate the national energy savings potential of portable humidifiers when comparing efficient and inefficient products.

Table 8: Assumptions: National Efficient vs. Inefficient Portable Humidifier Savings Potential

Product Type & Efficiency Level	Watt Rating[52]	Average Cost of Unit $	W Converted to KWH	$ per KWH	Annual Hours of Operation	Electricity Cost Per Year $
Ultrasonic Inefficient (baseline) 75th Percentile	44.5	151	0.0445	0.1151	843.25	4.32
Ultrasonic Efficient 25th Percentile	30.5	100	0.0305	0.1151	843.25	2.96
Cool Mist Inefficient (baseline) 75th Percentile	81	72.99	0.081	0.1151	843.25	7.86
Cool Mist Efficient 25th Percentile	38	36.11	0.038	0.1151	843.25	3.69
Warm Mist Inefficient (baseline) 75th Percentile	220	189.99	0.22	0.1151	843.25	21.35
Warm Mist Efficient 25th Percentile	125	55.97	0.125	0.1151	843.25	12.13

Sources: EIA (2008). 2005 Residential Energy Consumption Survey. Table US-3, Total Consumption by Fuels Used, 2005, Physical Units (PDF) (4 pp, 50K, About PDF). EPA (2009). eGRID2007 Version 1.1. U.S. EPA.

[52] Watt ratings are 25th and 75th quartile of all of the available watt ratings for a given subcategory.

Table 9: Comparison: National Efficient vs. Inefficient Portable Humidifier Savings Potential[53]

Type	75th and 25th Quartile of Energy Consumption	Amount of Households Within Each Category [54]	Total National Lifetime Electricity Consumption (Mkwh)	Total National Lifetime Operating Cost[55] ($Millions)	Payback Period (years) [56]	National Lifetime Savings Potential (Mkwh)	National Lifetime Savings Potential ($Millions)
Ultrasonic	Inefficient (75th)	3,302,400	495.6	$57.0	N/A	155.9, a decrease of 32%	$17.9 a decrease of 32%
	Efficient (25th)		339.7	$39.1	N/A		
Cool Mist	Inefficient (75th)	8,256,000	2,255.6	$259.5	N/A	1,197.4, a decrease of 53%	$137.7 a decrease of 53%
	Efficient (25th)		1,058.2	$121.8	N/A		
Warm Mist	Inefficient (75th)	4,953,600	3,675.8	$423.0	5 years[57]	1,587.3, a decrease of 43%	$182.6,a decrease of 43%
	Efficient (25th)		2,088.5	$240.3			
Lifetime Total Combined National Savings Estimate[58]	**Savings of 2,940.6 Mkwh and $359.5M (4,528.6 Mlbs of CO_2)[59]**						

Over the course of the estimated lifetime of each product (four years), and if all portable humidifiers meet the 25th quartile of energy consumption of their respective subcategory, the energy consumption calculation results in a savings of approximately 2.9 terawatts of electricity and $360 million. That reduction in energy consumption would also prevent approximately 4.5 billion pounds of carbon from entering the atmosphere. On a per-household basis, switching

[53] Figures weighted based upon weighted annual hourly usage.
[54] Weighted based upon market penetration of each subcategory of each technology and a total of 17.2 million households with a humidifier.
[55] Cost of electricity = $0.1151/kWh
[56] Efficient ultrasonic and cool mist portables cost less than their inefficient counterparts, which means there is no payback period for these products.
[57] The cost difference between an efficient vs inefficient warm mist humidifier is approximately $45. That is to say that efficient warm mist humidifiers cost roughly $45 more initially than their inefficient counterparts.
[58] If 100% of currently installed portable humidifiers meet the 25th quartile of energy consumption over 4 years.
[59] 1 kwh = 1.54 lbs of CO_2

from an inefficient ultrasonic, cool mist, or warm mist humidifier to an efficient model will save approximately $5.44, $16.68, and $36.68, respectively, over the estimated four year lifetime.

Table 10: Portable Humidifiers: Household Energy Savings Potential By Switching to Efficient Product[60]

Type	Estimated Savings
Ultrasonic	$5.44
Cool Mist	$16.68
Warm Mist	$36.68

Of the three major technology types within the portable category, ultrasonic devices use the least amount of energy. Assuming near-identical usage patterns, the average ultrasonic humidifier uses approximately 58% less energy per year than the average cool mist humidifier. Since consumers may be inclined to use these comparable humidifiers for the same purpose, table 11 shows the energy savings potential if every consumer that owns a cool mist humidifier instead purchased an ultrasonic humidifier.

Table 11: Comparison: National Portable Humidifier Savings Potential – All Cool Mist Humidifiers Switched for Ultrasonic Humidifiers[61]

	Amount of U.S. Homes with Humidifier (50% Cool, 30% Warm, 20% Ultrasonic)	Annual National Energy Savings Estimate ($Millions)	Weighted Total Annual Energy Consumption U.S. Total Mkwh (# of units x annual kwh usage)
Ultrasonic	3,302,400	$11.5	100.4
Cool Mist	8,256,000	$68.4	594.9
Assuming 8,256,000 cool mist purchases switched to ultrasonic	11,558,400	$40.4	$351.4
Total kwh and $ Savings Potential	$39.5M and 343.9 Mkwh (522.8 Mlbs of CO_2)[62]		

If every ultrasonic and cool mist humidifier purchase in the U.S. were comprised of only ultrasonic humidifiers, the total present energy cost per year for both subcategories would decrease by approximately 49%.

[60] Based on figures in table 10.
[61] This table assumes one year of use.
[62] 1 kwh = 1.54 lbs of CO_2

Whole-House Savings Opportunities

Though the whole-house humidifier market consists of bypass, fan powered, and steam technologies, only the latter two categories have a wide range of watt ratings. Of the watt-ratings found in the marketplace, the difference in energy consumption between the 25th and 75th quartile of bypass devices is effectively zero. Therefore, table 12 consists of a comparison of the energy savings potential of efficient fan powered and steam humidifiers. Similar to table 7, table 12 assumes certain baselines to compare any potential energy savings. The baseline for the inefficient product assumes a watt rating of 108 for fan powered, and 1,916 for steam. Tables 12 and 13 illustrate the national energy savings potential of whole-house humidifiers when comparing hypothetical efficient and inefficient products.

Table 12: Assumptions: National Efficient vs. Inefficient Whole-House Humidifier Savings Potential

Product Type & Efficiency Level	Watt Rating	Average Cost of Unit $	W Converted to KWH	$ per KWH	Annual Hours of Operation	Electricity Cost Per Year $
Fan Powered Inefficient (baseline) 75th Percentile	108	229.41	0.108	0.1151	843.25	10.48
Fan Powered Efficient 25th Percentile	90	164.68	0.09	0.1151	843.25	8.74
Steam Inefficient (baseline) 75th Percentile	1916	699.95	1.916	0.1151	843.25	185.96
Steam Efficient 25th Percentile	1410	609.95	1.41	0.1151	843.25	136.85

Table 13: Comparison: National Efficient vs. Inefficient Whole-House Humidifier Savings Potential[63]

Type	75th and 25th Quartile of Energy Consumption	Amount of Households Within Each Category[64]	Total National Lifetime Electricity Consumption (Mkwh)	Total National Lifetime Operating Cost[65] ($Millions)	Payback Period (years)	National Lifetime Savings Potential (Mkwh)	National Lifetime Savings Potential ($Millions)
Fan Powered	Inefficient (75th)	206,400	187.9	21.6	N/A*	31.3, a decrease of 17%	$3.6, a decrease of 17%
	Efficient (25th)		156.6	18.0			
Steam	Inefficient (75th)	68,800	1,111.5	127.9	N/A*	293.5, a decrease of 26%	$33.7, a decrease of 26%
	Efficient (25th)		818.0	94.1			
Lifetime Total Combined National Savings Estimate[66]	**Savings of approximately 450.2 Mkwh and $51.8M (693.3 Mlbs of CO_2)[67]**						

*More efficient Fan Powered products are generally cheaper than inefficient products. With regards to Steam products, there are very few data points available, which do not allow determining the payback period.

Over the course of the estimated lifetime of each product (ten years), and if all fan powered and steam humidifiers meet the 25th quartile of energy consumption of their respective subcategory, the energy consumption calculation results in a savings of approximately 450.2 gigawatts of electricity and $52 million. That reduction in energy consumption would also prevent approximately 693 million pounds of carbon from entering the atmosphere. On a per-household basis, switching from an inefficient fan powered or steam humidifier to an efficient model will save approximately $17.47 and $491.11, respectively, over the estimated ten year lifetime.

Table 14: Whole-House Humidifiers: Household Energy Savings Potential By Switching to Efficient Products[68]

Type	Estimated Savings
Fan Powered	$17.47
Steam	$491.11

[63] Figures weighted based upon market penetration and average annual hourly usage.
[64] Weighted based upon market penetration of each subcategory of each technology and a total of 17.2 million households with a humidifier.
[65] Cost of electricity = $0.1151/kWh
[66] Assumes a 10 year lifetime.
[67] 1 kwh = 1.54 lbs of CO_2
[68] Cost of electricity = $0.1151/kWh, 206,400 fan powered and 68,800 steam units.

Table 15 contains a comparison of national savings potential if every consumer that owns a fan powered humidifier and/or steam humidifier instead owned a bypass humidifier.

Table 15: Comparison: National Whole-House Humidifier Savings Potential – All Installed Fan Powered and/or Steam Humidifiers Switched for Bypass Humidifiers[69]

	Amount of U.S. Homes with Humidifier (60% Bypass, 30% Powered Fan, 10% Steam)	Weighted Total Annual Energy Consumption U.S. Total $ Millions (# of units x $ cost of kwh use per unit)	Weighted Total Annual Energy Consumption U.S. Total Mkwh (# of units x annual kwh usage)
Bypass	412,800	$0.5	4.0
Fan Powered	206,400	$2.0	17.4
Assuming 206,400 fan powered purchases switched to bypass	619,200	$1.7 savings & 72% decrease	15.3 savings & 72% decrease
Steam	68,800	$11	100.7
Assuming 68,800 steam purchases switched to bypass	481,600	$11.5 savings & 95% decrease	100.1 savings & 95% decrease
Total kwh and $ Savings Potential by switching all Fan Powered and Steam to Bypass	**Savings of approximately 115.4 Mkwh, $13.2 Million and a decrease of 178 Million lbs of CO_2[70]**		

If every bypass and fan powered whole-house humidifier in the U.S. used the equivalent amount of energy as the average bypass humidifier, the total energy cost per year would decrease by approximately 72%.

If every bypass and steam whole-house humidifier in the U.S. used the equivalent amount of energy as the average bypass humidifier, the total national energy cost per year would decrease by approximately 95% and save homeowners approximately $11.5 million on an annual basis. Collectively, this scenario would prevent approximately 178 million lbs. of CO_2 from entering the atmosphere.

[69] This table assumes one year of use.

[70] 1 kwh = 1.54 lbs of CO_2

HVAC Effects

Whole-house humidifier manufacturers claim that a properly humidified house can reduce a homeowner's heating costs. Though no peer-reviewed scientific studies have been carried out to quantify this effect specifically for the whole-house humidifier market, a major manufacturer claims[71] that maintaining proper relative humidity within the home can save a homeowner approximately 1,500 – 2,100 kwh per year. This figure is based on an analysis of a case study performed in three homes in varying climates across the country. Further, only the HVAC system as a whole was evaluated for energy savings – not the humidifier by itself. More research is needed to determine the veracity of these claims.

6. Key Market Players

Industry Associations

Air-Conditioning, Heating, and Refrigeration Institute (AHRI) is a trade association of HVAC product manufacturers. AHRI collects shipments of whole-house humidifiers on an annual basis. AHRI does not currently offer a certification program for humidifiers.

The Association of Home Appliance Manufacturers (AHAM) is a trade association of home appliance manufacturers. Similar to AHRI, AHAM collects shipment data, administers certification programs on behalf of its members, and does not currently offer a certification program for humidifiers.

Product Manufacturers

Table 16: Product Manufacturers

Manufacturer	Brand(s)
Air-O-Swiss	Air-O-Swiss
Aprilaire	Aprilaire, Lennox
Crane	Crane
Essick	Essick
Jarden	Sunbeam
Hunter	Hunter
Honeywell	Honeywell (Whole-House)

[71] Brodsky, Eric – Aprilaire – The Need for Humidifiers in Energy Efficient Homes – Presentation 2/2/2011

Idylis	Idylis
Kaz	Honeywell (Portable), Vicks
Pureguardian	Germ Guardian
Sunpentown	SPT
VentaSonic	Ventasonic

7. Industry Contacts

Humidifier Industry Associations

- Jennifer Cleary, Director of Regulatory Affairs at AHAM
- Laura Petrillo-Groh, Senior Certification Engineer at AHRI

Portable Humidifier Manufacturers

- Dirk Niedermann, Vice President of Operations at Crane USA
- Jamie Libregts, Senior Marketing Manager at Jarden
- Allen Huang, Marketing at Sunpentown

Whole-House Humidifier Manufacturers

- John Bloemer, Director of Engineering at Aprilaire
- Dr. Sanjeev Hingorani, Engineer at Lennox
- Dan O'Donnell, Director at Honeywell