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Sustainability

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Contents

Introduction	1
1. Reducing Energy Consumption and Costs	1
2. Getting Serious About Recycling	3
3. Moving Toward Sustainable Facilities	4
4. Using Energy-Efficient Products and Equipment	6
Conclusion	7
Survey Results	8

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Sustainability stories make good reading. There are scores of heroes and many happy endings. Individuals, organizations and corporations are continually finding and implementing solutions to new problems arising from our heightened awareness of the negative impact of previously acceptable practices. This new earth-friendly stewardship by engineers, architects, operations and maintenance personnel results in a cumulative positive impact on the health of our community and environment.

This paper addresses sustainability goals that most industries and manufacturing companies are pursuing, based on a survey conducted by SSOE in the Fall of 2007. That survey identified the following as the top four sustainability goals:

1. Reducing energy consumption
2. Recycling
3. Achieving sustainable facility design
4. Using energy-efficient products and equipment

Rather than a detailed technical guide, this is an overview of practical solutions in these four categories that are being implemented in industrial and manufacturing environments. Hopefully, documenting these examples will create awareness of the many ways companies can move the needle toward safeguarding our health and environment.

1. Reducing Energy Consumption and Costs

The extra incentive behind many sustainable practices is that some, if not all, of the cost is recoverable. It's much easier to change behaviors or expend manpower if the financial benefit is measurable and in sight.

For example, energy is becoming increasingly expensive and there are abundant ways to conserve it. 3M Company saved over \$750 million between 1986 and 1997 from pollution and energy reduction measures ("Cradle to Cradle", by McDonough & Braungart, page 53).

Peak shaving

Energy demands usually peak midday when air tempering and process conditioning machinery are running at their maximum. Customers can be subjected to peak demand surcharges from an energy supplier who wants to level energy production to make best use of their existing infrastructure and maintain a steady flow of energy in the power grid. Industrial companies can reduce their peak demands and create a more constant level of energy usage to avoid these surcharges.

One peak shaving strategy is to reduce the peak cooling load by storing ice. At night, when energy use is likely to be at its lowest, the company expends energy to make and store ice. During the day, this stored ice is used for cooling. This reduces the amount of peak daytime energy needed to bring temperatures down. Depending on the location and type of process going on in the plant,

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45%
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this cooling load can be significant year round. In this case, the cost of the controls and ice storing system can be recovered in a short amount of time.

Alternative energy sources

Among the options companies have for alternative energy generation, solar power is one of the most viable. It is an on-site solution; therefore it has more local impact than buying green power that subsidizes alternative energy installation and production in some far away location. For many, the current combinations of federal and state tax incentives are reducing the cost for installing solar power to about a 10-year payoff. For the subsequent 10-15 years of service life, the generated solar power is “free.” And of course your rate never goes up. Additionally, many states offer grants for the installation of solar and other alternative energy sources.

The amount of solar power generated is limited by the amount of area available for solar power collectors. Subsequently, they may not generate enough power to run an industrial process, but they will likely be adequate to support front office operations: computers, lighting, office machines and the like.

Tales of energy gluttons

Compressed air systems

Looking at day-to-day operations, compressed air systems—common in the manufacturing world—are among the worst offenders in a plant environment. The hissing sound detectable in many plants is a dead giveaway of leaks in the system and lost energy. Companies are finding that

repairing these leaks is a relatively easy process that yields potentially significant savings.

It’s rare to find a manufacturing or industrial process that does not use copious amount of heat and water. Cookers, common food-industry equipment, generate a lot of heat energy, much of which dissipates into the environment and increases the need for air conditioning in the plant. Insulating the cookers reduces heat loss significantly. An insulating coating which reduces total heat transfer has the added benefit of avoiding the problems associated with wet insulation on steam cookers.

Water

To put water use in perspective, a single major beverage producer will use 11 million gallons of water a day. The practice of dumping process and utilities waste water into the drain where it eventually made its way out into spray fields surrounding the plant or into the municipal waste water system frees a considerable amount of energy into the environment that could have been used elsewhere in the plant. With the trend to conserve energy and water, manufacturers are seeing these practices in a different light. For example, since processes which involve heating frequently also involve cooling, using the cooling process to preheat water “recovers” some of the energy expelled from the heating step.

Parallel systems

More is not always better. Running parallel systems in efficient, well-managed plants may be another

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58%

of public companies surveyed had sustainability goals compared to only 40% of private companies.



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unproductive energy waster. If back-up production lines are on, run in stand-by mode hour after hour, shift after shift the energy they consume is wasted. Many companies are evaluating whether they can run these back-up lines less frequently, or in ways that use less energy. There are other options for reducing interruptions in production that make back-up lines unnecessary.

Minor energy-draining practices add up to expensive bad habits in plants spread out over hundreds of thousands of square feet. These quickly add up to surprisingly large figures. Glue pots not shut off; lighting left on or using inefficient light sources; devices or equipment not running at top efficiency because they are poorly maintained are a few examples. In some cases the solution is as simple as using timers, motion sensors or automatic shut off systems.

2. Getting Serious About Recycling

A case study

Some of recycling's best practices can be found in the glass industry because glass is fairly easy to recycle and can be reused in many different products and applications.

First Solar, one of the fastest growing manufacturers of thin film solar modules, is a model of sustainable product lifestyle practices. Its recycling program assures that substantially all components of the modules, including the glass and the encapsulated semiconductor materials and metals, are treated and processed for recycling into

new modules or other products.

The process involves separating the layers of glass in the panel, cleaning the glass and providing it to glass manufacturers for recycling. First Solar has to maintain a consistent chemical make-up in its glass to assure the quality of the recycled product. Recycled glass is abundant. In its "second life" it is part of such things as concrete items, drainage systems, tiles, other glass products and in its sand form, even beach sand.

First Solar also separates the metal layers from the remaining module components and purifies the metals so they can be recycled into commercial products. All these efforts yield impressive results—a significant majority (by weight) is processed for recycling rather than entering the waste stream.

The lessons for manufacturers include:

- Early defect detection can streamline the recycling process and reduce energy waste.
- Including a plan for recycling into product and process design can net significant dividends.

Recycling water

Filtered water, used in the blending process for many beverages, results from a multi-step process that removes dissolved solids and organic matter from water supplied by well systems or municipal water systems. Many beverage producers use nanofiltration technology that converts roughly 75% of the water flowing through it into process filtered water for blending. This and the water used for other process

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The two industries with the highest percent of companies responding positively to having sustainability goals were automotive and glass - both at

75%



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utilities commonly result in only 50% of the water coming into the plant actually being used in beverage production. The other 50% is commonly sent down the process/sanitary drains for treatment and eventually released back into the environment. But sustainability-minded manufacturers are now conserving water by capturing that “gray” water and using it to water lawns, flush toilets, or in other parts of the production process.

Turning by-products into raw material and opportunities

One of the added bonuses of the alternative fuels industry is that its by-products are not only harmless but reusable. For example, one by-product of the biodiesel process, glycerin, can be used to make soap and, with some additional processing, a variety of other products. The fact that the demand for biodiesel is creating a glut of glycerin on the market isn’t necessarily bad news, because the situation is inspiring everyone from basement scientists, to farmers, to university researchers to come up with various valuable uses for glycerin. Among them are: home heating fuel, feed stock and a form of propylene glycol which can be used as nontoxic antifreeze for automobiles.

In the case of ethanol production, its by-products are primarily used in feedstock for cattle. The process of producing ethanol actually “releases” the food content of the raw material. Agricultural scientists have also discovered that the by-product of ethanol fermentation from corn stover (the plant part remaining in the field after harvesting corn) can increase the

structural stability and organic matter content of highly eroded soil. One Minnesota ethanol company is even turning ethanol by-products into high-energy protein lick-blocks for cattle.

3. Moving Toward Sustainable Facilities

Environmentally friendly construction has historically implied higher construction costs for owners of many types of facilities. With the cost of energy, water and penalties for poor air quality, that notion is turning upside down. It’s those facilities that were built without concern for conserving energy and the environment that are amassing bulging operational costs and reduced performance and productivity of staff. When a facility is programmed for these characteristics before design begins, the impact on construction cost is minimal and the ROI is higher.

Companies and entities who want guidance on sustainable practices can look to LEED®, the industry standard developed by the United States Green Building Council (USGBC). LEED is an internationally recognized rating system that indicates how environmentally friendly a building is. A qualifying building is rated from good to best—either Certified, Silver, Gold or Platinum. In addition to a growing number of state and local incentives, LEED certification is a third party validation of the owner’s concern for the environment and a productive and healthy working environment.

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28% of companies with **1-100** employees has sustainability goals compared to **64%** of companies with **10,000+** employees.



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Even if LEED® certification is not on your list of goals, your efforts to deliver a more economically profitable, environmentally responsible, healthy, productive place to work will result in generous paybacks of various kinds. Companies that invest in sustainable practices are held in high regard by the local community, their employees and customers.

Existing facilities can use LEED-EB as guidance for improving existing building operations. Opportunities for Improvement include:

- whole-building cleaning and maintenance issues including chemical use
- indoor air quality
- energy and water efficiency
- recycling programs and facilities
- exterior maintenance programs

It may also help to organize your efforts, by starting with an Energy Star analysis www.energystar.gov.

While the facilities and maintenance departments will be on the front line of the drive to improve the physical plant, a program needs top-down management support and the buy-in of finance and purchasing to be effective. Otherwise, finance may opt for buying inexpensive materials to repair energy leaks although they don't fix the problem adequately. To minimize these tugs-of-war, the organization as a whole needs to adopt a sustainability mindset that acknowledges three principles:

- Every unit of energy and water saved is important (optimize versus maximize).

- Maintenance costs need to be evaluated in terms of ROI.
- Education on sustainability issues needs to include all staff so they understand what behaviors need to change and what benefit will result. This is most important for maintenance staff.

Companies that have limited budgets to improve their older facilities can save resources by making small repairs. For example, rather than replacing older toilets that use a lot of water with waterless urinals or low flow models, some companies are taking an interim, less expensive step and installing metered flushing valves.

In the realm of new construction, forward-thinking architects and engineers are pushing for closer collaboration on design projects. In what is being called “high-performance design,” there is an emphasis on better integration of the various building systems—those influenced by architects with those influenced by engineers. When design and engineering decisions are made in isolation, the project is susceptible to missed opportunities for sustainability. The HVAC system is one example. The orientation of the building and building material choices will affect the need for heating and cooling. To encourage operational efficiency the system should be positioned to allow easy access for regular maintenance.

From the onset, the design of the projects and the specification of materials need to be approached with an open mind. If everyone on the team

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58%

The top driver in the implementation of sustainability goals among respondents was to maintain consistency with corporate beliefs.



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thinks “metal building” whenever a new manufacturing facility is discussed, then more sustainable options will always be left on the table. The same is true if new materials are rejected because they will require different maintenance routines and techniques. However, a top-down commitment to sustainable construction, including a solid training component for maintenance staff, can be a strong incentive to give up conventional solutions.

4. Using Energy-Efficient Products and Equipment

The mother of all guiding principles when determining what product or system to purchase is to consider all the variables that contribute to sustainability. Is the equipment appropriately sized for the process; not under- or over-powered for the work it needs to do? Is a build-for-use system a more energy-efficient option than off-the-shelf equipment for the specific application? Is the system itself eco-friendly in terms of its composition and ability to be recycled or reused? What maintenance is required for it to run at its optimal performance level? Don't be surprised to find that your goal of making more product with less energy and fewer resources in less time is as good for the environment as it is for profits.

Drive motors

It is worthwhile to consider using motors with variable frequency drives rather than standard motors wherever possible. Now that variable frequency drives have matured, the price

differential has narrowed, and when the cost of energy is figured into the comparison, the variable frequency is the better buy.

Variable output requirements are achieved by matching the desired process output to pump RPM rather than throttling the output, inlet vanes, or output dampers. These non VFD practices are energy wasteful and inefficient; the initial cost of these devices is eliminated when using VFDs. Motors operating at 30% load will consume approximately 3% of the energy in a typical VFD arrangement when compared to a constant speed pump operating at 30% load. Variable frequency drives also increase motor life by reducing operating temperature when the motor is operating less than full speed.

These drives have many applications. On HVAC systems, they allow minor adjustments to be made to the level of cooling desired. On water and compressed air distribution systems, they can be used to drive pumps or compressors that can vary their speeds based on demand, resulting in lower energy usage when demand is low.

Gas-fired boilers are another case in point. They used to be either on or off. New boilers provide greater efficiency through the use of multistage burners that allow steam generation to be controlled to meet demand. Waste heat going up the stack is now commonly reclaimed to preheat the condensate water coming back into the boiler.

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The most common source cited in the development of sustainability goals was an internal task force or committee.

45%

Only approximately 1/3 of respondents performed industry benchmarking.



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Turning waste into reclaimed energy

In the best of worlds, manufacturing processes include self-sustaining operations in which the energy generated by a certain process is captured or reclaimed to power the next sequence of that same process. Some plants are implementing an “off-grid” approach to energy usage where the ultimate goal is to produce or reclaim as much energy from by-products and waste streams as is used in the entire production process. More and more, the technology and equipment needed to implement these energy cycles is readily available.

A project at a major juice plant provides a good example of a step in that direction:

Before: The process of making juice results in a waste water stream that typically contains sugars and other bio-solids that support bacteria growth. Many juice plants have their own wastewater treatment systems that use bacteria to remove these bio-solids. Bio-gases released as part of this process are commonly incinerated and a stack vacates the EPA-compliant residuals into the atmosphere.

After: Instead of burning off the bio-gases at the flare, they are captured and treated to allow use in a small turn-key electrical generation system that is usually of sufficient size to power the entire wastewater treatment plant. Emissions into the atmosphere are further reduced, potentially freeing carbon credits for other uses.

This is no longer a complicated process. Complete, packaged, turnkey systems are available that include the major components necessary to facilitate energy conversion from waste products. For example, one all-inclusive system will collect the gas, filter and treat it, measure the BTU content, add natural gas if necessary and pump it to a generator to produce electricity.

Conclusion

In the forties and fifties, when natural resources were cheap and concern for the environment was not a priority, the goal in manufacturing facilities was zero maintenance. There was high demand for materials that would last and last, regardless of the elements that enabled such longevity and regardless of the methods needed to dispose of them. In some cases, we didn’t know the potential harm. And with resources so plentiful what was the point of conservation or reuse?

Now industries and manufacturing are compelled by the cost of doing business, legislation, market pressure, and the desire to be good stewards of the planet to make radical changes. Even as computers and electronics are governing every aspect of our lives, we are striving for more sustainable product lifecycles, so that invention is not its own worst enemy.

There are so many opportunities to conserve, recycle and reuse. There are fewer and fewer reasons for not doing it. With both of those forces combined we can anticipate an era of transformation on the plant floor.

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Only
1/3
of companies with
sustainability goals
have incorporated
them into formal
training programs.

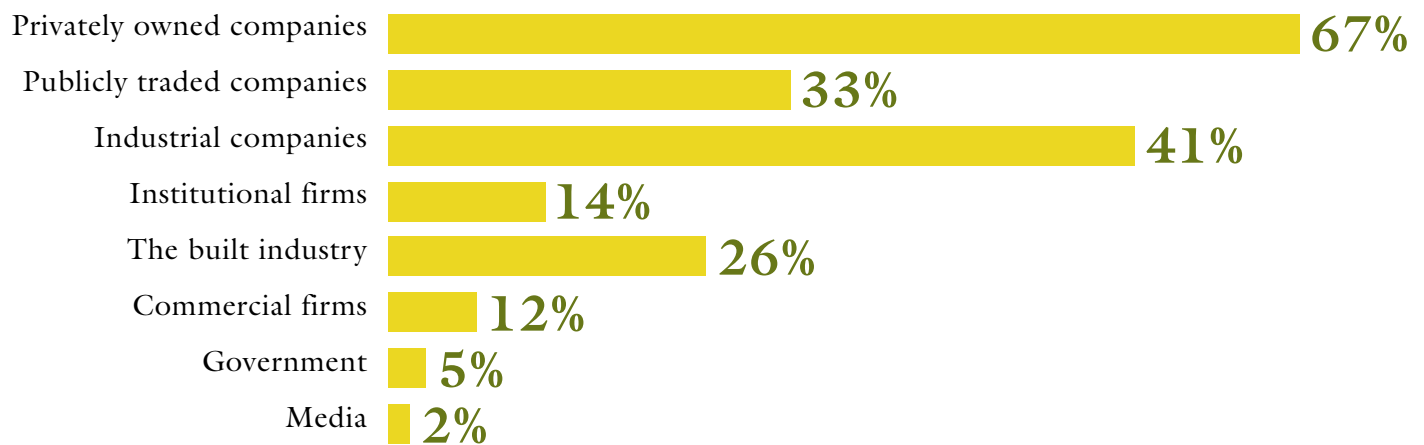


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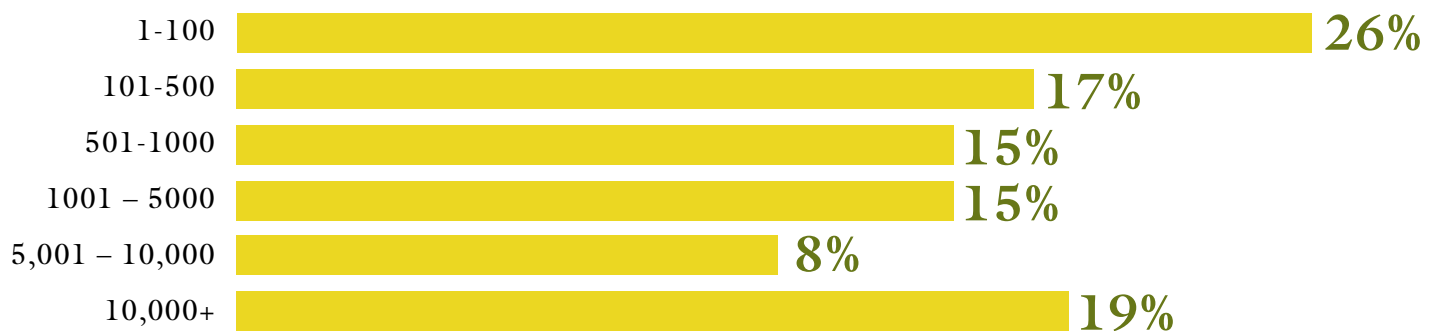
SSOE Sustainability Survey Results

Demographics

176 respondents representing 158 different companies.



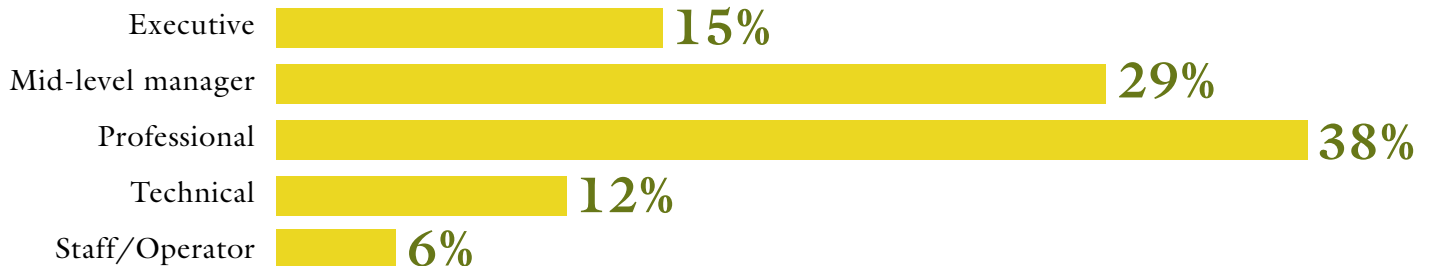
Company size of respondents (by number of employees)



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Respondents represented these levels within the organization:



Industries Represented

- Alternative energy
- Automotive
- Biofuels
- Chemical
- Commercial
- Construction
- Education
- Energy
- Facility management
- Food and beverage
- General manufacturing
- Glass
- Government
- Healthcare
- Media
- Metals and mining
- Personal and household care
- Professional organizations
- Real estate development
- Retail
- Science and technology
- Warehouse and distribution

Findings

45% of the companies surveyed have formalized sustainability goals.

Public vs. Private companies that **DO HAVE** sustainability goals in place



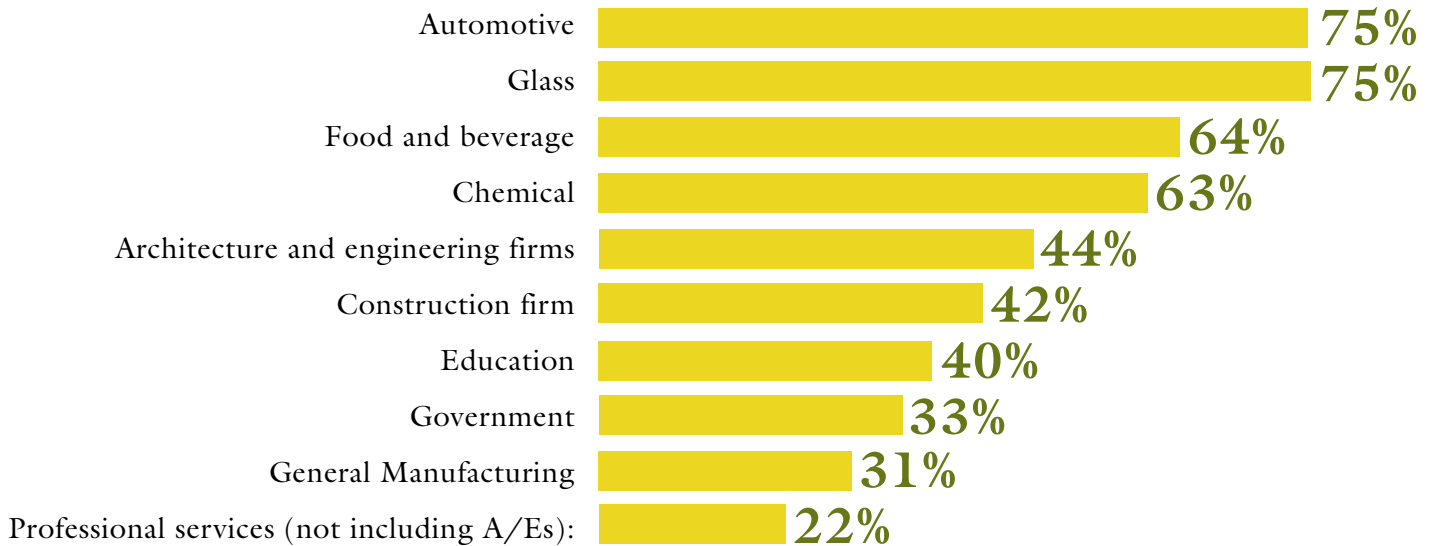
Companies by category that **DO HAVE** sustainability goals in place



Sustainability

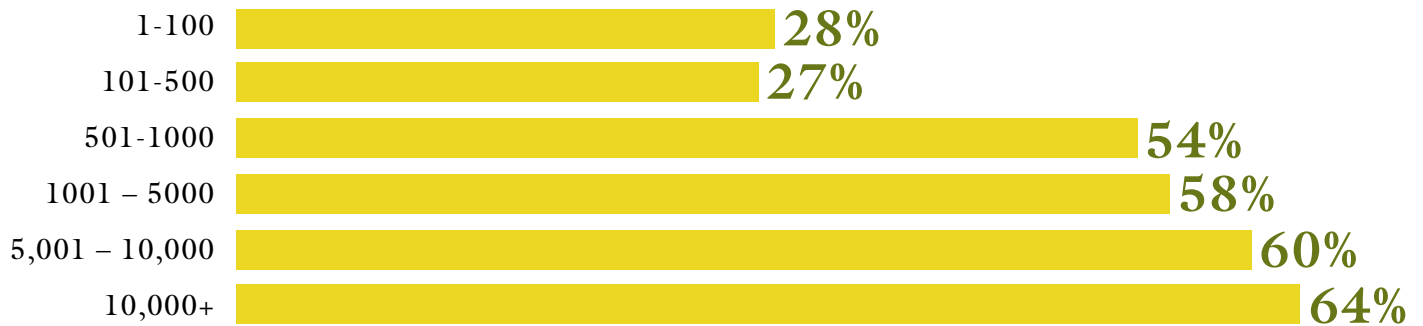
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Industry highlights* companies that **DO HAVE** sustainability goals in place



*each of these industries is also included in one of the previous categories; not all industries are listed here

Companies by number of employees that **DO HAVE** sustainability goals in place



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Top 10 sustainability goals among respondents

1. Energy use reduction	74%
2. Recycling	58%
3. Facility Design	51%
4. Use of energy efficient products and equipment	50%
5. Hazardous waste reduction	44%
6. Waste reduction, eliminating scrap in the production process	39%
7. Emissions reduction	36%
8. Carbon footprint measurement	28%
9. Products – making sure the products being manufactured have minimal impact	24%
10. Procurement of sustainable raw materials	23%

What is driving the implementation of sustainability goals?

Consistent with corporate beliefs	58%
Corporate citizenship	50%
Public relations	39%
Customer demand	34%
Government regulations	28%
Employee demand	14%
I don't know	5%

What is driving *public* companies to implement sustainability goals?

Corporate citizenship	64%
Consistent with corporate beliefs	58%
Public relations	42%
Government regulations	39%
Customer demand	33%
Employee demand	9%
I don't know	6%

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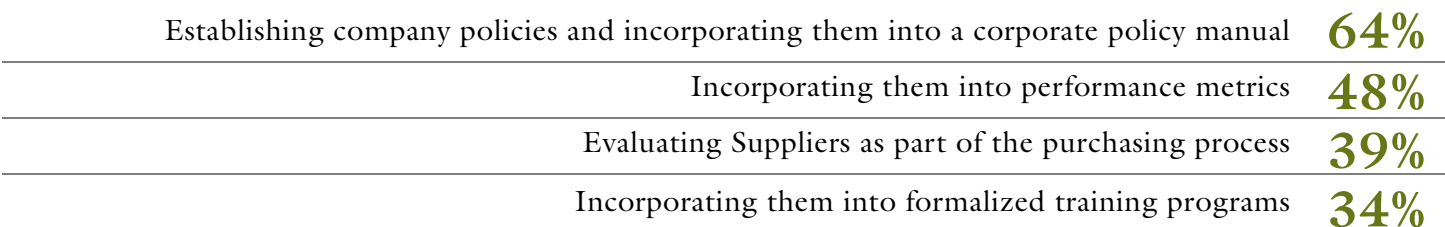
From where have your company's sustainability goals been derived?



From where have your company's sustainability goals been derived? (public companies)



How are you reaching your sustainability goals?



To whom in the organization have sustainability goals been communicated?

70%

of respondents said their sustainability goals have been communicated to the entire organization.

19%

of respondents said their sustainability goals have not been communicated past mid-level management.