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Throw in the Towel: High-speed, Energy-efficient Hand Dryers Win Hands Down

Learn why a Life Cycle Assessment (LCA) is the "gold standard" for proving sustainability claims and revisit the conventional wisdom about hand drying in K-12 schools and other public restrooms.

High-speed energy-efficient hand dryer

Provided by Excel Dryer, Inc.
By Roger C. Brady, AIA, LEED AP

High-speed, energy-efficient (HSEE) hand dryers have been developed by several manufacturers over the past 10 years and are now the most sustainable solution for drying your hands in public restrooms. This class of dryers is better for the environment than conventional (electric) dryers and old-fashioned paper towels.

CONTINUING EDUCATION

Use the learning objectives below to focus your study as you read **Throw in the Towel: High-speed, Energy-efficient Hand Dryers Win Hands Down**. To earn one AIA/CES Learning Unit, including one hour of health safety welfare/sustainable design (HSW/SD) credit, answer the questions on page 9, then follow the reporting instructions or go to **ce.ArchitecturalRecord.com** and follow the reporting instructions.

Learning Objectives
After reading this article, you should be able to:

- List the primary benefits of high-speed, energy-efficient hand dryers for K-12 school applications
- Distinguish between the two main categories of HSEE hand dryers
- Identify the major stages or phases in an environmental Life Cycle Assessment
- Describe how the midpoint and endpoint categories figure into the LCA methodology
- Discuss the concepts of Scenario Evaluations and Sensitivity Tests and their impact on an LCA
- Recognize the environmental Life Cycle Assessment benefits and impacts for various hand-drying approaches

This course will first look at the key benefits of high-speed, energy-efficient (HSEE) hand dryers for K-12 and higher education facilities. Then it will shift gears for the remainder of the article and examine how a manufacturer goes about proving the sustainability of its product; namely by commissioning a peer reviewed, Life Cycle Assessment (LCA), which is the current "gold standard" in proving the case of a product's (relative) sustainability.

Many architects are familiar with some level of life cycle cost calculations, payback periods for one selection vs. another, or ROI (Return on Investment) on the initial cost of an investment. But few of us have delved into the details of an LCA sufficiently to articulate the major stages, describe midpoint and endpoint impact categories, the rigor & conscientiousness of scenario evaluations and sensitivity tests, and why a peer reviewed LCA is the only internationally accepted method of comparative environmental assessment of products.

WHY HIGH-SPEED ENERGY-EFFICIENT (HSEE) HAND DRYERS ARE RIGHT FOR K-12 SCHOOLS

Like most businesses, households, and public entities in the United States, school districts are looking for ways to live within their means, reduce costs, and spend their money wisely. Something as small as drying your hands can have a big impact, especially when you have 10s or 100s, or 1,000s of restrooms throughout your facilities. Paper towels are still commonly used. But new

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HSEE hand dryers have a more modern look, much different from conventional dryers.

evidence suggests this is no longer the cost effective or best choice environmentally. Since 2000, smart organizations have dispensed with paper towels and now use the latest in hand drying technology. What benefits do these so-called, high-speed, energy-efficient (HSEE) hand dryers have in common?

• **Energy-efficient.** To be considered in this class, they need to provide a 3-4 fold energy savings over conventional air dryers. There are various mechanical and electrical innovations (and patents) to improve the low horsepower motors for hand dryers to spin from 20,000 up to 40,000 RPMs.

• **High-speed.** To save energy, you not only need a more efficient motor, but you need to move the air at a much faster velocity – even up to 16,000 LFM. Airflow is measured in lineal feet per minute (LFM) for new dryers vs. cubic feet per minute (CFM) with old-technology dryers.

• **Hot air.** The introduction of heat — at 135 degrees at the air outlet — is necessary to speed the drying process from 30-45 seconds down to typically 10-15 seconds. Heat is a vital element to the drying process for HSEE hand dryers, since it evaporates the "residual boundary layer of moisture" on skin.

• **Faster drying times.** To be in this class of dryer, at least a 3-fold improvement in drying time vs. conventional dryer times (of 30-45 seconds) is required. Furthermore, "completely dry" is now defined to mean .02 grams of residual water. New HSEE dryers 'penetrate the boundary layer' of moisture on the skin and the broken down water molecules are then easily evaporated by the heated airstream. (It should be noted that rubbing your hands actually slows down the drying process with the new technology.)

• **Motion sensitive.** Virtually all dryers in this new classification are also motion sensitive so you don't have to grab a handle or push a button to activate the drying process, making them more hygienic than conventional dryers or paper towel dispensers.

• **Cleaner restrooms.** Hand dryers — HSEE or conventional — eliminate the paper clutter of a school restroom with towels on the floor, in the toilet fixtures, and overflowing waste receptacles. Less time is spent cleaning a K-12 restroom with hand dryers and you will have fewer calls to your plumber.

A peer reviewed, Life Cycle Assessment (LCA)... is the current "gold standard" in proving the case of a product's (relative) sustainability.

• **Cost Effective.** First, initial costs of HSEE hand dryers can vary greatly depending on the manufacturer. The payback period for some manufacturer's hand dryers versus paper towel systems — with their low initial costs but high operating costs to purchase and dispose of the towels — is less than a year.

Of special note, as schools face myriad budget cutbacks, Federal Stimulus money may be available to school districts for purchasing HSEE hand dryers that are "Made in USA" certified. The 2009 American Recovery and Reinvestment Act (ARRA) approved over $4.5 billion to convert and renovate federal facilities into high-

School District Saves Time and Money

The Niles Township School District 219, just north of Chicago, has over 4,800 students and like most school districts; it is asking hard questions about every dollar of operating expense.

Joe Tomaselli, Aramark Director of Operations for the District, said "Restrooms had always been an area where we faced a lot of extra work. Our student restrooms had both paper towels and traditional hand dryers, but we were constantly dealing with vandalism, blocked toilets and more, which translated into an extra four hours of clean-up every night. This was costing us an extra $16,500 per year in restroom maintenance!"

And the District was spending over $35,000 each year on paper towels alone, plus the additional cost of running the inefficient, conventional hand dryers for 30 seconds per use.

Bottom Line: The District removed virtually all of their towel dispensers and replaced all their existing, inefficient, conventional hand dryers with high-speed, energy-efficient hand dryers in the restrooms, based on Tomaselli's research and recommendation. By eliminating $35,000 each year in paper towel expense and reducing the extra $16,500 previously spent on extra clean up in the restroom maintenance, the District realized a one year payback on the new dryers. "In terms of energy savings, the new HSEE hand dryers drew an average of 1500 watts, compared to the traditional 2300 watts. Annually, this translated into an electrical consumption savings of $52 per unit, or for 80 units, an additional $4,160 per year in savings. The dryers delivered a return on investment in just one year. "Once we did the math, the cost savings were clear."

performance, green buildings. A combination of ARRA funds and energy tax credit bonds may be available to help schools turn their facilities into energy-efficient, high performance buildings.

Even with all these compelling benefits, not all HSEE dryers are created equal. It is important for design professionals or owners to do their homework and ask the right questions to get a fair comparison among the various new and old options.

PAYING ATTENTION TO DETAILS

How a manufacturer balances the energy use, motor speed, and amount of heat not only makes for a more or less successful drying experience, but it also impacts what may seem to be unrelated issues such as maintenance, hygiene, useful life, and suitability for a particular application. There are significant differences among the products in this 21st century-class of dryers, including:

• **Conventional or trough-style design.** Each manufacturer chooses between either the 'traditional' design approach – with the hands positioned under the air outlet or the "trough-style" approach – where the user puts his/her hands into a trough or enclosure of some sort.

• **Hygiene and vandalism.** These fundamental design decisions, in turn, can lead to hygiene and vandalism issues, both critical to K-12 schools and other public facilities. Trough-style designs can collect excess water from the user's hands in the trough creating a cool damp environment which bacteria needs to grow and a hygiene issue can result. The trough area can also provide a vandalism opportunity for a prankster to use his/her creativity to introduce another type of liquid that might require maintenance staff to remove and clean or could even necessitate a repair. Even though some 'trough-style' units filter the air that blows out of it, unless the trough area is free of all excess used water and debris, it is just filtered air blowing into unfiltered, perhaps contaminated air, which then swirls around the hands as they dry, making it less sanitary than a conventional design.

Additionally, the design of the motion sensor can prevent or create an opportunity for damage from moisture or vandalism. A completely sealed sensor and control assembly defends against both.

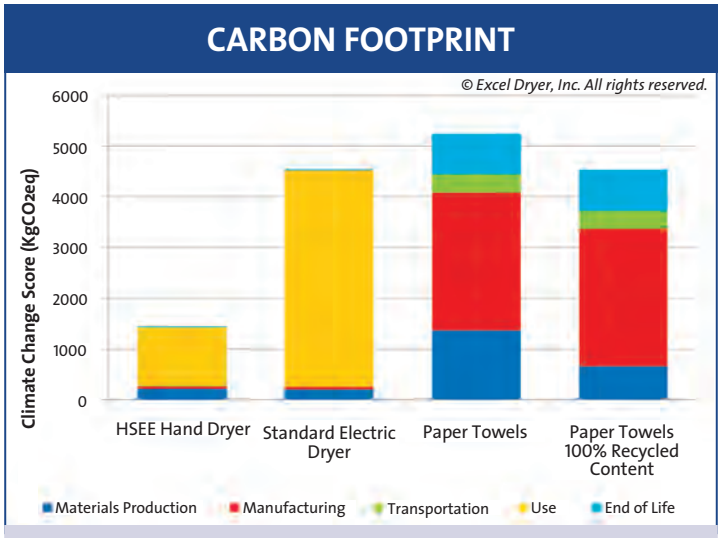
• **Useful life.** Each manufacturer has its own unique approach, to the design and speed of the motor and the necessary heat required to achieve a fast and a "completely dry" experience. The balance of these factors the manufacturers chose affect the useful life as well as scheduled maintenance, and likelihood of repair of a unit. An RPM rate that is too high can lead to burn outs and a short lifespan, while an RPM rate that is too low can lead to an inefficient or ineffective drying experience.

• **Maintenance, service, or repair.** Each manufacturer creates a complete system that is more or less maintenance free. A unit's design, components, and assembly determine the level of expertise and how much effort is required to get inside the unit to maintain, service, or repair it, or replace a part. What's required to get inside the machine? Is it serviceable on the wall or must it be removed? Can you do (some) repairs with your staff or must it be sent to a service center?

• **Drying position.** The 'trough-style' design used by some manufacturers requires the user to place her hands into the dryer. This may be an issue for disabled persons, school children of various heights, of individuals who may be leery of putting their hands into a dryer.

• **Noise.** With high-speed air comes a greater amount of sound. HSEE hand dryers will add some decibels to the environment, but with flushing toilets, running faucets, and the chance to talk in a normal tone with others, this is not usually a concern for most schools or other public restrooms. Some manufacturer's offer a noise reduction nozzle for sound sensitive areas.

• **Cost and savings.** This benefit includes several components and is a variable, dependent on your dryer selection. Reduced energy use and no paper towels to buy are obvious financial benefits over conventional dryers and paper towel dispensers respectively. But initial cost of the new technology varies among manufacturers, which affects how quickly the realized savings can payback that cost. A somewhat hidden cost, but real nonetheless, is the labor cost for required service, scheduled maintenance, and repair by your staff and/or an authorized provider.



Total life cycle climate change score for each system for the 5-endpoint or damage categories

THE LCA PROCESS

Saying a product or process is sustainable or more sustainable than the alternatives is increasingly common, as most architects can attest. But where's the irrefutable proof? Sometimes it is intuitive or it just makes sense. Other times, it can be so complex to identify and measure the variables that we might just take it on faith or throw up our hands.

Very few manufacturers submit their product or assembly to the detailed scrutiny of an environmental Life Cycle Assessment (LCA), which has been peer-reviewed by an independent panel of experts to ensure compliance with the ISO 14040 and 14044 standards. This approach is the 'Gold Standard' of rigor that addresses virtually all the environmental issues involved to give design professionals and building owners the indisputable evidence necessary to "prove it" with regard to sustainability. An LCA of

hand drying systems was completed by Quantis of Salem, MA (www.quantis-intl.com) in July 2009.

The remainder of this course will examine the major steps of one such LCA process and discuss the methodology and its implications to architects as it relates to HSEE hand dryers.

The LCA method examines a broad range of environmental impacts at all stages of the product life cycle, including all material, energy, and pollutant inputs and outputs. For instance, global warming and the resulting climate change is one of 16 environmental categories or issues studied. (See nearby diagram)

The three systems compared in this study were a specific make and model of high-speed, energy-efficient (HSEE) electric hand dryer, a conventional electric hand dryer, and paper towels containing between 0% and 100% recycled content. Each system was evaluated to determine the environmental impact of providing 10 years of service (drying 260,000 pairs of hands or 500 uses per week), which was a conservative or lower range of use.

The peer-reviewed LCA is the only internationally recognized and accepted method for identifying and comparing the total environmental impacts of producing and consuming a product or service.

USGBC decided to 'Throw in the Towel' at its HQ

USGBC's headquarters building is LEED Gold and its 22,000-sq. ft. interior is LEED Platinum. By using new HSEE hand dryers in each restroom, USGBC saves energy, which contributed to its Earth and Atmosphere Credit 1 — Optimizing Energy Performance. A spokesman for USGBC said, "We wanted dryers that would limit paper towel use and minimize energy consumption; but we also wanted them to work quickly and thoroughly. Not many hand dryers can make that claim."

In addition, HSEE dryers may help K-12 facilities qualify for the following credits in the LEED for Schools rating system:

- EA Credit 1: Optimize Energy Performance (1-19 points)
- MR Credit 5: Regional Materials* (1-2 points)
  *For projects within 500 miles of East Longmeadow, MA
- ID Credit 1: Innovation In Design - Path 1 (1 point)
- ID Credit 3: The School as a Teaching Tool (1 point)

A Life Cycle Assessment is comprised of the following four phases:

(a) Goal & Scope Definition: defining the purposes of the study, determining the boundaries for the system life cycle in question, and identifying important assumptions;

(b) Inventory Analysis: compiling a complete record of the important material and energy flows throughout the life-cycle, in addition to releases of pollutants and other environmental aspects being studied;

(c) Impact Assessment: using the inventory collide above to create a clear and concise picture of environmental impacts among a limited set of understandable impact categories; and

(d) Interpretation: identifying the meaning of the results of the inventory and impact assessment relative to the goals of the study.

An LCA is best practiced as an iterative process where the findings of each stage influence changes and improvements in the others to arrive at a study design that is of sufficient quality to meet the goals of the study and the principles, framework, requirements, and guidelines to perform an LCA as described by the international standards ISO series 14040 and 14044 (ISO 2006).

For this LCA, the objectives of the study were to:

1. Comprehensively **define the environmental impacts** over the whole life cycle for each of the three systems,
2. Provide an accurate **comparison of impacts** among the systems, and
3. Assess the **influence of several key variables** or characteristics, such as intensity of use (duration per dry or towels per dry), recycled content, alternative electricity sources, etc.

The intended audiences for this study included architects and interior design professionals, facility owners and operators, purchasers of hand dryers, and interested others. The intent of the study is to provide these audiences with the information they need to make a valid comparison of the life cycle environmental impacts of the systems in question. The impacts described in the study are estimates of potential impacts rather than direct measurements of real impacts.

The Functional Unit of the study is to dry **260,000 pairs of hands** over a 10-year life cycle, which applies to all three systems and serves as a common basis of comparison. A System Description is another key element of any LCA. The three systems were each manufactured in the USA, each was assumed to be distributed in the same way, their supply chain distances were assumed the same, with similar packaging material and recycled at the same rate, each had a motor, optical sensor for activation, and powered by batteries for the paper towel dispenser and electricity for the two hand dryers in question.

Finally, the System Boundaries and Characteristics is another key element of the Scoping stage of the LCA process. The life cycle assessment methodology addresses the environmental aspects and potential environmental impact (e.g., use of resources and release of pollutants) throughout a product's life cycle. In this case the life cycles of the three systems were divided into their five principle life cycle stages: **(1) Material Production; (2)**

Transportation;(including to the production site, to the point of use, and to the end-of-life location); (3) Manufacturing; (4) Use; and (5) End of Life (landfilling, recycling, or incineration). All identifiable 'upstream' inputs are considered to provide as comprehensive a view as practical of the total influence of each products system. As an example, not only the truck fuel to transport the system to the facility, but the energy to process the fuel are factored in to ensure all inputs are traced back to the original extraction of raw materials.

All components were included where the necessary information was available or a reasonable estimate could be made. Components may have been omitted if their impacts were anticipated to fall well below 1% of the total system impacts. Labels and screws fall into this classification. The System Boundaries for each hand drying method under consideration are diagramed with key reference flows nearby.

CONDUCTING THE LIFE CYCLE ASSESSMENT — STEP BY STEP

The Life Cycle Inventory — Data and Information Collection

Life Cycle Assessors obtain available data (for example, from www.ecoinvent.ch, a Swiss-based international source of Life Cycle Inventory (LCI) data) and consider each datum's "representativeness," consistency, accuracy, geographic, and temporal relevance before making a final selection that best meets this combination of criteria. They note the data in the study that are poor in addressing these criteria. Best available data was selected for the conventional dryer and paper towel approaches. Since no data existed for the HSEE dryer, absolutely specific information and data points were secured. To mitigate the potential favorable bias this specific data would create for the HSEE dryer, the Assessors used the same, generic 'supplier delivery distances' for all three systems, even though verifiable distances for the HSEE dryer were available.

Over 50 life cycle inventory processes were researched and selected — from "Natural gas, burned in industrial furnace low-NOx >100k," "Sealing tape," "Disposal, steel, to inert material landfill," "Electronic component, active, unspecified, at plant," to disposal, hazardous waste, 25% water, to hazardous waste incineration." The amount (in various units of measure) of each (of the 50+) process or material was accounted for in the full life cycle for each system.

LIFE CYCLE IMPACT ASSESSMENT METHOD

In the hand drying LCA, five primary impact categories were selected: Climate Change Score, (Fresh) Water Use, Human Health, Ecosystem Quality, and Resource Depletion.

In the impact assessment, the LCI flows of materials, energy, and emissions into and out of each of the three hand drying systems are classified and combined based on the type of impact their use or release has on the environment using the "Impact 2002+" impact assessment methodology. Impact 2002+ was selected as the assessment approach because it represented the best available science and its ability to combine "midpoint" indicators that affect a similar "endpoint" indicator, allowing for a clearer and comprehensive communication of the outcomes.

Referring to the schematic, the Life Cycle Inventory (in the far left column) with over 1000 types of flows of energy, materials

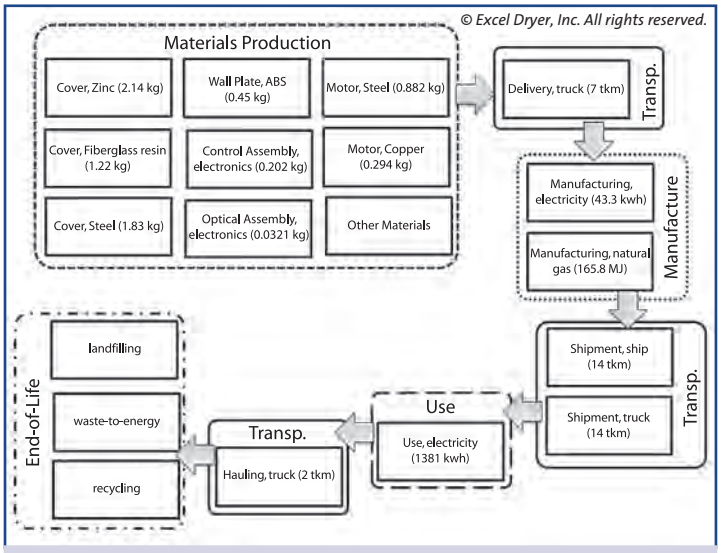


Diagram of life cycle system boundary and key reference flows for HSEE hand dryer

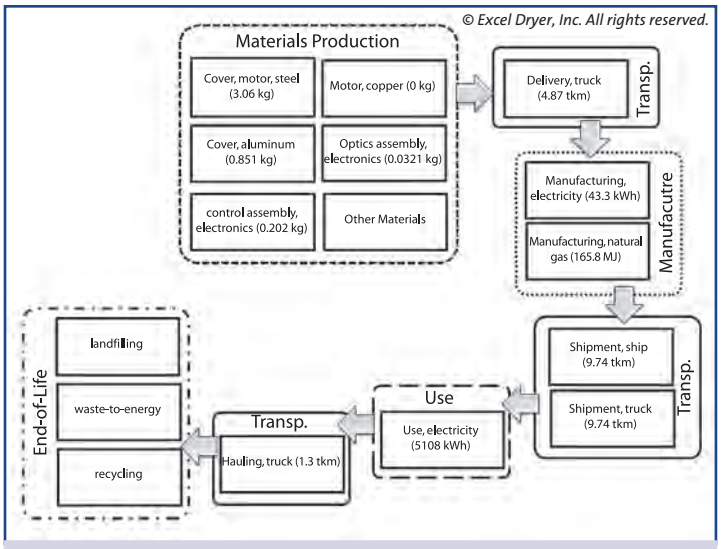


Diagram of life cycle system boundary and key reference flows for conventional hand dryer

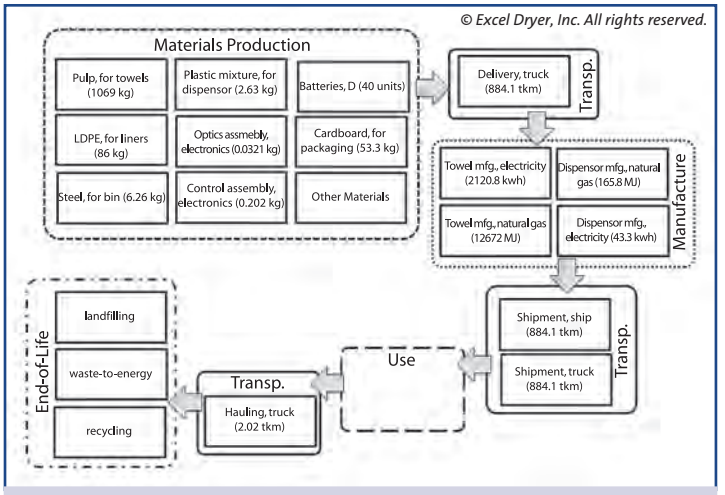
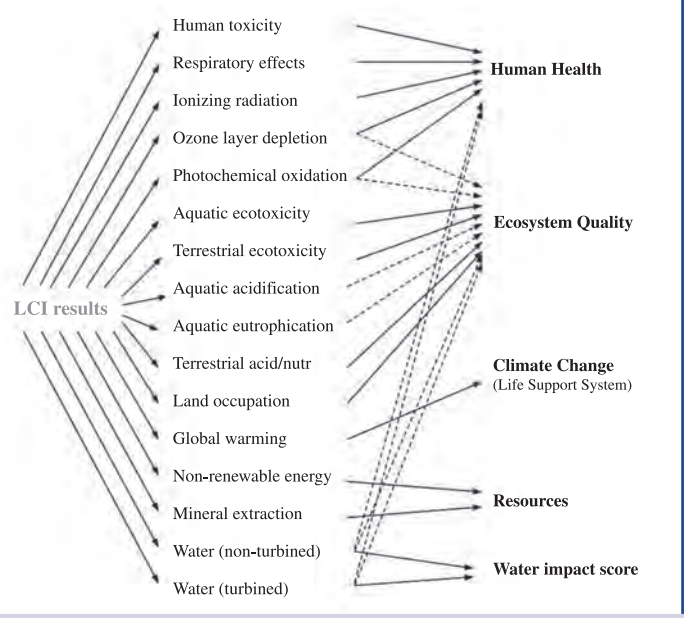


Diagram of life cycle system boundary and key reference flows for paper towel system



A schematic of IMPACT 2002+ impact assessment system

and emissions, resulting from the use of more than 50 materials and processes are distributed and condensed into the 16-Midpoint categories (in the middle column), which in turn are allocated and condensed into one or more of the 5-Endpoint or damage categories (in the right column). These five categories for environmental damage provide a comprehensive and quantitative measure of the overall environmental impact. The midpoint and inventory information can be called on, in turn, to answer specific questions about the nature of environmental impact that is being reported.

SENSITIVITY TESTS, SCENARIOS, AND UNCERTAINTY ASSESSMENT

For some of us, more answers inevitably lead to more questions. You may have more detailed questions, having gotten this new verifiable information. The LCA methodology addresses these even more specific issues using Scenario Evaluations, Sensitivity Tests, and peer-reviewers. You may be wondering about the impact of 0% vs. 100% recycled paper or renewable vs. fossil fuel energy generation or the heat given off by the electrical equipment.

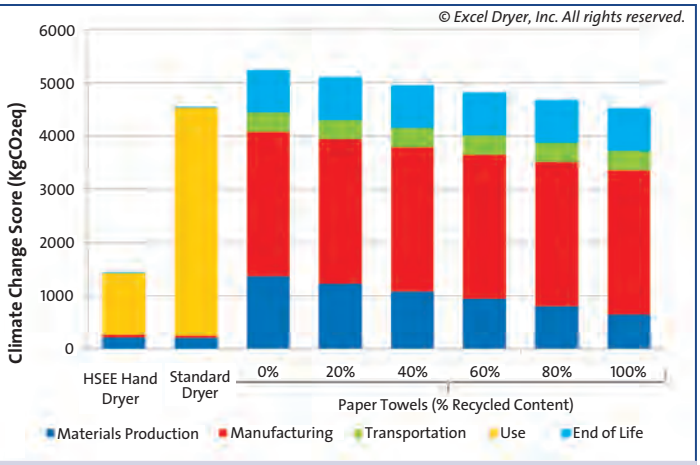
Sensitivity Tests and Scenario Evaluations examine the responsiveness of the LCA results to varying conditions and explore the strength of the findings to alternate assumptions. Uncertainty Assessment – of the climate change impacts in this LCA – considers the range of measurement uncertainty in estimating the flows of material and energy in the systems and the uncertainty of the emission of pollutants or other impacts associated with each of these. The results of these efforts in this LCA "indicate that the differences among the three hand drying systems are quite significant, with the probability of the opposite conclusion being less than one in one million for the climate change score."

RECYCLED CONTENT AND ITS ALLOCATION

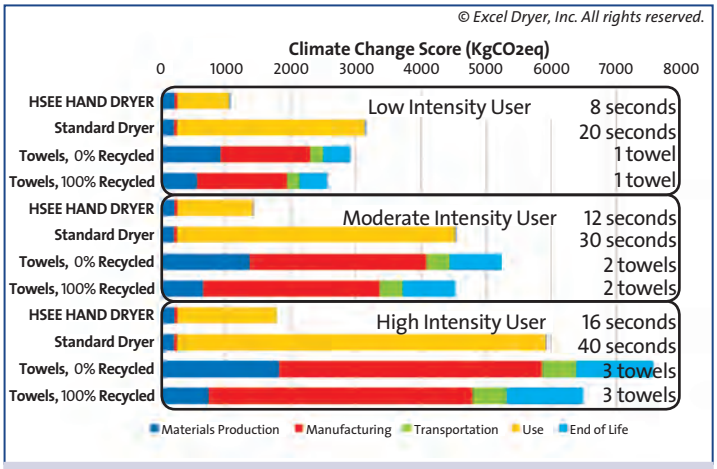
The chart nearby shows the Climate Change Score improvement that can be attained by increasing the recycled content of the paper towels. Even with 100% recycled content the paper towel system remains 220% above the impacts of the HSEE hand dryer and remains above the conventional dryer as well.

The baseline scenario in this LCA for paper towels did not consider the impacts of forming recycled pulp from previously used paper products because of a lack of data of suitable quality to characterize the process. This, in effect, reduced the climate change impact for the process of recycling paper into pulp for new paper towels to zero for purposes of assessment. This choice errs on the side of underestimating the recycled towels impacts. But even when pulp processing is factored into the LCA using other scenarios, there is a "potential difference in the climate change score of up to 20%."

"However, the differences resulting from alternative approaches for allocating these impacts are [were] too small to change the findings of the comparison." In fact, a study of paper products in 2007 showed "a slightly higher impact on all indicators they report for paper washroom towels with recycled content." While this omission would not have altered the basic findings of this study, it does suggest further research would be useful regarding virgin vs. recycled content for paper towels.



Climate change score for paper towels of varying recycled content, in comparison to the HSEE and conventional hand dryers.



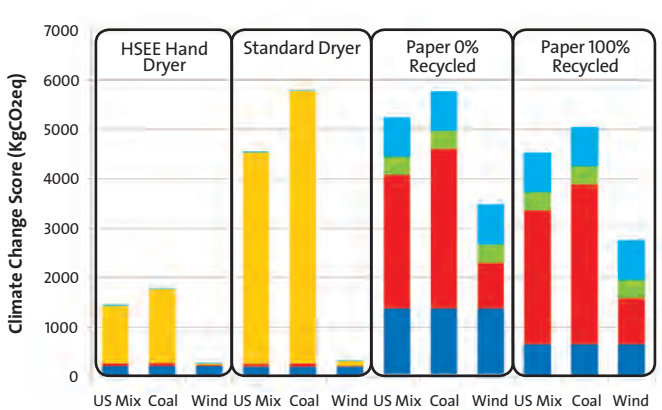
Variation in climate change score with varying intensities of use (dry time or number of towels).

INTENSITY OF USE

The Intensity of Use is one of only a few user-driven variables that can affect the level of environmental impact for each system. The sensitivity test graphed on the chart nearby looked at the environmental benefits and impacts of extended or shorter drying times and multiple (or longer lengths of) towels. These multiple scenarios to gage the sensitivity of results based on the user's behavior. But even when a high intensity HSEE dryer user dries his hands longer time than normally required for completely dry hands, the HSEE dryer still has an environmental life cycle advantage over low intensity conventional dryer or paper towel users, i.e., someone who uses less time or paper and does not dry his hands. The chart nearby shows the largest variation for paper towel users – 300% – from one towel to three towels. But the impact of user intensity – from low to medium to high intensity – also increased for both hand dryers but by less than 100%.

SOURCE OF ELECTRICITY

Sensitivity tests on the source of electric power provided minor reductions in the relative differences among the three systems' environmental impact scores, but the HSEE dryer remained the vastly more sustainable choice, regardless of power source. The issue with electric power is determining which source of power will provide the short-term power demanded by a hand dryer. Should the average of all electrical power sources in the US be used (which includes some renewable sources) or should you 'penalize' the hand dryer, and assume all of the short-term power demanded would come from fossil fuels (coal or natural gas) and totally exclude renewable sources, since renewable sources cannot inherently respond to a demand spike, regardless of how small it may be. In either case, the HSEE dryers produce a lower environmental impact score. Interestingly, the paper towel systems use 75-80% as much electricity over its life cycle as the HSEE dryer so a change in electricity source does very little to change the comparison among the systems' environmental impacts. And when you add in the other impacts of the paper towels themselves - pulp, bleaching, packaging, transporting, and disposal, paper towels end up with a much more negative environmental impact, according to this peer-reviewed LCA.



Climate change score for the hand drying systems under varying electricity sources during their use and production, in comparison to 0% recycled content and 100% recycled content towels.

Alternatively, in the unlikely event of a change to wind-power occurred, it would improve the environmental impact of all three systems. For both electric hand dryers, their climate change scores would be reduced by 80-95%. The paper towel system would see its climate change impact reduced by about 1/3, since its impact is only partially dependent on electricity use and pulp production, packaging, transportation, and disposal also add to its climate change impact. But if all systems have the same benefit, they stay in their relative positions, with the HSEE hand dryers being the best environmental choice in this scenario as well.

DOUBLE-CHECK MIDPOINT IMPACT INDICATORS

The rigor of LCA is re-doubled by employing a second assessment methodology—in this case, TRACI (Tool for the Reduction and Assessment of Chemical Impacts). This two-fold assessment methodology confirmed that the HSEE hand dry solution is "the lowest scoring system on each criteria evaluated, often by a wide margin" when using a wide variety of midpoint-level environmental indicators.

From a quantitative perspective, the complete LCA document has a detailed table for each hand drying system that shows the LC Inventory items and their respective impacts on each of the five-endpoint or damage categories under the baseline scenario.

COMPARISON WITH PRIOR STUDY RESULTS

As an ISO 14040 compliant LCA, this study examined the results of previous studies (conducted by others) for consistency and also analyzed those study results to explain any differences. As testing and measurement techniques improve, Life Cycle Inventory databases become more complete and accurate, and advancements in products and processes become more sophisticated and environmentally beneficial, prior studies loose their efficacy for comparison purposes with current LCAs.

STUDY LIMITATIONS

Life Cycle Assessors, like Quantis, assess the quality and consistency of the information used to support the results of the study. In this study, noted limitations – disposal of batteries and the process of producing recycled pulp from used paper — form a top the "To Do List" for future study by someone. Both of these limitations would likely result in greater impacts for the paper towel system, and therefore, they would not change the direction of the LCA's conclusions. The interaction between the heat discharged from the hand dryers and each buildings HVAC system is another issue, but it is so complex – with multiple climates, time of use and whether the building is being heated or cooled, etc. – it is beyond the scope of this study. This study was focused on the United States but it would be useful to new full assessment would be warranted for countries where renewal energy, for example is a higher percentage contributor the power source total.

THE RESULTS OF THE LCA

Overall Conclusions

The overarching conclusion of this environmental Life Cycle Assessment is that the high-speed, energy-efficient (HSEE) hand dryer studied "shows a significant advantage in its environmental

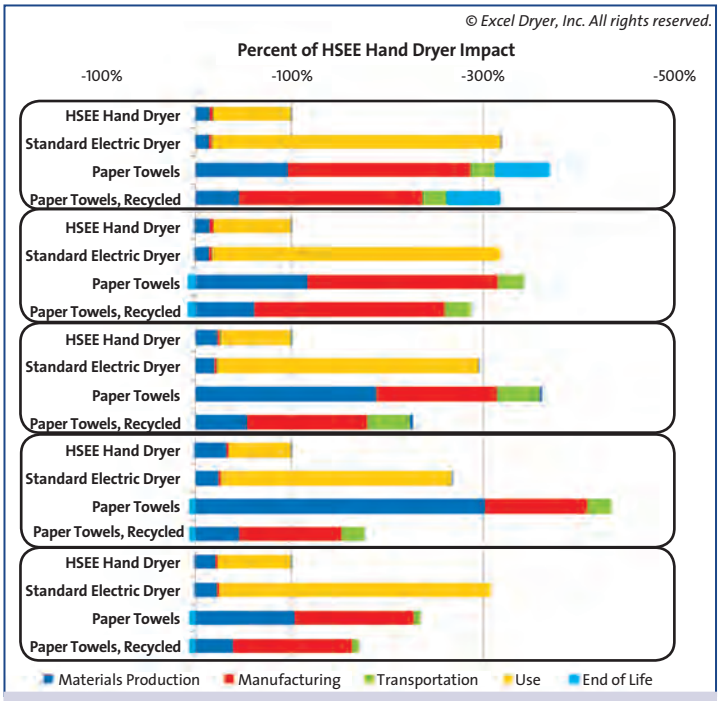
impacts in comparison" with a conventional (old technology) electric hand dryer and the paper towel dispenser tested. Further, HSEE hand dryers reduce the environmental impact of hand drying from 50% to 75% vs. either other method. The study also found that "the comparison among conventional electric hand dryers and paper towels systems is within a close enough range to be highly influenced by the specific product and use characteristics and the assumptions of the study."

Both electric dryers created the majority of their environmental impacts during the use phase, when electricity was being used to dry hands. The paper towel system created most of its negative impacts in the production of the raw materials and the manufacture of the towels, the transportation of the towels to the facility, and the landfill implications of the used towels. All told, the towels themselves are responsible for >90% of the life cycle impacts of that system.

The sensitivity and uncertainty tests showed that the assumptions of the study had very little to do with the outcome, meaning that the results of the comparison were so strong that even when changing a wide range of assumptions one way or the other, it did not substantially change the direction or magnitude of the comparison. Even when recycled paper was used in the towel system, it did not gain substantial ground on the HSEE dryer alternative. Interestingly, the sensitivity tests on "producing recycled pulp suggests that there may be very little, if any, benefit from using recycled content in paper towels."

RESULTS BY IMPACT CATEGORY

The chart nearby attributes the total life cycle impacts to each of the five-endpoint or damage categories. It also identifies in graphic form the relative contribution of the five principle life cycle stages – Materials Production, Manufacturing, Transportation, Use, and End of Life. This chart uses the HSEE dryer impacts as the baseline for each category and gives it a value of 100. It then compares the conventional dryer and the paper towel systems — using 0% and 100% recycled sensitivity tests. It shows that the Materials Production and Use phases are dominant for the electric hand dryers, with the Use phase being much more dominant for the relatively less efficient conventional dryer. The Materials Production, Manufacturing, and Transportation phases are dominant for the towel systems. And the towels are the largest impact contributor (between 89 and 94% of the total impacts) across all five life cycle stages in each of the five damage categories (A detailed, numeric accounting is found in the Appendix of the full LCA report.)



Total life cycle impacts for each system as a percentage of the HSEE system

LCA PROVES THE "SUSTAINABILITY BOTTOM LINE"

For K-12 schools, other educational facilities, and virtually any public restroom setting, the results of this environmental Life Cycle Assessment point to a clear advantage for the HSEE hand dryer system over a conventional hand dryer or a paper towel dispenser system.

Further, that advantage is significant enough that there are few, if any options for paper-based systems to improve adequately to compete with this new generation of HSEE hand dryers on environmental performance. Conventional dryer have been used in the United States for the over 30 years and the new technology is a sufficient enhancement that they will be disappearing as design professionals and owners understand or experience the benefits of the HSEE dryers. While previous LCA research led to inconclusive or contradictory results regarding the relative advantages of paper-based or conventional electric drying methods, HSEE hand dryers have established a definitive advantage in environmental performance over their electronic predecessors and the increasingly obsolete paper towel approach.

When this exhaustive and conclusive environmental Life Cycle Assessment is combined with the other benefits of HSEE hand dryers including: significant return on investment and short payback period, ease of maintenance and repairs, improved hygiene, useful life, reduced opportunities for vandalism, and ongoing operating cost reductions – design professions have a compelling case to make to the owners of virtually any commercial facility including educational, retail, office, restaurant, arena or stadium, convention center and many more.

See Quiz on the Next Page
or
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Program title: **"Throw in the Towel: High-speed, Energy-efficient Hand Dryers Win Hands Down" (1/10).** AIA/CES Credit: This article will earn you one AIA/CES LU hour of health, safety, and welfare/sustainable design (HSW/SD) credit. (Valid for credit through January 2012). **Directions:** Refer to the Learning Objectives for this program. Select one answer for each question in the exam and fill in the box by the appropriate letter. A minimum score of 80% is required to earn credit. **To take this test online and avoid handling charge, go to ce.ArchitecturalRecord.com**

1. Which of these attribute groupings do all high-speed, energy-efficient (HSEE) hand dryers have in common?
- ❑ **a.** Hot air, fast drying time, motion sensor, cleaner restrooms
- ❑ **b.** Simple elegant design, quiet operation, 20-year warranty, Hot air
- ❑ **c.** Pricing similar to conventional dryers, maintenance contracts, life time parts replacement at no charge
- ❑ **d.** Numerous model designs, motor speeds of 10-15,000 RPMs, Air temperatures of 70-90 degrees

2. What issues should design professionals and K-12 Schools consider before selecting an HSEE hand dryer?
- ❑ **a.** Conventional or trough-style design and hygiene and vandalism
- ❑ **b.** Useful life and maintenance, service, or repair
- ❑ **c.** Drying position and cost and savings
- ❑ **d.** All of the above

3. Which element below is not a requirement for a top quality environmental Life Cycle Assessment of a product or process?
- ❑ **a.** Peer-review
- ❑ **b.** Follow ISO 14040 and 14044 standards
- ❑ **c.** A Life Cycle Cost Analysis
- ❑ **d.** Perform Sensitivity Tests, Scenario Evaluations, and Uncertainty Assessments

4. Which of the following is the correct order and names of the Major phases of a Life Cycle Assessment?
- ❑ **a.** Assessment, Life Cycle Analysis, Recommendations, Implementation
- ❑ **b.** Needs Assessment, Boundary Definitions, Environmental Impact Report, Implementation
- ❑ **c.** Goal & Scope Definition, Inventory Analysis, Impact Assessment, Interpretation
- ❑ **d.** Uncertainty Assessment, Scenario Development, Sensitivity Testing, Damage Category Diagnostics

5. The life cycles of the three systems under study were divided into these principle life cycle stages:
- ❑ **a.** Climate Change, Resources, Human Health, Ecosystem Quality, Freshwater Use
- ❑ **b.** Material Production, Transportation, Manufacturing, Use, End of Life
- ❑ **c.** Ionized Radiation, Ozone Layer Depletion, Terrestrial Ecotoxicity, Mineral Extraction, Land Occupation
- ❑ **d.** Definition of Environmental Impacts, Comparison of Impacts, Influence of Key Variables

6. The Life Cycle Inventory lists numerous materials and processes – each with flows of energy, materials and emissions ¬– that are distributed and condensed into the Midpoint categories, which in turn are allocated and condensed into one or more of the Endpoint or Damage categories, which are a comprehensive and quantitative summary of the Life Cycle Assessment results.
- ❑ **a.** True
- ❑ **b.** False

7. According to this peer-reviewed LCA, the sensitivity tests on "producing recycled pulp suggests that there may be very little, if any, benefit from using recycled content in paper towels."
- ❑ **a.** True
- ❑ **b.** False

8. On which of these issues was a Sensitivity Test performed in the hand drying LCA?
- ❑ **a.** The temperature of the water on the washer's hands
- ❑ **b.** Distance from the floor of the electric hand dryer or paper towel dispenser
- ❑ **c.** Intensity of use (of the subject hand drying system) by the user
- ❑ **d.** Various price points of the system to see which one sells best

9. All told, the paper towels themselves are responsible for ___% of the life cycle impacts of the paper towel dispenser system.
- ❑ **a.** <50%
- ❑ **b.** 70%
- ❑ **c.** 80-85%
- ❑ **d.** >90%

10. High-speed, energy-efficient hand dryers reduce the environmental impact of hand drying _____ when compared with conventional electric hand dryers or a paper towel dispenser.
- ❑ **a.** >90%
- ❑ **b.** between 30-50%
- ❑ **c.** from 50-75%
- ❑ **d.** <50%

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Material resources used: This article addresses issues concerning health and safety and sustainable design.

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