New York State
Pollution Prevention Institute

NYSP2I Sustainable Supply Chain and Technology Knowledge Resource Tool

Introduction:

This tool supports environmental professionals, marketing professionals, procurements professionals, top management, and any other parties that are involved in making their supply chain less costly and more sustainable.

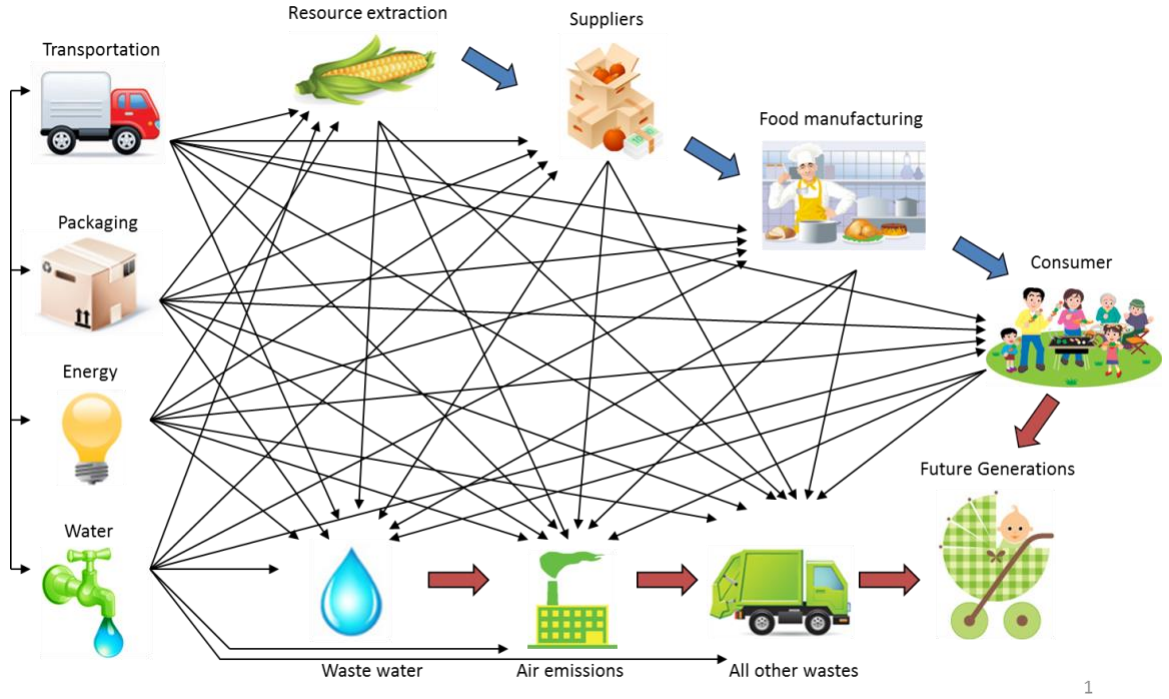
The purpose of this tool is to provide resources to assist companies with understanding and improving their sustainability, both as a member of their own primary supply chain and of a larger global supply chain.

Being part of a sustainable supply chain also means that your company is involved in sustainable manufacturing. This tool contains information about how sustainable manufacturing, as part of the supply chain, is important and how it is being implemented in the United States and around the world. The U.S. Department of Commerce's Sustainable Manufacturing Initiative defines sustainable manufacturing as "the creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers and are economically sound."

A. Overview

What is a "Sustainable Supply Chain"?

The United Nations Global Compact defines supply chain sustainability as "the management of environmental, social and economic impacts, and the encouragement of good governance practices, throughout the lifecycles of goods and services. The objective of supply chain sustainability is to create, protect and grow long-term environmental, social and economic value for all stakeholders involved in bringing products and services to market."



Why is a sustainable supply chain important?

It helps businesses

- ensure compliance with laws and regulations;
- adhere to and support international principles for sustainable business conduct;
- improve social, economic, and environmental impacts;

act in the company's own interests, the interests of their stakeholders, and the interests of society at large. Sustainability has three commonly accepted pillars: environment, society, and economy, also often stated as "people, planet, and profit." Sustainability cannot exist if any one of these pillars is missing.

For more information about sustainable supply chains, download "Supply Chain Sustainability: A Practical Guide for Continuous Improvement," a publication of the United Nations Global Compact.

Business Benefits of a Sustainable Supply Chain

The benefits of supply-chain sustainability are often highlighted as reduced carbon footprint, energy, and resource consumption. However, the benefits are much greater than those associated with the logistics and transportation segment of the supply chain. Organizations should give consideration to sustainability in their supply chains for the following additional reasons outlined by the United Nations Global Compact:

- Corporate customers are requiring suppliers to adhere to sustainable practices in order to continue to conduct business together. Recent research from the Carbon Trust, a non-profit organization, shows that 56% of multinational companies plan to drop suppliers based on low carbon performances. A sustainable supply chain can improve bottom-line financial results.
- A recent Mercer study stated that the best way for financial investors to manage portfolio risk associated with climate change may be to shift 40% of their portfolios into climate sensitive assets with an emphasis on those that can adapt to a low-carbon environment.
- Tax and investment incentives from the U.S. government and other countries are being offered to companies with sustainable practices. This trend for mandating sustainable practices is growing in some regions of the world.
- Companies that can identify and implement sustainable supply-chain practices experience positive public relations due to being perceived as a good global citizen which can yield great benefits.

Per the United Nations Global Compact, a sustainable supply chain helps companies

- better anticipate and manage risk;
- reduce operational risks, such as disruption to supply, increased cost, and lack of access to key raw materials;
- earn “informal” or “social” license to operate within communities, legal systems, and governments that otherwise might be antagonistic;
- reduce costs and enhanced efficiency and productivity;
- improve working conditions that can reduce turnover and improve quality and reliability;
- improve efficiency and profitability;
- enhance corporate brand and values, which can build customer loyalty;
- drive process and product innovation, which empowers suppliers to uncover opportunities for developing sustainable products and services;
- and increase shareholder value.

Determining Environmental Sustainability

How do you determine your environmental sustainability as a manufacturer? A company can determine how environmentally sustainable they are by measuring the impacts they have on the environment due to their operations and purchasing choices.

By utilizing a lean manufacturing or Six Sigma approach, the steps of DMAIC (define, measure, analyze, improve, and control) can be used to assess and improve environmental performance as a sustainability management cycle.

The sustainability management cycle process, as used by NYSP2I, can be followed by any company hoping to make their own operations more sustainable, enabling their improved responses to customer scorecards, and generating a periodic sustainability report for stakeholders. A company desiring to establish their own supplier requirements may wish to use this process to establish a supplier scorecard and measure their supplier's performance.

The sustainability management cycle, using DMAIC as the foundation, features the following as a continuous cycle towards improvement:

- The goals for a sustainable Management program, including supply chain, will be defined and a plan to achieve them will be established.
- The company is looked at as a system, with inputs and outputs that are then measured.
- Critical areas or activities having the greatest environmental impact are prioritized and analyzed for improvement opportunities and action plans are created.
- At this stage, the company is able to report on their goals, measurements, and action plans to their customers and stakeholders. This provides transparency, which is increasingly expected by customers and the public. Communicating the value and benefits of these goals and actions may be done through marketing, such as on the company's website or social media.
- Solutions are developed to improve the company's environmental impact, reduce risk, and become more sustainable.
- Once improvements are implemented, the company is able to control their impacts through monitoring, training and documentation.
- Continuous improvement is made by evaluating the current state and assessing these same stages on a periodic basis.

B. Supplier Continuous Improvement

Introduction

This section provides links and resources for developing a supply chain sustainability management cycle.

The supply chain sustainability management cycle process, as used by NYSP2I, can be followed by any company hoping to make their own operations more sustainable, enable their improved responses to customer scorecards, and generate a periodic sustainability report for stakeholders. A company desiring to establish their own supplier requirements may wish to use it to establish a supplier scorecard and measure their supplier's performance.

The cycle uses the DMAIC process as a framework, which includes the following steps:

1. **Define & Commit** – Define the company's sustainability goals based on generally accepted sustainability guidance, with a focus on industry-level initiatives. This may involve responding to customers' sustainability requests or scorecards, developing a supplier requirements program, or obtaining an ecolabel or certification.

2. **Measure & Calculate** - Measure the company's environmental performance in one or several areas of impact. First, a baseline needs to be established then performance is measured at defined periods of time. Areas of impact may include the following:

   - energy consumption
   - water use
   - air emissions
   - waste generation
   - chemical use
   - procured goods (e.g., paper)

3. **Analyze** – Analyze critical areas or activities that have the greatest environmental impact, prioritize them, and then identify improvement opportunities for those areas.

4. **Report** – Once a company has defined their goals, measured performance, and analyzed areas for improvement, it may elect to share their information in the form of a sustainability report to share with shareholders, customers, or the public.

5. **Improve** – The company will need to improve their environmental impacts, reduce risk both internally and through suppliers, and become more sustainable by implementing the improvement opportunities they've identified.

6. **Control** – Ultimately, measures will need to be put into place to control the company's environmental impacts through monitoring, training, and process documentation.

Other Resources

United Nations Global Compact Supply Chain Sustainability - A Practical Guide for Continuous Improvement

The U.N. Global Compact has created Ten Principles for more sustainable supply-chain practices. To help companies improve, the Global Compact and its partners developed guidance on how to take a more proactive approach to integrate the Ten Principles into supply chain management practices.

Organization for Economic Co-operation and Development (OECD) Sustainable Manufacturing Toolkit - Seven steps to environmental excellence From the OECD website: "The OECD provides a forum in which governments can work together to share experiences and seek solutions to common problems. We work with governments to understand what drives economic, social and environmental change. We measure productivity and global flows of trade and investment. We analyze and compare data to predict future trends. We set international standards on a wide range of things, from agriculture and tax to the safety of chemicals. Excellent guide to sustainable manufacturing including good background information, and metrics and measurable indicators."

U.S. Department of Commerce's Sustainable Manufacturing Initiative
Being part of a sustainable supply chain also means that your company is involved in sustainable manufacturing. The US Department of Commerce's Sustainable Manufacturing Initiative defines sustainable manufacturing as: "The creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers and are economically sound."

1. Define & Commit

Manufacturers are under greater pressure today to measure and document their environmental and societal impacts. Major manufacturers are asking their upstream supply chain partners to report on their impacts as part of sustainable supply chain initiatives. Sustainable supply chain programs may be initiated to comply with environmental regulations, like the European Union's RoHS (Reduction of Hazardous Substances) or California's standards, to strategically position with customers and investors, or to improve efficiency and save costs.

To get started with making a company a sustainable supplier in their supply chain, there needs to be a commitment and a defined approach to establishing a sustainability program.

Top management commitment

Managers should

- assign one corporate owner for overall supply chain risk. Company procurement, operations or another central department should own overall supply chain risk management, with the right budget, resources and IT infrastructure to ensure logistics and regulatory compliance.
- assign other functions (legal, compliance, finance, ethics, corporate social responsibility, operations, and business units) to create a proactive cross functional approach to supply chain risk management, crisis management, and post-crisis learning. (Learn more about supply chain risk from Ethical Corporation.)
- encourage key departments in the company to partner to ensure well-strategized approach and areas for opportunity.
- integrate environment and safety functions into the supply chain process using the same approach as any other business priority.
- educate and inform company's procurement professionals about internal strategies and external priorities.
- set the expectation that sustainability is the responsibility of every procurement professional.
- outline corporate values or principles.

Business case

A company must

- develop a business case to understand the drivers for a sustainable supply chain, for making a change or for implementing an improvement. Internal drivers or influencers may include impacts, costs and resources. External drivers may include customers, stakeholders and regulations.
- understand the voice of the customer, which includes requirements from customers, non-government organizations, purchasing agents, legislation, and the community. Through hazard and risk assessments, including health and safety, corporations can prioritize which metrics they apply to their company and industry and can then create corporate sustainability goals. In this definitive stage, a company may consider entering into collaboration and partnerships with other organizations and strategic entities.
- understand the marketplace to

  - gauge industry best practices;
  - identify stakeholder and customer concerns;
  - know current and future regulatory requirements facing the world's supply chain; and
  - engage, create dialogue, and collaborate with third parties and industry's major influencers such as NGOs, industry consortiums, and others.
- consider possible factors that relate to the overall supply chain risk that should be considered when developing the business case:
  - third-party risks (supplier, vendor, distributor, agent, consultant, venture partner, or partner)
  - labor and human rights risks (including child labor and slave labor).
  - health and safety risks
  - ingredient/component and product quality/safety risks
  - private or public procurement risks
  - regulatory risks (specific to the industry in question)
  - corruption, fraud, or money laundering
  - misrepresentation/false advertising
  - environmental impact
  - climate change/sustainability impact (water, energy, and other resource use)
  - business continuity and crisis management

Vision
A company needs to establish a sustainable supply chain vision and set objectives and targets.

Corporate Policy
A company must also establish sustainability expectations for its supply chain. To do this, they should reflect on corporate values, the marketplace, and key impacts including compliance, health and safety issues, labor practices, and human rights. They should also understand the impacts of the products or services that the company delivers.

Other Resources

- MIT Sloan Management Review – Sustainability Interactive Tool
- United Nations Global Compact Supply Chain Sustainability
- Organization for Economic Co-operation and Development (OECD) Sustainable Manufacturing Toolkit - Seven steps to environmental excellence
- European Union REACH Directive

2. Measure and Calculate

Understanding how to collect data, measure, or audit your performance can be just as challenging as knowing what to measure. The purpose of measuring is to track performance against the company's objectives and targets. For a sustainable supply chain, data must be transparent and reportable.

Internal Measurements

The objective of sustainability metrics and indicators is to inform corporate decision makers, and potentially shareholders and the general public, on the environmental, social, and economic performance of the company.

Impacts and priorities

A company should determine the scope of what to measure based on business priorities and impacts. Do this by measuring its environmental performance in one or several areas of impact.

Measure Baseline of Environmental Impacts

It's important to understand inputs and outputs, and to establish a baseline. This can be done by assessing recent and current performance, and conducting self-assessments.
Areas of impact may include:

- energy consumption
- air emissions
- water use
- waste generation
- natural resources/materials
- chemical use
- procured goods (e.g., paper)

Map and Prioritize Suppliers

A company needs to determine and prioritize which suppliers to focus on initially and to organize them in tiers. Priorities may include the following:

- top 20% by dollars purchased
- location of supplier in a high-risk community, region, or country
- opportunity for company growth*
    - strategic growth – Potential for a trust-based relationship where gains and cost efficiencies can be shared, value can be created beyond the contract; and may have sustainability leadership and could influence customer
    - operational suppliers – achieve aligned interests and measure joint performance; may have sustainability transparency with 2 goals publicly available and may have innovation and cost improvement program
    - tactical supplier – react only to opportunities. Focus is on managing the contract; may have a sustainability program with EHS staff and possibly ISO certification
    - transactional supplier – focus only on delivery and fulfilling POs; may only have sustainability awareness with baseline data and focus on compliance

**Information originally presented by Tom LaVake of Johnson & Johnson in October 2011.*

Code of Conduct

Supply chain risk can be managed by communicating expectations through a code of conduct and by engaging with suppliers to improve performance. A code of conduct, as part a supplier program, can help to

- create goodwill among suppliers by making expectations clear. [2]
- encourage transparency with suppliers by sharing plans and expectations and learning from their ideas and knowledge.
- Other ways to communicate with suppliers in addition a code of conduct include the following:
    - legal agreements (contracts, agreements, bid requests, and purchase orders)
    - external means (website, social media, etc.)
    - internal practices (purchasing and procurement policies, employee training, etc.)
    - listening to and gathering feedback from suppliers
    - involving suppliers in strategic discussions through dedicated forums
- The Ethical Corporation's "How to Commercialise a Sustainable Supply Chain" offers more information on how to create a code of conduct.

Supplier Scorecard and Baseline

- Supply chains can have the biggest influence on reducing environmental impacts, reducing risk, saving cost, and eliminating waste. That is why scorecards can determine which suppliers a buyer may want to do business with and therefore improve the sustainability of the company and the supply chain as a whole. Suppliers who comply with scorecard requests and are transparent with their data are more likely to remain suppliers to their customers and potentially gain additional new business.
- Scorecards today rate energy and climate change, water scarcity, and energy risk, as well as raw material and natural resource management, waste, and governance, along with fair labor practices and community engagement activity. Scorecards may assist organizations with their purchasing decisions and use scorecard responses to determine a product's impact through its lifecycle.

Scorecards typically include baseline information and track progress towards a set goal and reduction targets. Some things to consider include the following:

- Suppliers completing the scorecard appreciate
  - clarity of customer expectations,
  - ease of use,
  - a consistent scoring process, and
  - objectivity through data-driven scoring with flexibility for differences in reporting sustainability projects.
- When issuing scorecards to suppliers, look for
  - clarity of company's expectations and reasoning,
  - how the score is derived,
  - data driven metrics and rigor so that scoring is not too easy, and
  - simplicity of scoring methodology.
- A scorecard should have stability over the long term and ease of comparison from year to year.
- Emphasis should be on continuous improvement.

Other Resources

- Responsible Business Alliance (RBA) Code of Conduct (supplier code of conduct example): The RBA is a coalition of the world's leading electronics companies working together to improve efficiency and social, ethical, and environmental responsibility in the global supply chain.
- U.S. Department of Commerce Sustainable Manufacturing Initiative This website serves as the central information portal for what the U.S. Department of Commerce and other federal government agencies are doing to support sustainable manufacturing in the United States.

- ISO 14040:2006 Environmental management -- Life cycle assessment -- Principles and framework.
  This standard describes the principles and framework for life cycle assessment (LCA), including definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, the relationship between the LCA phases, and conditions for use of value choices and optional elements.
- Life Cycle Assessment
  American Center for Life Cycle Assessment website contains information on LCA, example assessments, and a list of certified LCA professionals.
- TRACI: Life Cycle Impact Assessment
  The U.S. Environmental Protection Agency (EPA) has developed TRACI (Tool for the Reduction and Assessment of Chemical and other environmental Impacts) to assist in impact assessment for sustainability metrics, LCA, industrial ecology, process design, and pollution prevention.
- ReCiPe: Life Cycle Impact Assessment
  From the ReCiPe website: "This site presents the ReCiPe methodology for Life Cycle Assessment Impact Assessment. The objective is twofold: 1. Provide generic information on the method, how to apply it, and on which principles it is based 2. Provide detailed information on the models used, and allow every researcher to analyze and potentially improve the models."
- Impact 2002+: Life Cycle Impact Assessment
  IMPACT 2002+ provides characterization factors for more than 1000 LCI results. This methodology is currently implemented into the ecoinvent Database.
- Sustainability Consortium Open IO model
  Open IO has adapted for LCA purposes the input-output structure of the U.S. economy developed by the U.S. Bureau of Economic Analysis.

3. Analyze

The analysis phase of the sustainability management cycle first focuses on translating the measured data into performance metrics. For example, a company might measure its in-house energy use but will then need to convert those measurements into sustainability metrics, such as fossil fuel use, green-house gas emissions, or human-health impacts from air emissions. The performance can then be compared to the corporate goals in a gap analysis, and from there, a root-cause analysis can be performed to identify focus areas and potential improvement projects. A company can determine the scope of its efforts based on its business priorities and impacts.

Supplier Analysis

Take the following steps when performing a supplier analysis:

1. Determine what to buy, know the properties of the materials and services. *
    1. Strive for materials made with recycled or certified components or services that have a positive impact on sustainability.
    2. Materials that may not contain any recycled or certified components but are not banned or prohibited (e.g., California Proposition 65) or services that are planning to integrate sustainability may be acceptable but may need guidance to move in the right direction towards sustainability.
    3. Avoid materials that are banned or prohibited or services that do not take in, or have a plan to take in, any aspects of sustainability into account. These need attention and an action plan to seek improvement.
2. Determine who to buy from, and have an understanding of the supplier because their level of transparency is important.
    - Strive for suppliers that have publicly available sustainability information, including goals and reports progress on at least two key metrics (energy reduction, water use reduction, waste reduction, workforce injury / illness reduction, workforce wellness, or community investment).
    - Even if a supplier has publicly available sustainability information, they may require some assistance to work towards greater sustainability and transparency.
    - A supplier with no publicly available sustainability information will eventually need to create an action plan to show a commitment to sustainability.
3. Determine where the supplier obtains materials to understand the complete supply chain.
    1. Choose suppliers that know where the materials they use originate and confirm that the source company legally grew, harvested, or mined the materials.
    2. It may be acceptable to know the addresses for your primary and secondary suppliers, but some additional assistance may be required to get those suppliers moving towards sustainability.
    3. Avoid primary and secondary suppliers whose addresses are unknown or, if that is not possible, create an action plan with them to implement sustainable practices.
4. Understand and assess risk. For example,
    1. privilege conflict-free minerals (Frank Dodd Act), and
    2. evaluate the impacts of any rare earth materials used.

**Information originally presented by Tom LaVake of Johnson & Johnson in October 2011.*

Other Resources

Green Suppliers Network Calculator
This is an Excel-based tool for documenting operations inputs and outputs to calculate benefits. The Green Suppliers Network is a joint effort of the U.S. EPA, the U.S. Department of Commerce, National Institute of Standards & Technology, Manufacturing Extension Partnership Program, and is a component of the Federal E3 Initiative (Economy, Energy, and the Environment).

U.S. EPA Waste Reduction Model (WARM)
This tool calculates the benefits of recycling and waste reduction efforts.

U.S. EPA Greenhouse Gas Equivalencies Calculator

This tool calculates the impacts of energy and fuel use and the savings from reducing both.

U.S. EPA Emissions & Generation Resource Integrated Database (eGRID) EPA database that provides emissions for various energy mixes specific to U.S. zip codes.

U.S. EPA Power Profiler
The Power Profiler calculates the air emissions attributable to the electricity a company uses normalized over one year, along with a description of what these numbers mean in everyday terms.

Examples of industry best practices:

- Wal-Mart Supplier Sustainability Assessment
  Wal-Mart requires their global suppliers to evaluate their own sustainability using a custom survey.
- Environmental Paper Network Paper Calculator
  This tool calculates the environmental impact of recycled paper choices.

4. Improve

The improvement phase of the sustainability management cycle focuses on implementing the practical solutions identified in the analysis phase. It is not possible to anticipate all possible issues that arise in the wide variety of manufacturing supply chain sectors. This section provides information on some common issues, such as material hazards and energy use, green purchasing requirements, and possible funding sources.

Company Internal Environmental Improvement

A company's environmental impact should be considered, namely energy consumption and associated greenhouse gas emissions, air emissions, water use, waste generation, natural resources, chemical use, and the impacts of procured goods.

Collaboration and Partnership

A company may consider entering into collaboration and partnerships with other organizations and strategic entities. This may require

- educating suppliers on sustainability by hosting / promoting sustainability events.
- demonstrating a commitment to supplier improvement by implementing supplier development programs.
- encouraging transparency and visibility.

Capacity Building

Forge industry collaboration and multi-stakeholder partnerships to advance objectives efficiently.

Green Purchasing

- New York State (NYS) Executive Order No. 4 (EO4)
  NYS launched the State Green Procurement and Agency Sustainability Program, which directs all state agencies, departments, offices, commissions, public authorities, and public benefit corporations to green their procurements and to implement sustainability initiatives in accordance with EO4.
- U.S. EPA Environmentally Preferable Purchasing (EPP)
  Environmentally Preferable Purchasing (EPP) helps the federal government "buy green," and in doing so, uses the federal government's purchasing power to stimulate market demand for green products and services.
- National Association of State Procurement Officials (NASPO) Green Purchasing Guide
  NASPO's Green Purchasing Guide provides purchasers with a basic understanding of green purchasing and recommends steps and strategies to enable a green purchasing program.
- The Responsible Purchasing Network (RPN)
  The Responsible Purchasing Network (RPN) is an international network of buyers dedicated to socially responsible and environmentally sustainable purchasing.

NYS Financial Assistance for Improvement Projects

- NYS Empire State Development Environmental Investment Program (EIP) This program helps businesses capture the economic benefits associated with pollution prevention, waste reduction, reuse, recycling, and the use of sustainable products and processes.
- NYS Empire State Development Environmental Small Business Environmental Ombudsman (SBEO)
  To provide businesses with free, confidential assistance to help them understand and comply with environmental regulations.

Other Resources

- ISO 14001:2004 Environmental management systems - Requirements with guidance for use
- ISO 50001:2011 Energy management systems - requirements with guidance for use
- Substitute It Now (SIN) List
- GREET
- EPA Alternatives Assessment
- ENERGY STAR for Industry, Tools and Resource Library

5. Control

The control phase of the sustainability management cycle is used to ensure that variances from the desired objectives and targets are detected and corrected. This may be achieved through auditing, training, and corrective action.

Internal Auditing

Internal auditing should be conducted by a team of individuals that follow an audit checklist and schedule. Individuals look for conformance to the sustainability policy, objectives, and targets, and ensure that measurements are taken to assess performance. Any observations that identify non-conformance with the sustainability plan should have a root cause identified and a corrective and/or preventive action implemented.

Supplier Auditing

A supplier audit can ensure alignment and follow-up internally (remediate supplier non-compliance and invest in continuous improvement). Critical components of an effective supply chain risk management strategy include the following:

- checking, testing, and auditing supply chain third parties
- internal and external auditing and checking of third-party facilities, ingredients, components, quality, safety, and labor practices

Companies with extensive supply chains should consider forming an internal supply chain risk audit team or developing part of their internal audit function to accomplish such ongoing and periodic tasks. (Learn more at Ethical Corporation's website)

Performance Tracking
It is important to track performance against goals and verify conformance. When doing this, companies should be aware of suppliers' operational performance at all times. Suggested measurement tools include the following:

- product / material disclosures
- transparency and public corporate sustainability reports with goals
- performance assessments and auditing using
- supplier report cards
- business reviews
- onsite evaluations of location and types of activities
- third-party audits
- corrective actions and monitoring backed by appropriate penalties
- improvement assistance
- reward and recognition system

Corrective Action
Anytime there is an observation where continuous improvement is being hindered, including targets not being met, or performance not being measured, then a corrective action should be developed to understand the root cause and then a plan to correct the issue should be identified and implemented.

Training
Training is an element of continuous improvement that will benefit the company's performance. A training program should be designed to uniquely address each individual's role in the company.

Management Review
The company's performance towards the elements of the sustainability plan, including policy, objectives, targets, measures of performance, and communication, should be reviewed with management on a periodic basis.

Other Resources
Greenstone Supplier Portal
"SupplierPortal" is a user-friendly online responsible sourcing solution for suppliers and their buyers to track and monitor environmental, labor, health and safety and anti-bribery and corruption information. This global solution facilitates efficient communication between buyers and suppliers, enables suppliers to report key responsible sourcing data and calculate their carbon, waste and water footprints, and enables buyers to view and compare their suppliers' performance across key responsible sourcing metrics.

6. Report

Once a company has defined their goals, measured performance, and analyzed areas for improvement, the company may elect to share their information. Various forms of reporting include a company sustainability report, or use sustainability labels or certifications. These act as tools for sharing information with stakeholders, customers, and the public.

Reporting Progress to Stakeholders

Scope and Boundaries

When planning a report to stakeholders, a company must consider what content to include, who will be reading it, how often it will be published, and in what format the report will be distributed (printed, website, social media, etc.).

Transparency

The key to sustainable supply chain management is transparency. Developing a credible message regarding the full impacts of a company's operations, services, and products can strengthen its brand, reinforce employee understanding of its corporate values, and facilitate engagement with a broader set of stakeholders.

No matter where a company resides in the supply chain— raw material/component supplier, final producer, or distributor—it will need to report information about its social and environmental impacts to many different audiences, including government agencies, NGOs, investors, partners and customers.

Below are six characteristics of transparent, effective communications [1]:

1. Transparency uses data to communicate and it needs to be accurate. When stating conclusions, it is important to state what data was used and how the data was obtained.
2. A company's stakeholders are the ones that will benefit from the information in order to make a better decision. These stakeholders should be identified and targeted as an audience for communications.
3. The right format and means of communicating is imperative for reaching the intended stakeholder audience. This includes determining whether print media, websites, or social media is most appropriate for effective communication.
4. Timing of communications should consider whether the stakeholder(s) is able to take action in a timely matter in order to make a decision and improve an outcome. If the company communicates too late, they may have missed an important trend or competitive positioning.

5. Periodic communication can be effective and the company needs to determine the frequency for sharing information without being overly burdensome on the audience or appearing to not communicate effectively.
6. A company should be genuine in its communications and about why information is being shared. Sometimes transparency is a reaction to an issue or it may be a response to a request. A company should consider when to not communicate and the consequences that such a decision may bring.

These points summarize "Six Elements of Effective Transparency" by Lorraine Smith from sustainability.com.

Responding to Supplier Scorecards How to respond to customer scorecards:

- The way a company approaches scorecard requests and the strategy it employs to improve its score has a dramatic impact on long-term value derived from the exercise.
- Sustainability scorecards are gaining momentum globally across supply chains for many industries. It's no longer just in retail, where it had its origins with consumer products, but rather across nearly every industry sector. This includes electronics, paper and printing, and even food. Industry shareholders and investors, trade organizations, NGOs, and government (the largest purchasing power), are all placing requirements on suppliers across the supply chain to reduce emissions and environmental and societal impacts. These requirements include disclosing and being transparent about the data for these impacts and any sustainability efforts in place.
- Below are three best practices for suppliers that can help achieve long-term value and high scores (originally published in "The Growing Trend of Sustainability Scorecards" by Renewable Choice Energy):

    1. **Understand Your Customer's Motivations** – Large buying organizations implement supply chain sustainability programs because they believe the program will result in some business value such as cost reduction, improved customer loyalty, or risk mitigation.
    2. **Consider Values Beyond Compliance** – Suppliers that respond to scorecard requests generally fall somewhere on the sustainability spectrum between leader and reluctant complier. Reluctant compliers generally perform a simple calculation involving consumer/buyer pressure and cost when deciding on a desired score and potential outcomes. While this may be effective at producing acceptable scores, there is little long-term benefit. The sustainability leader, however, understands that sustainability programs will only succeed if they provide lasting value for the company. These companies will analyze requests in the context of their specific business environment to identify actions that can save money and improve customer satisfaction.

3. **Build Support from the Top Down** – Implementing any kind of new business strategy requires strong support from senior leadership, and sustainability is no different. Executives need to believe the business case behind the new initiative and support its champions over the long term. Nearly all sustainability projects will require participation from many, if not all, company departments. Building internal support from senior leadership will ensure teams understand the larger story behind sustainability projects and facilitate efficient project execution.

Scorecards can provide a means for suppliers to differentiate themselves against competition and add true business value.

A recent study by Renewable Choice Energy stated: "Sustainability scorecards have become a key to success for suppliers and are here to stay. In fact, they are becoming more prevalent, more complex, and more mainstream—the sooner suppliers understand this and get on board, the sooner scorecards will no longer be viewed as a burden but instead as a springboard for success and growth as well as a competitive differentiator."

Other Resources

- Global Reporting Initiative (GRI)
  The Global Reporting Initiative (GRI) is a nonprofit organization that provides companies and organizations with a comprehensive sustainability reporting framework that is widely used around the world.
- GRI Reporting Checklists
  This tool is a convenient checklist with questions for each of the GRI reporting criteria and for each covered manufacturing sector.
- Carbon Disclosure Project
  The Carbon Disclosure Project (CDP) is an independent not-for-profit organization working to drive greenhouse gas emissions reduction and sustainable water use by businesses and cities.
- ASSET4
  ASSET4 provides objective, relevant, and systematic environmental, social, and governance (ESG) information based on 250+ key performance indicators (KPIs).
- World Resources Institute GHG Protocol
  The Greenhouse Gas Protocol (GHG Protocol) is the most widely used international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions.
- The Climate Registry
- IIRC
- SASB

Sustainability Labels

- UNOPS 2009, A GUIDE TO ENVIRONMENTAL LABELS - for Procurement Practitioners of the United Nations System
  This guide reviews in the context of UN procurement different environmental labels, ecolabels, product declarations and many other logos that aspire to define the environmental performance of consumer products.
- Global Ecolabelling Network (GEN), "Introduction to Ecolabelling", July 2004 This document provides an introduction to ecolabelling, the general objectives, guiding principles, key features, and some indicators of success.
- Green Labels
  Consumer Reports Greener Choices is a website enabling lookup and descriptions of various eco-labels.
- Ecolabel Index
  Ecolabel Index is the largest global directory of ecolabels.
- Green Seal
- Design for the Environment
- Forest Stewardship Council
- The Climate Registry
- IIRC (International Integrated Reporting Council)
- SASB (Sustainability Accounting Standards Board)

C. Environmental Management

It is important for an organization to have a plan for using resources like energy, water, or materials and to identify opportunities for continuous improvement. A successful plan is dependent on all employees throughout an organization having an understanding of the company's environmental management goals and objectives.

A strong strategic plan, based on the most impactful changes and a clear environmental policy, will help an organization reach its environmental and associated financial goals. Measurable targets and several indicators can help evaluate progress toward goal completion.

Energy Management

Manufacturing organizations use several energy sources. The typical sources are electricity and natural gas, but these are provided by a utility supplier using its own energy resources. Energy may be produced onsite as well from solar, wind, and geothermal technologies, but is most commonly generated from the combustion of fossil fuels. Common energy uses throughout industrial sectors include lighting, heating and cooling systems, transportation, and a wide variety of process equipment.

The costs of energy uses are not always apparent to management personnel because many organizations allocate them to overhead usage rather than to their appropriate processes. Possibly the most primary form of energy documentation is a facility's utility bill, which charges an organization based on the amount of electricity used in a billing period and the peak use each month averaged over a short time period.

Typical Sustainable Supply Chain Scorecard Energy Questions

1. Does your organization comply with regulations regarding use of energy resources?
2. Does your organization take measures to reduce energy consumption?
3. Are reductions achieved?
4. Does your organization monitor and record its energy consumption? Are reduction targets developed and are they achieved?
5. Does your organization provide information and train employees to implement energy reduction measures?
6. Does your organization employ initiatives to provide energy-efficient or renewable energy-based products?
7. Has your organization initiated practical activities to reduce energy consumption?
8. Which of the following systems have you implemented energy conservation/efficiency measures for your corporate facilities (if your organization has selected "other," please describe)?
    A. Equipment: Energy Star Appliances / Automatic Sleep Modes / AfterHour Timers / etc.
    B. Lighting: Natural Light / CF Bulbs / Occupancy Sensors / Daylight Dimmers / Task Lighting / etc.
    C. HVAC: Programmable Thermostat / Timers / Occupancy Sensors / Shade Sun-Exposes Walls / Double-Paned Windows / etc. D. Other
9. Does your organization have a climate strategy that identifies opportunities to reduce your energy consumption?
10. What is your direct energy consumption by your primary energy source?
    A. Use this formula to calculate the amount: Total direct energy consumption = direct primary energy purchased + direct primary energy produced – direct primary energy sold
11. What is your indirect energy consumption by your primary source?
12. How much energy is saved due to conservation and efficiency improvement?
13. What percentage of energy (relative to organization revenues) was saved in the last year for your corporate facilities?
14. What is your organization's energy intensity?

   A. Use this formula to calculate the amount: (energy consumed in production processes + energy consumed in overhead) / normalization factor = MJ/normalization factor

15. What is your organization's total energy use from renewable resources (kWh)?
16. What is your organization's renewable portion of energy consumed?
    A. Use this formula to calculate the amount: renewable energy consumed / total energy consumed X 100 = %
17. Has your organization increased its use of renewable energy annually at its corporate facilities?
18. What percentage of energy used is from renewable onsite energy production for corporate facilities?

Energy Indicators and Measurement

To answer these scorecard questions, a company needs to identify which indicators will best provide useful answers and then find a management strategy with established goals and targets for reduction. Below are typical energy operational performance indicators and methods for measuring energy consumption and use.

Typical Energy Operational Performance Indicators [1]

- Quantity of energy used per year, quarter or month
- energy used per unit of production
- energy used per service or customer
- type of energy used and related quantity
- onsite renewable energy generated
- energy from renewable sources
- energy units saved by conservation initiatives

Measuring Energy Use of Individual Processes

Simply knowing the total energy consumption of an entire facility isn't enough for identifying energy improvement opportunities. Energy consumption of each process and system must be quantified so that it can be analyzed in order to identify and prioritize areas of improvement. The highest energy savings is gained by focusing efforts on the largest energy usages. Third-party performance ratings and manufacturers' specifications provide enough information for estimating energy usages, but these figures can vary significantly from a facility's equipment's actual energy consumption when accounting for operating conditions, wear of components, and maintenance issues. Submetering facility processes provides the most accurate information for determining actual usages. Submeters that monitor and provide real-time energy consumptions can inform immediate changes to reduce or eliminate energy usages, avoiding unnecessary costs and use of natural resources. [2]

Direct Energy Consumption by Primary Energy Source

The GRI's G3.1 Indicator Protocols Set: Environment recommends that organizations report their direct energy consumption by their primary energy source in their indicator EN3. [3]

Energy Intensity

Even though the energy intensity of production processes worldwide is continually improving, our increasing volume of production is driving levels of energy consumption even greater. [4] However, many organizations have successfully continued to grow their production processes while improving their energy intensity in a way that maintains or decreases their total energy consumption. For an organization to accurately assess their energy management, they need to account for both total energy consumption and energy intensity. The Organization for Economic Co-operation and Development (OECD) provides indicators for calculating energy intensity.

$$energy\ intensity = \frac{(energy\ consumed\ in\ production\ processes + energy\ consumed\ in\ overhead)}{normalization\ factor}$$

Unit of the indicator: MJ/normalization factor

Energy intensity should include the energy consumed in production processes and overhead activities. The margins of this formula may be extended or reduced for measuring and monitoring a broader range of activities or specific activities explicitly.

Renewable Proportion of Energy Consumption

Minimizing an organization's dependence on fossil fuels and release of greenhouse gases through energy efficiency improvements is great, but these actions have limitations. To go beyond those limitations, energy demands need to be met by renewable energy sources. Some current sources of renewable energy include hydro, solar, tidal, and wind power. The technology of renewable energy is rapidly changing in a way that is shrinking the pay-back period of such investments. [5] Meanwhile traditional energy sources are becoming more expensive due to their dwindling supplies and the increasing energy demands of mankind. OECD provides an indicator for calculating renewable proportion of energy consumed.

$$renewable\ proportion\ of\ energy\ consumed = \frac{renewable\ energy\ consumed}{total\ energy\ consumed} \times 100$$

Unit of the indicator: percent (%)

Renewable sources of energy also have related environmental impacts, but in general they contribute far less to climate change and are much more sustainable than nonrenewable energy sources. Each organization has different opportunities to increase the renewable proportion of energy consumption depending on their region, utility supplier, and other factors. Facility installations like small-scale solar and wind power technologies are great, but an organization should optimize its energy efficiencies first because such improvements are much less expensive.

Energy Audits & Assessments

An organization's total energy use and breakdown of energy-using processes is not enough to effectively manage energy consumption. It needs to periodically audit and assess the efficiencies of their equipment, operations, and systems to attain improvements in performance. Energy assessments are typically performed to understand how energy is used within a facility, whereas energy audits aim to measure the energy use of a facility's individual processes.

Energy audits and assessments should be conducted by personnel with energy expertise and background knowledge of a facility's energy using equipment, procedures, and systems. Auditors and assessors should be comparing actual performances of these components against designed performances, which will identify potential energy savings. They should also consult with process operators and managers to gain their perspective and thoughts about energy management mechanisms. These initiatives can vary in depth and focus, so it's important to establish minimum criteria in process documentation and to prioritize components based on their energy significance.

Energy Improvements and Implementation

Maximize motor efficiencies – The machinery and equipment of many manufacturing organizations is powered by obsolete, inefficient motors. Replacing them with more energy-efficient motors is an effective means of lowering operating costs. The key to sustaining motor efficiencies is regular maintenance. Identifying and addressing motor issues before a breakdown occurs is cheaper than addressing a motor failure. Downtime due to motor failure can be avoided by having in place a plan for procuring a high-efficiency motor.

Lighten your lighting energy – The energy consumption of lighting fixtures is often overlooked because they don't consume a lot of energy in respect to other energy-consumptive processes. However, taking into account the amount of time that lighting fixtures are on as opposed to other processes reveals a big opportunity for energy savings. Installing high-efficiency lighting systems and utilizing natural light improves lighting quality while lowering energy consumption.

Higher your HVAC efficiency - Heating, ventilating, and cooling (HVAC) systems more than a decade old are easily beat by today's higher-efficiency HVAC equipment. They feature more computer-controlled options with newer technology, which makes upgrades cost-effective while making it easier to achieve energy savings. A facility's HVAC energy usage can be lowered by minimizing use during less productive periods, like weekends, overnight, or when natural conditions allow.

Improve your compressed air systems – Most industrial operations use compressed air for hand tools, pneumatic controls, or in applications applying a blend of these two types of technologies. Compressed air is nearly always generated onsite and can account for one of a facility's highest energy demands with energy efficiencies as low as 10-15%. [6] The efficiency of compressed air systems can be improved by ensuring proper installation, identifying leaks, isolating systems when not in use, filtering out water and solid particles, employing air conserving practices, and avoiding over pressurization as well as pressure drops. [7]

Procuring Green Power

The term "green power" is used to express multiple concepts, but, in the broadest sense, it refers to environmentally sound energy and energy technologies. [8] Numerous energy utility providers allow their customers to purchase a percentage of their electricity from renewable energy sources. In New York, there are over 20 enrollment programs according to the U.S. EPA's Green Power Network (www.epa.gov/greenpower). These providers' sources of renewable energy include wind, biomass, and hydro. Other renewable resources that may not be available to New York organizations but are found in other parts of the United States include geothermal, solar, low-impact hydro, and biogas.

The cost of power generated from fossil fuels continuously fluctuates because it is affected by fuel prices. Green power, conversely, is much more reliable and new technologies are continually making it more cost-efficient to invest in such energy resources. Its environmental benefits include less pollution, reduced greenhouse gases, and improved human and environmental health. Green power sources also don't experience as many supply disruptions as nonrenewable sources do. Plus, there are less compliance concerns when it comes to environmental regulations. Currently, governing entities worldwide are addressing global climate change and regional air quality concerns by increasing the price of traditional electricity resources. Procuring green energy also adds credibility to an organization's commitment to environmental objectives, demonstrating social leadership, and offering a good publicity opportunity. Not only does it improve employee morale, it can create jobs while securing current employment. Using green power may also distinguish your organization's products and services from competitors, while becoming a preferable partner in green supply chains.

Below are general steps to purchasing green power provided in a publication produced as a collaboration between the U.S. Department of Energy, the U.S. EPA Green Power Partnership, the World Resources Institute, and the Center for Resource Solutions. [9]

1. **Set goals** – Before an organization procures green power, it should identify what green power options will best attain its environmental targets while meeting its energy demands. It ought to set goals while considering green power, such as most important criteria, and which certification and verification processes it wants to incorporate.

2. **Identify key decision-makers** – An organization should figure out which staff members have the knowledge and expertise to provide good input for the decision-making process regarding resource purchasing, energy management, environmental compliance, and marketing aspects. Their input in the planning stage can lead to large rewards later on.

3. **Gather energy data** – When determining how an organization may benefit from green power procurement, the people involved should be familiar with its energy use, energy sources, and their environmental aspects. Data should be gathered to build such an understanding, which may include energy inventories, energy efficiencies, load management, and an energy portfolio.

4. **Choose green power options** – Every green power option come with different criteria in regard to its environmental benefits, financial impacts, and market positioning. An organization needs to decide initially whether to generate power onsite or to purchase green power from utility providers, if not both. It also needs to develop financial approaches to overcome capital costs of converting its energy procurement means. Every region has different green power options available in the local energy market, so decision makers must figure out which ones are available and determine which are the most practical.

5. **Evaluating the purchase** – After an organization has procured green power resources, it must evaluate how well it is working for against what it anticipated. Is the organization taking actions to benefit from green power procurement? What objectives has it accomplished or narrowed the gap toward accomplishing? With onsite generation, it is important to evaluate the associated processes to get the most out of efforts being made.

Procuring Green Power

Rather than purchasing renewable energy from a utility provider, or perhaps in addition to, an organization may get the most benefits from installing its own renewable energy generation technology. Onsite renewable generation is more reliable than energy from a provider, produces better power quality, and protects against price instability. Some onsite renewable energy technologies for generating green power include photovoltaic panels (solar), wind turbines, fuel cells and biomass combustion. [10] Some popular options are described below, but technology continues to improve so it is important to do research to determine the current options.

Solar – Photovoltaic systems can be configured to nearly any size from only a few kilowatts up to several megawatts. As such, they can be installed onto various buildings or as standalone structures. Integrating this technology into building designs can displace material costs such as roofing or parking lot shading.

Wind – Small wind turbines can provide 100 KW or less whereas large ones range from 500 KW to more than three MW. Because of their nature, wind turbines are usually most practical in non-urban environments, since they often require zoning permits. Wind turbine installations typically need about one acre of land per turbine and wind speeds the average at least 15 mph 150 feet above the ground. [11] Wind turbine performances can be affected from nearby buildings, which is another reason they're not generally suitable for urban environments.

Methane gas capturing – Methane gas released from landfills, sewage treatment plants, and manure or agricultural waste digesters can be in large enough concentrations to be a viable source of generating energy. Once captured, it may be used as fuel for an internal combustion engine, gas turbine, boiler and/or other power conversion technologies. Common methane gas implementations produce 0.5–4 MW of electrical energy.

Biomass combustion – Biomass combustion is essentially the process of generating electricity through burning plant material in a boiler to drive a steam turbine. Plant material often consists of agricultural or foresting wastes. It may produce both heat and energy for a facility. The technology is most suitable for organizations with a large resource of biomass and a significant need for heat.

Hydrogen fuel cells – Hydrogen fuel cells are not considered a renewable resource unless they operate exclusively on a renewably generated fuel. However, they typically meet that measure by using digester gas or hydrogen resulting from photovoltaic or wind turbine processes. They are more efficient than other forms of generation and basically release no air pollutants.

Biodigester – A biodigester, or anaerobic digester, is simply an airtight chamber that allows organic matter to succumb to a biological process in which bacteria breaks it down in the absence of oxygen. [12] This process generates a gaseous mix of methane and carbon dioxide known as biogas, as well as animal bedding and fertilizer. The biogas may be used as fuel for energy generation, serving as an onsite renewable energy source. This process reduces greenhouse gas emissions as well as organic wastewater and waste streams since it consumes manure, biosolids, food waste, agricultural waste, and other organic matter.

Monitoring and Controlling Energy Use

Energy monitoring practices at the facility level should be from the perspective of overall consumption processes. This includes the facility's manufacturing processes, their supporting energy sources, and the environmental impacts related to those sources. Comprehensive monitoring includes periodically measuring, documenting and reporting key energy flows as well as identifying energy savings. An energy flowchart and energy balance should be continually updated, if not using real-time data already. Progress towards attaining energy performance targets should be designed through action plans and measured against them. However, these targets should be updated if a facility's energy consumption patterns change significantly. Energy improvement opportunities can be identified by comparing monitoring data against different operational factors, such as shifts, maintenance practices, operators, and procedures. It is important to confirm that targets are appropriate by comparing monitoring data with benchmark data.

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[12] U.S. Environmental Protection Agency. *Case Study Primer for Participant Discussion: Biodigesters and Biogas*. Washington, DC: EPA, May 14, 2012. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100EDJ5.PDF

Water Management

Introduction

Water management practices should be related to the magnitude and cost of a facility's water consumption. Water management initiatives should promote continuous improvement in the form of reducing water consumption, attaining water savings, effective water treatment, efficient water usage, and responsible disposal practices. Initiatives for water management may include rainwater harvesting, wastewater treatment for water reuse, in-process recirculation systems, dry process technologies to conserve water, water pressure management, and loss prevention.

Wastewater management aims to effectively use, treat, store, transfer, and dispose of water. When not properly managed, wastewater can easily become a significant source of pollution that poses excessive risk to the environment and public health. In such a situation, an organization faces many liabilities and risks that threaten its future, especially when its management practices don't adhere to legal requirements. On the other hand, managing wastewater in an efficient and responsible manner enables organizations to obtain numerous benefits and opportunities for improvement, including the following:

- reduced volume of wastewater discharged
- reduced quantity of pollutants discharged
- reduced risk of pollution incidents and liabilities
- reduced cost of wastewater treatment and discharge
- improved reputation with customers, stakeholders and the community
- increased cost-efficiency of water use

Typical Sustainable Supply Chain Scorecard Water Questions

Water Consumption [1]

1. Does your organization monitor total water consumption and the amount of water reused or recycled?
2. Does your organization take measures to reduce water consumption?
3. Does your organization have a strategy to reduce water consumption?

4. Does your organization have targets for reducing water consumption and/or increasing the amount of water reused or recycled in different business operations and activities?
5. Has your organization initiated practical activities to reduce water consumption?
6. Which of the following water conservation methods have been implemented at the majority of your facilities, including offices?
    A. low-flow toilets/urinals
    B. low-flow faucets or showerheads
    C. grey-water usage for irrigation/toilets
    D. low-volume irrigation
    E. harvest rainwater
    F. other (Please specify.)
    G. none
7. Does your organization provide information and train employees to implement measures to reduce water consumption?
8. Does your organization's use of water not negatively affect the sustainability of water resources, the natural environment, or the availability of water for drinking and sanitation purposes?
9. Does your organization engage with national, regional, and local public authorities, and civil society organizations to address water sustainability issues related to the affected water resources?
10. What water sources are significantly affected by your withdrawal of water? [2]
11. Does your organization have the necessary permits to extract water or obtain water from the public water supply?
12. What is your organization's total water withdrawal by source, and subsequently, its total water use? [3][4]
13. What is the percentage and total volume of water recycled and reused? [5]
14. What is your organization's water intensity? [6]
    A. Use this formula to calculate the amount: total water intake / normalization factor = m3/normalization factor

Wastewater

1. Does your organization have a program and/or procedures for the management of wastewater, including monitoring, characterization, prevention, treatment, discharge, reduction, and/or recycling?
2. Does your organization monitor wastewater discharges, including types, limit values, and quantities of pollutants in the wastewater?

3. If wastewater treatment takes place outside of the organization's premises, is your organization aware of the effectiveness of the treatment?
4. Does your organization continuously attempt to prevent and reduce wastewater discharges via resource reduction methods (e.g., wastewater recycling or use of less harmful substances)?
5. What type of wastewater is generated at your organization?
    A. sanitary
    B. industrial
    C. none
6. Does your organization treat wastewater before discharge (pre-treatment) to reduce adverse environmental impacts?
7. Which of the following methods are used to manage your wastewater?
    A. onsite wastewater treatment
    B. discharge to a municipal treatment facility
    C. collection and transfer to a waste management entity
    D. other (Please specify.)
8. Does your organization comply with legal requirements relating to wastewater discharges?
9. Does your organization have the necessary permits for wastewater discharges? Are you required to apply for a National Pollutant Discharge Elimination System (NPDES) permit and / or state permit? [7]
10. Does your organization provide information and train employees on the safe management of wastewater?
11. Have you managed storm water runoff issues properly by developing a pollution prevention plan? [8]
12. Have you prevented storm-water contamination from parking lots, excavation areas, refuse areas, and so on, where storm-water runoff would be contaminated with hazardous pollutants? [9]
13. What is your organization's total water discharge by quality and destination? [10]
14. What is your organization's intensity of pollutant releases to surface water?
    A. Use this formula to calculate the amount: weight of releases (from production processes and, if available, overhead) to surface water / normalization factor = tons/normalization factor [11]

Water Indicators and Measurement

To answer these scorecard questions, a company needs to identify which indicators will best provide useful answers and then find a management strategy with established goals and targets for reduction. Below are typical water operational performance indicators and methods for measuring water consumption and use.

Typical Water Operational Performance Indicators [12]

- quantity of water consumed per year or unit of production
- quantity of or number of times waters is re-circulated or recycled within a facility
- quantity or percentage of water reused
- amount of water cost savings from water conservation initiatives
- quantity of water saved from loss prevention actions
- concentration of a specific contaminant in groundwater or surface water
- difference in upstream and downstream turbidity of a stream adjacent to the facility
- change in groundwater level of sourced aquifer
- water temperature of surface water facility discharges to
- average number of specific contaminants per gallon of surface water

Sub-metering – Measuring Individual Process or Activity Water Use An excellent way to accurately account for a facility's water uses is submetering. Sub-metering the water uses of specific processes aids water management actions and helps operators become more apt to conserve water. The size of a sub-meter should be determined by the actually flow rate of an operation's usage, opposed to the diameter of the pipe. An organization may use a temporary strap-on meter to measure the flow rates, which will help decide where to apply a sub-meter. Sub-metering a facility's largest water uses will help attain the biggest water savings, making the sub-meters cost-effective. Low flow rates may be easily measured by the bucket and stopwatch method or by using micro-weirs. Micro-weirs are hand-held weirs that are small enough to be used in tight spaces with flow rates up to six gallons per minute.

Water Balance

A water balance helps an organization prioritize the significant water uses in their facility and identify areas for water conservation, reuse, and efficiency by providing an inventory of the water in a system. Water systems can be very complex when comprised of numerous inputs, losses and outputs, but they can be simplified using a water-flow diagram. Once all components of a water system are identified, a facility-wide water balance may be developed by measuring the total water consumption and wastewater discharge. The difference between these quantities account for the amount of water lost from leaks, evaporation, irrigation, etc. A water balance may be applied to different areas of a facility and even specific processes for identifying water losses. The general formula below describes a typical water balance.

balance = process or facility water input - (water losses + process or facility water output)

Leak Detection

Leaks exist at all facilities from negligible amounts to amounts that account for a good portion of the total water usage. A couple of symptoms of water leaks include dirty water and low water pressure. Leaks may account for a significant portion of a water balance. Identifying leaks may be done through visual or audio observations. Assessors should examine common sites for leaks, like piping joints, where sealants are used, processing equipment that uses water, and attachable water devices like nozzles and valves. Leaks are also commonly found in domestic areas including bathroom fixtures, drinking fountains, and kitchen components. Tightening or replacing such water control devices is typically the easiest solution for cutting water losses. An important note for assessors to consider is that many leaks are only apparent when the associated water fixtures, devices, or equipment are in use. Thus, assessments rarely identify all leaks and that's why it's important for employees to be responsible for notifying maintenance personnel or management of any detected leaks. Some water leak equations are below.

The Greely formula may be used to estimate rates of water loss for a more or less closed system:

$Q = (30.394)(A)(\sqrt{P})$

Where Q = leak rate (gpm), A = area of leak (in^2), and P = line pressure (psi).

This formula may be used to estimate leaks in joints, cracks, or broken seals:

$Q = (22.796)(A)(\sqrt{P})$

Where Q = leak rate (gpm), A = area of leak (in^2), and P = line pressure (psi).

Leaks from underground or under-the-floor sources may be identified by a leak detection survey with a water meter by shutting off all other associated water uses and then reading the water meter for a minute at minimum. If using the water meter for the entire facility, this should be performed after all operational activities have completed and when employees have left for the day so that no water will be in use by the facility. A leak is present if the meter dial continually moves during your reading. For small leaks, you may want to record meter readings every half hour over the period of two hours, but remember that no water should be used during this time. Measuring water loss and cost savings due to leaks may justify the importance of prioritizing repairs. Measurements may track the amount of water lost over time by using a bucket and a stopwatch. A good way to normalize small leaks is to calculate the water loss per day by tracking a leak through number of drips per second.

Water Use Intensity

Water consumption of industrial activities is a significant contributor to the depletion of surface waters and groundwater tables when it isn't returned to the same water body in its original quantity and quality. [13] Most water is eventually returned to the environment either directly or indirectly to surface waters at a lower quality or through evaporation. A handful of industrial applications for water use include cooling, heating, cleaning, steam, and separation. An organization should improve its water intensity, especially in regions that are prone to water shortages, that have frequent water quality issues, or that experience increasing water scarcity. The OECD provides Indicator O1 to measure and monitor an organization's water intensity.

$$water\ intensity = \frac{total\ water\ intake}{normalization\ factor}$$

Unit of the indicator: m^3/normalization factor

An organization's total water intake should account for production processes as well as overhead activities. It can improve its water intensity by recycling it for use in the same or other processes and water conservation practices. It should monitor the quantity and quality of water being recycled to identify improvement opportunities and anticipate problems before they occur.

Water Releases Intensity

A facility's wastewater discharge to surface water may be one of the organization's most significant environmental impacts, especially if the wastewater contains water pollutants of concern or the biotic elements of surface water are sensitive to the discharge. Releases of residuals in water can affect the economy, human health, and the environment. [14] Aquatic species affected by these residuals are part of the food chain, which in turn affects an environment's biodiversity. OECD recommends their Indicator O7 to measure a facility's intensity of pollutant releases to surface water.

$$intensity\ of\ pollutant\ releases\ to\ surface\ water = \frac{weight\ of\ releases\ to\ surface\ water}{normalization\ factor}$$

Unit of the indicator: tons/normalization factor

Preventing residuals from entering a facility's wastewater is the most effective means of improving this environmental performance. The numerator in the formula should include releases from both production processes and overhead.

Water Audits & Assessments

To start effectively managing an organization's wastewater, it is necessary to find out where wastewater is being generated. The activities and processes that generate wastewater need to be determined, as well as the volume of wastewater, the content of the wastewater including solid material, chemicals, etc. Then the potential areas in the wastewater stream for treatment as well as reusing treated or un-treated water need to be identified.

Water Auditing

Water audits provide an assessment of current water usage and costs while identifying issues and improvement opportunities. They characterize all water uses of a facility by factors such as flow rate, flow direction, contaminant content, temperature, and quality. The process of a water audit is elaborated on in the following general steps.

1. **Develop a water balance** – Water balances identify all water uses from their sources, through all onsite operational activities, to wastewater discharges. They are traditionally displayed as a diagram or summary chart. The total water inflow must equal the sum of the total outflow and all areas of water loss in order to account for all water uses.

2. **Selecting a water auditing team** – A well-rounded water auditing team includes representatives from maintenance, facility management, the organization's designated water-efficiency person, and personnel familiar with the facility's operations at the plant level. It may also include outside auditors that possess valuable input and experience.

3. **Gathering information** – Collect abundant background information that is relevant to the facility or area being audited in order to develop an idea of the current status, past initiatives, and areas of concern. Documents of consideration may include water bills, water meter records, process submetering data, wastewater treatment, sewer bills, production rates, pipeline layouts, employee procedures, maintenance schedules, and information from previous water audits.

4. **Walk-through survey** – With adequate preparation, the auditing team should conduct a walkthrough survey. Using direct observations, taking measurements, and conducting interviews with equipment operators and other significant personnel, the auditors should follow a written auditing procedure. Steps in a typical water auditing procedure may include identifying all equipment that uses water, confirming pipeline layouts, quantifying flow rates, measuring water quality, observing employee behaviors, identifying water losses, and calculating water-use efficiencies in contrast to efficiency potentials.

5. **Calculate the cost of water** – The true cost of water usage includes a number of variables beyond what is put on a water bill. Such variables may include water heating, chemical agents, water treatment, equipment wear, pumping energy, related labor, fugitive evaporations, and discharge fees. To calculate the dollar savings from a reduction in water usage, you must first derive a value for each unit of water used. One way is to divide the total costs of water used per year by the total amount of water used. Using the production rates, one could calculate the cost-per-unit output, then prioritize reduction of the most expensive factors of water usage. The total water cost may include several tangible variables such as the ones below.
   - expenditures from water utility bills
   - wastewater sewer rate and surcharges
   - cost of onsite water treatment processes, including labor, chemicals, and energy
   - cost of energy for heating water
   - cost of maintenance personnel working on equipment that uses water
   - cost of energy needed for pumping water in, out, and within the facility

There are a few other things to keep in mind when water-auditing. If touring a facility with site personnel to get familiar with the area, a team should record where to take measurements but wait on taking them until after the initial walk through to minimize any obstruction of normal operational activities. Better accuracy can be attained by speaking directly with the operators of processes that use water to confirm information. Especially at larger facilities, it's hard to equate the sum of all water losses and the facility's total discharge with the facility's total water usage. An acceptable range for unaccounted for water is 6–12 percent. [15] The water audit report presents the team's findings and recommendations to a facility managers. It should be concise but comprehensive, while being direct but well-justified. A typical report encompasses an executive summary, introduction, facility description, water usage history, current water balance, efficiency calculations, and recommended follow-up actions within a specified time frame.

Identifying Wastewater Streams

Both the quantity and quality of wastewater will vary between organizations of the same sector, between facilities of the same organizations, and between operations of the same facility. This variability depends on many influential factors, and understanding how they coincide to produce a certain wastewater stream is crucial to determining the best treatment and disposal options. The constituents that govern the treatment and disposal options include the following:

- cost
- volume of wastewater produced
- composition of the wastewater produced
- location of the facility producing the wastewater
- potential for onsite and off-site reuse of treated wastewater
- characteristics of the wastewater produced, including the following:
    - the volume and flow at which the wastewater stream in produced
    - amount of suspended solids
    - biological oxygen demand (BOD)
    - chemical oxygen demand (COD)
    - toxicity
    - amount of heavy metals
    - acidity and alkalinity
    - color
    - temperature
    - foam
    - content of nitrogen, phosphorous, grease, oil, etc.

After the sources, contaminants, flow direction, and discharge points of an organization's wastewater streams have been identified, they should be made known to everyone. They should be categorized according to the types of contaminants (solvents, oils/greases, solids, etc.) they contain rather than attempting to identify all individual contaminants separately. One way to do this is to use color-coding on pipes, drain covers, and other equipment used to divert wastewater streams (i.e., red for sewage effluents, green for process effluents, and blue for surface water effluents).

Water Improvements and Implementation

Water Reuse and Reclamation

A facility may have the potential to divert its wastewater to be reused by another industry or organization. Or perhaps an organization could use reclaimed municipal water or water from another organization, facility, or process for certain uses. The concept is that the reduction of water consumption will provide enough cost savings to justify the capital expenditures of reusing a particular water source. For a water discharge to be reused, it must meet the water quality standards of the process it is to be used in. For each area of water use, whether it's initial use or reuse, there needs to be related water quality standards in order to satisfy the required quality control and assurance. Water that doesn't meet the standards of a water-using process should not be used in that process. Every water-using process or operation has its own water quality standards that determine whether a water source is acceptable for use or reuse. There are many treatment technologies that can be employed to improve the quality of a water source to meet a process's standards. In some instances, only minimal treatment might be necessary, making it cost effective. Or perhaps complex treatment is necessary for one water-using process, but no treatment is necessary for a different process. Strategically aligning in-process water discharges with or without cost-effective treatment for reuse in the same process or a different process will significantly increase an organization's water efficiency by reducing total withdrawal of source water and total discharge of wastewater.

Set-up Support and Resources

Not even the best water efficiency plans can be put into action without the appropriate resources and supporting factors. Organizations need to designate management responsibilities, achieve employee involvement, and communicate the importance of water efficiency.

- **Designate water efficiency personnel** – Whether it be a water conservation manager, an environmental staff member, or a team leader, the organization should appoint responsibilities for water efficiency. That person should assess current water efficiency measures to identify improvements, understand regulatory compliance in regard to wastewater and water usage, and be able to manage some sort of water efficiency system. They should establish implementation criteria for designing water efficiency measures, conduct regular water efficiency audits, manage implementation initiatives, and regularly review progress and modify aspects towards continuous improvement. It's important that they are able to manage others since employee participation is crucial.

- **Obtain employee involvement** – A manager or an environmental personnel member may be in charge of improving an organization's water efficiency, but they can't achieve this goal without employee participation. Employee training, awareness, and involvement are crucial for water efficiency initiatives since they typically account for a large portion of the water usage. Employees should be responsible for adhering to the requirements of a water efficiency system that provides education, training, awareness, incentives, and opportunities. The crucial role that employees play should be emphasized as a team effort for achieving water efficiency and environmental goals. Employees should be given a means of communicating their observations and suggestions concerning water losses, usage, and improvement areas. Employees respond to incentives, so the power of recognition, peer pressure, and competition shouldn't be underestimated. Employee participation can be supported through rewards, like winning a percentage of the quarter's direct cost savings. Rewards are most effective when they are immediate, certain, and positive.

- **Communicate water efficiency awareness** – The importance of conserving water and water efficiency should be communicated throughout the entire organization, but especially at the facility level. A few means of communication include announcements, bulletins, e-mail, newsletters, training, paycheck stuffers, and signs. Some things that should be communicated include policies, initiatives, progress reports, and incentives. Staff meetings are opportune areas for communicating plans, getting feedback on ideas, and recruiting resources. Appointing responsibilities from top management in a policy, letter, or other governance element establishes greater awareness. Thinking outside the box, organizations can communicate the importance of water efficiency by providing water-conserving devices for the home, informational materials, and demonstrations that will educate employees how to recognize improvements.

Water Conservation Strategies

There are simple and quick ways to reduce water usage as well as options that require greater implementation effort and cost. Water conservation strategies include both behavior changes and technological changes. Technological changes provide a more stable manner of improving water efficiency. Behavioral changes on the other hand are less stable, but they may be made quickly and they provide similar water savings without the up-front cost of equipment. Both methods should be implemented for an organization to reach its potential in water efficiency. Regular training along with the use of appropriate tools and equipment will achieve more stable water efficiency.

Improvements for water efficiency should be considered in the context of other process improvements in order to attain the best results. Process changes that may affect wastewater volume or quality have a related influence on the facility's wastewater treatment process and environmental impacts. Therefore, the operations and processes of each facility determine the best water management practices and technologies that apply. Changes in processes should include testing for potential solutions, implementing a change, evaluating the actual process performance after the change, and developing or updating an associated standard of procedure. Common ways to change processes for water savings are listed below.

- Adjust water flow.
- Modify existing equipment or install water-conservative devices.
- Replace existing equipment with more water-efficient versions.
- Recycle water for reuse, treat if needed.
- Replace an existing process with a water-conservative or waterless process.

Behavioral Water Efficiently

An often wasteful and large source of a manufacturing facility's wastewater is their cleaning and rinsing practices. At many organizations, workers use more water than necessary to rinse machinery, parts, and manufacturing lines, and to clean equipment, floors, and other areas of facilities. This wasteful use can be a big opportunity for water savings by changing employees' behavioral procedures.

Initial Dry Clean-up – Cleaning up equipment and areas before using water for the job reduces water usage and wastewater. Instead of mopping entire floors each day, sweep intermittently and spot-mop where necessary as an alternative to cut down mopping frequency. Use brooms, brushes, dusters, towels, squeegees, and other cleaning instruments to remove debris in dry form, then use water for secondary cleaning if needed.

Wash and Rinse Efficiently – Employees should be shown how to use water wisely. For example, they can be educated to

- turn off water when not in use;
- understand that using a hose instead of a broom to clean debris from floors wastes water, energy, and time; and
- use optimized rinsing techniques by using high-pressure, low-volume spray nozzles along with a standard procedure for each rinsing and washing process.

Water-efficient Cooling Towers

Cooling towers remove heat from air conditioning systems and a range of other processes that generate excess heat. Although all of them use a closed loop system to constantly cycle water, they typically represent the largest use of water in manufacturing applications, which can be up to 30 percent or more of a facility's total water usage. Cooling towers continuously pump warm water from heat sources to their top where it is sprayed or dripped through internal fill. The adhesive property of water molecules makes them adhere to the abundant surface area of the fill in a film-like fashion. As the water is pushed or pulled down the tower by fans, the heat energy is lost to evaporation, along with water.

- **Evaporation and drift** – The best evaporation rate is achieved by mixing the air and water as thoroughly as possible to maximize surface space, allowing for the most water vapor pressure. Evaporative cooling releases just about 1,000 British thermal units (BTUs) for each pound of water, or about 8.34 gallons depending on temperature, atmospheric pressure, and dew point. The evaporation rate is approximately one percent of the circulating water's flow rate for every 10-degree reduction (Fahrenheit) in water temperature. Water in the form of mist that is carried away from the cooling tower is known as drift losses. This water loss is near negligible since drift rates are generally 0.05–0.2% of the system's circulation rate. However, an organization that employs a lot of cooling towers can justify the initiative to improve their water efficiency through *drift eliminators*. These devices improve operating efficiency by preventing drift losses, which retains water as well as water-treatment chemicals.

- **Blowdown and make-up** – As evaporation occurs, the dissolved contaminants in the water build up since they don't evaporate with the water vapor. If not addressed, it affects the thermal efficiency of the process and the life of the cooling tower. So, to reduce contaminant build up, the water is flushed and replaced with fresh water. The flushed water is known as "blowdown" and the fresh water that replaces it is known as "make-up water." A blowdown may be controlled by valves triggered by timers of hydro-conductivity meters. The water quality in the cooling tower may be determined by the water composition, water treatment, and blowdown rate. In addition to the blowdown rate, the amount of make-up water a system needs, is dependent on the system's evaporation and drift rates. To minimize the cooling tower's blowdown rate, the system needs a suitable water treatment process to alleviate the blowdown frequency.

To optimize a cooling tower's water efficiency, you need to pursue the highest concentration ratio possible, which is expressed below.

$$concentration\ ratio = \frac{blowdown(gallons) + drift(gallons)}{make\text{—}up(gallons)}$$

Minimizing the blowdown and drift rates will enable the system to make the most out of each make-up, which by relationship increases the system's concentration ratio.

Cooling-tower water balance – Apply the water balance method to a cooling tower system to gain an even better understanding. This technique includes the evaporation variable, which is dependent on water quality. An appropriate water balance is below.

$$make\text{—}up(gallons) = evaporation(gallons) + blowdown(gallons) + drift(gallons)$$

A good water treatment process is important because maximizing the evaporation rate through better water quality will minimize the amount the make-up required. The relationship between the concentration ratio and the water quality is expressed below.

$$concentration\ rate = \frac{water\ quality\ of\ make\text{—}up}{water\ quality\ of\ blowdown}$$

Cooling-tower water treatment – The objective of a water treatment process for a cooling tower is to provide an uncontaminated heat-transfer surface for evaporation. A perfected evaporation rate will decrease water consumption and wastewater discharge. The factors of water quality include pH, alkalinity, conductivity, and hardness, as well as microbial growth, biocide, scaling, and corrosion-inhibitor levels. Traditionally, automated feeders either on timed intervals or triggered by conductivity meters deposit treatment chemicals into the water-circulation system. Modern technology allows more controlled chemical treatment in relation to quality requirements that may be monitored via internet at any time and from anywhere.

- **Sulfuric acid treatment** – Sulfuric acid controls scale accumulation by lowering the water's pH to a level that will dissolve it. The harder and higher in alkalinity water is, the greater demand there is for this acid feed. This chemical needs to be administered with certain system precautions because its aggressive corrosion properties will wear away metal surfaces. Corrosion inhibitors alleviate this concern, but there is still concern for worker safety. Employees handling this chemical should be trained to do so and know how to response to possible accidents.
- **Side-stream filtration** – Side-stream filtration alleviates the accumulation of solids by diverting a portion of the circulating water flow through a filtering system, typically using either rapid sand or cartridge filters. Changing or cleaning filters can be worthwhile if using make-up water that has high levels of suspended solids or if airborne particulates can settle in a system's water. These filtration systems increase the system's overall efficiency by ensuring heat transfer and lowering blowdown rates since they reduce particle loading in the cooling tower.
- **Ozone treatment** – Ozone may be injected into the circulating water to prevent problematic organics and control scale buildup. It controls scale by creating mineral oxides that precipitate to the basin of the cooling tower, usually in a separation tank or low-flow circulation area. Ozone treatment requires an air compressor, an ozone generator, a control system, and a diffuser or contractor. The precipitated solids, or sludge, must be removed periodically and capital costs are significant, but it can be cost-effective if dealing with such contaminants because it will greatly increase the system's efficiency.
- **Magnetic treatment** – Unique magnetic particles produced for the purpose of water treatment have been reported to physically combat scale deposits on surfaces in the cooling tower system. Suppliers claim they do so by altering the surface charge of suspended particles in the water, which provides chemical-free treatment. The dislodged deposits settle in a low-flow circulation area and are removed from the system mechanically. A similar treatment technology is the electrostatic field generator.

Water Efficient Boilers

Boilers consume energy and water to create steam for a wide variety purposes, such as running production equipment, providing heat, and sterilizing materials. Simply put, all water processed through boilers contains impurities. Dissolved solids can accumulate in boilers to the extent that they're released with the steam and cause damage to piping, steam-control devices, and production equipment. Suspended solids accumulated as sludge within a boiler hinder its capacity to transfer heat as well as its water and energy efficiency.

Blowdown – Removing a portion of the water contained in a boiler is known as blowdown, and this procedure keeps impurities at a tolerable level. Blowdown may be released regularly from the boiler's steam drum, mud drum, bottom header, or its bottom. To reduce the level of dissolved solids, blowdown is done from the boiler's surface water. To reduce a boiler's sludge content, blowdown is performed from the bottom of it. It's imperative to have an appropriate amount of blowdown for reaching peak efficiency. Not enough blowdown will cause a boiler to be inefficient and damaging, but too much blowdown will cause a waste of treatment chemicals, energy, and water. The amount of blowdown required for optimal system efficiency depends on the type of boiler, steam pressure, treatment chemicals used, and the quality of the feed water. Blowdown for boilers is typically expressed as a percentage of the boiler's feed-water current. The wide variation of water quality makes it hard to generalize a blowdown rate that will work best for each boiler system, but typical percent blowdowns range from four to eight percent. The conductivity of the boiler's water feed and blowdown water are sensible factors for calculating the blowdown amount and frequency because the water's conductivity determines its concentration of dissolved solids. A formula for calculating the optimal percent blowdown is below.

$$percent\ blowdown = \frac{water\ quality\ of feed\ water}{water\ quality\ of\ blowdown\ water} \times 100\%$$

$$percent\ blowdown = \frac{total\ disolved\ solids\ of\ feed\ water(\mu mhos)}{total\ disolved\ solids\ of\ blowdown(\mu mhos)} \times 100\%$$

Water treatment – Treating feed water before it enters the boiler, externally, will reduce blowdown frequencies and make your boiler system's efficiency more manageable. Treatment systems can remove suspended solids, dissolved solids, and oxygen content. A few treatment technologies for a boiler's feed water include, but are not limited to, softeners, reverse osmosis, and demineralization.

Treating water that is inside the boiler, internally, seeks to control corrosion and deposits.

Steps to Optimizing Boiler Blowdown

1. Monitor a boiler's feed-water quality, blowdown-water quality, and blowdown rates.
2. Determine and implement the best water treatment methods to achieve water efficiency goals by
    A. building an understanding of the pros and cons of water treatment options, and
    B. by seeking expert advice.
3. Set maximum acceptable levels of water impurities.
4. Estimate possible cost, water, energy and chemical savings.
    A. Institute a management system to continuously monitor boiler efficiencies and make needed modifications.

Monitoring and Controlling Water Use

Water-monitoring practices at the facility level should be from the perspective of overall consumption processes. This includes the facility's manufacturing processes, their supporting operations, and the environmental impacts related to those activities. Comprehensive monitoring includes periodically measuring, documenting, and reporting key water uses and discharges as well as identifying water savings. A water balance should be continually updated if a facility is not using real-time data already. Progress towards attaining water-use targets should be designed through action plans and measured against them. However, these targets should be updated if your facility's water consumption and use patterns change significantly. Identify water-use improvement opportunities by comparing monitoring data against different operational factors, such as shifts, maintenance practices, operators, and procedures. Targets can be assessed as appropriate by comparing monitoring data with benchmark data.

[1] https://globalcompactselfassessment.org/management/implement

[2] https://www.globalreporting.org/standards/media/1909/gri-303-water-and-effluents-2018.pdf#:~:text=GRI%20303%20addresses%20the%20topic%20of%20water%20and%20effluents.&text=The%20Sustainable%20Development%20Goals%2C%20adopted,water%20and%20sanitation%20for%20all'

[3] https://www.globalreporting.org/standards/media/1909/gri-303-water-and-effluents-2018.pdf#:~:text=GRI%20303%20addresses%20the%20topic%20of%20water%20and%20effluents.&text=The%20Sustainable%20Development%20Goals%2C%20adopted,water%20and%20sanitation%20for%20all'

[4] http://sustainabilityadvantage.com/documents/BCorpImpactAssessment.pdf

[5] https://www.globalreporting.org/standards/media/1909/gri-303-water-and-effluents-2018.pdf#:~:text=GRI%20303%20addresses%20the%20topic%20of%20water%20and%20effluents.&text=The%20Sustainable%20Development%20Goals%2C%20adopted,water%20and%20sanitation%20for%20all'

[6] http://www.oecd.org/innovation/green/toolkit/oecdsustainablemanufacturingindicators.htm

[7] https://www.govinfo.gov/content/pkg/CFR-2011-title40-vol22/pdf/CFR-2011-title40-vol22-sec122-26.pdf

[8] https://www.govinfo.gov/content/pkg/CFR-2011-title40-vol22/pdf/CFR-2011-title40-vol22-sec122-26.pdf

[9] https://www.govinfo.gov/content/pkg/CFR-2011-title40-vol22/pdf/CFR-2011-title40-vol22-sec122-26.pdf

[10] https://www.globalreporting.org/standards/media/1012/gri-305-emissions-2016.pdf

[11] http://www.oecd.org/innovation/green/toolkit/oecdsustainablemanufacturingindicators.htm

[12] *Environmental management – Environmental performance evaluation – Guidelines.* ISO 14031:1999. Geneva, Switzerland : ISO.

[13] Organization for Economic Co-operation and Development, "OECD Sustainable Manufacturing Indicators." *O1. Water intensity*. *OECD Sustainable Manufacturing Toolkit*. http://www.oecd.org/innovation/green/toolkit/o1waterintensity.htm

[14] Organization for Economic Co-operation and Development, "OECD Sustainable Manufacturing Indicators." *O7. Intensity of residual releases to surface water*. *OECD Sustainable Manufacturing Toolkit*. http://www.oecd.org/innovation/green/toolkit/o7intensityofresidualreleasestosurfacewater.htm

[15] North Carolina Department of Environment and Natural Resources, "Water Efficiency. Manual for Commercial, Industrial and Institutional Facilities," May 2009 https://p2infohouse.org/ref///04/03097.pdf

Waste Management

Introduction

The management of waste in general should involve some sort of system or process that comprehensively accounts for all wastes generated by an organization. Manufacturing operations typically produce different types of waste, in different proportions. Fundamental management should address waste minimization, generation, storage, handling, transport, and disposal. However, good waste management goes beyond fundamentals with initiatives like waste prevention, recycling, reuse, treatment, and composting. Environmental staff should have an input on the operational changes of the facility to minimize wastes generated and to factor environmental concerns into management decisions. Environmental staff should have an input on the operational changes of the facility to minimize waste generated and to factor environmental concerns into management decisions.

Waste Generation from Manufacturing

Waste Management

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Waste Classification

- **Solid waste** – Solid waste is what commonly comes to mind when discussing waste management. Solid waste includes any non-hazardous garbage, refuse, and debris generated from operational activities.

- **Hazardous waste** – Hazardous waste is broadly referred to in industry as any substance containing chemicals that requires safe disposal. They are the types of chemical waste that can cause severe harm to human health and the environment, which may be in the form of liquids, solids, gases, or sludge. This inclusive meaning accounts for a wide range of waste streams that may or may not be classified as “hazardous waste” as defined by regulatory bodies. A narrower definition is used by the Resource Conservation and Recovery Act, which contains the federal laws and regulations that preside over the management and

disposal of wastes in the United States. For clarity, this document refers to hazardous waste in the broad sense of wastes that may pose a hazard.

- **Chemical waste** – Chemical wastes are similar to hazardous waste in that they pose the same concerns to human health and the environment, but with less severity. These wastes are typically generated from any unnecessary or excess use of a chemical, excess mixed or unmixed chemicals, and substances or materials contaminated with chemicals. They are commonly found in the form of mislabeled, unlabeled, or abandoned substances, as well as contaminated debris such as rags, gloves, containers, disposable utensils, etc. A precautionary management strategy handles and stores each of their chemicals with an understanding of the associated dangers for safety reasons.

- **Sludge** – Sludge may be another waste classification suitable for an organization. It is a byproduct produced from processes such as waste treatment and emissions control, but is typically associated with wastewater treatment. Wastewater treatment seeks to remove suspended and dissolved solids while converting soluble organic material to bacterial cells. Sludge management may incorporate a variety of methods, but organizations seeking to integrate it into other waste streams need to determine whether or not it is hazardous.

Typical Sustainable Supply Chain Scorecard Waste Questions [1]

Scorecard Questions

1. Does your organization have a program and/or procedures for the management of types and quantities of wastes produced, including monitoring, collection, separation, disposal, and/or recycling?
2. Does your organization have a strategy to manage waste responsibly? Does it continuously attempt to prevent and reduce the production of waste (i.e. resource reduction methods)?
3. Does your organization have targets for reducing waste production and/or increasing waste reused/recycled? Does it measure its progress against these targets?
4. Does your organization ensure that waste relevant for recycling is sorted and handed over to a recycling organization?
5. Does your organization mark areas used for storage of waste?
6. Does your organization properly label all containers for storing waste, including a relevant symbol of danger for hazardous waste?
7. Does the organization take measures to reduce the production of waste and ensure responsible waste management?

8. Which of the following methods does your organization use to dispose of solid waste?
    A. onsite disposal or incineration
    B. disposal at a public solid waste facility
    C. collection and transfer to a waste management entity
    D. other (Please specify.)
9. Does your organization use licensed contractors for the transport, storage, transport, recycling, and disposal of hazardous waste?
10. Does your organization request recycling and disposal receipts from transport contractors?
11. Does your organization comply with legal requirements for the handling, storage, transport, recycling, and disposal of waste, including, if relevant, the requirements for transporting hazardous waste across borders?
12. Does your organization have the necessary permits for the handling, storage, recycling, and disposal of waste?
13. Does your organization provide information and train employees on the safe handling, storage, transport, and disposal of hazardous and special waste types?
14. What is your organization's total weight of waste by type and disposal method? [2]
15. What is your organization's residuals intensity (waste output)? [3]
    A. (weight or releases (from production processes and, if available, overhead) to air + weight of releases to surface water + weight of releases to land + weight of releases from landfills + weight of transfers to disposal + weight of transfers for treatment + weight of transfers to recycling + weight of transfers for energy recovery + weight of transfers to sewage + weight of additional GHGs produced + carbon content of direct energy use) / normalization factor = tons/normalization factor
16. What is the total weight of transported, imported, exported, or treated waste your organization handles that is deemed hazardous under the terms of the Basel Convention Annex I, II, III, and VIII [4]? What percentage of it is shipped internationally? [5]
17. Does your organization generate types of waste that are classified as hazardous?
18. Does your organization have a program and/or procedures for the management of hazardous wastes, including monitoring, characterization, treatment or conversion, reduction, and disposal?
19. Which of the following methods are used to dispose of your hazardous waste?
    A. onsite waste treatment
    B. onsite temporary storage
    C. collection and transfer to a waste management entity
    D. discharge to ground or water
20. Is hazardous waste (batteries, paint, electronic equipment, etc.) always disposed of responsibly?

21. Has your organization set up a waste management program for universal wastes such as batteries, mercury-containing equipment, pesticides, and lamps? [6]

Waste Indicators and Measurement

To answer these scorecard questions, a company needs to identify which indicators will best provide useful answers and then find a management strategy with established goals and targets for reduction. Below are typical operational performance indicators and methods for measuring waste generation.

Typical Waste Operational Performance Indicators [7]

- amount of waste generated per year or per unit of production
- quantity of hazardous, recyclable, or reusable waste produced per year
- total waste for disposal per month, six months, or year
- quantity of waste stored onsite
- quantity of waste converted to reusable material per year
- quantity or percentage of hazardous waste eliminated by material substitution

Measuring Residuals Intensity

In a flawless manufacturing facility, all outputs of one process are inputs for another, in which residuals (wastes) do not exist. Unfortunately, no manufacturing operation is without residuals, and no organization can afford to ignore their costs and environmental impacts. An organization may help optimize their profitability by minimizing residuals because this action ensures a greater relative amount of their purchased materials are used, as opposed to being wasted. [8] OECD recommends their Indicator O5 to measure the residuals intensity of an organization, which uses both of the formulas below.

Mass balance approach:

$$residuals\ intensiy = \frac{(weight\ of\ all\ inputs + weight\ of\ fuel\ consumed - weight\ of\ all\ products)}{normalization\ factor}$$

Waste output approach:

$$residuals\ intensiy = \frac{\begin{array}{c}(weight\ of\ releases\ to\ air, surface\ water\ and\ land \\ +weight\ of\ releases\ from\ landfills \\ +weight\ of transfers\ to\ disposal, recycling,\ and\ sewage \\ +weight\ of\ transfers\ for\ treatmnet\ and\ energy\ recovery \\ +\ weight\ of\ additional\ GHGs\ produced \\ +carbon\ content\ of\ direct\ energy\ use\ )\end{array}}{normalization\ factor}$$

**Unit of the indicator: tons/normalization factor*

The mass-balance approach subtracts the weight of all products from the weight of all materials consumed in the overhead and production to calculate an organization's residuals intensity. The waste output approach calculated an organization's residuals intensity looking at the other side of residuals by totaling the quantities of residuals generated. The residuals' calculated intensity can be verified by using both approaches, for which relatively equivalent answers should result. If there is a difference, then an important residual may likely have been left out.

An organization's residuals may be broken up into categories of waste-output approach, which are the same ones used for many countries' governing Pollutant Release and Transfer Registries (PRTRs). The comprehensiveness of PRTRs varies between different countries. The U.S. PRTR is the Toxics Release Inventory (TRI), which contains data on discharges, transfers, emissions, and other releases of over 650 toxic chemicals from thousands of facilities nationwide. TRI also contains information on facilities' management practices related to toxic chemicals such as handling, recycling, energy recovery, substitution, and treatment.

Waste Generation Improvements and Implementation

Waste Minimization & Prevention

The production activities of an organization should be designed and operated in a way that minimizes or prevents wastes from being generated as well as any environmental health and safety (EHS) risks. Some waste prevention actions include the following:

- substitution of input materials and substances with less or non-hazardous alternatives
- substitution of input materials and substances with more efficient alternatives to reduce wastes generated.
- modification of production processes (e.g., design, operating conditions, operator procedures, and engineering controls of processes) to fabricate products more efficiently with higher output yields and with less EHS risks.
- establishment of good housekeeping, operating, and maintenance routines to maintain optimal process conditions and material quality (e.g., operation controls, inventory controls, material conservation, efficiency monitoring, and quality inspection).
- enabling of managers and operators to recognize and report improvement opportunities through training, awareness, and reporting/suggestion mechanisms
- implementation of waste segregation and contamination controls to prevent commingling of hazardous and nonhazardous waste

Recycling and Reuse

An organization's total quantity of waste generated may be reduced significantly through recycling and reuse practices. In evaluating an organization's waste sources, identify potentially recyclable and reusable materials that can be brought back into the generating process or used in another process. In order to reuse or recycle materials, they need to put through a treatment process to meet the input requirements of a process. An organization should consider external sources of recycled material from other manufacturing organizations to reduce costs of inputs and increase its environmental performance. Likewise, it should determine if components of its waste may be suitable for reuse in other manufacturing operations. Also helpful are employee training and incentive programs to support them in meeting recycling objectives like waste reduction and recycling quotas.

Hazardous Waste Handling, Storage, and Transport

It's always best to prevent or minimize the handling of hazardous waste. But when handling, storing, and transporting is necessary, an organization should focus on mitigating health, safety, and environmental concerns. In order to do so, environmental staff, employees, and contractors need to understand the possible risks and impacts related to the hazardous wastes they are dealing with. When hazardous waste is being handled and transported by contractors, an organization needs to ensure that they are credible and licensed properly with the applicable agencies. There are many regulations controlling the use and handling of hazardous waste, so it must be sure that its activities comply with the applicable laws. Even seemingly negligible hazardous waste such as oily rags or empty containers can be cited as violations.

The majority of concerns with waste storage are related to hazardous waste. Hazardous waste needs to be stored in a way that prevents contamination of soil, water and air. Avoid intermixing stored hazardous waste through use of physical barriers and ensure that storage areas may be comprehensively inspected for leaks or spillage. Storage areas should be maintained within environmental conditions acceptable for the materials and substances being stored, which may include weathering factors like sunlight, rain, frost and wind. Underground storage tanks and piping of hazardous waste and substances should be avoided since there is no easy way to inspect or maintain such apparatuses.

Transporting waste increases the risks of spills, accidental releases, and exposures to employees, the public and the environment. Every waste container for hazardous and non-hazardous wastes needs to be labeled, secured, and designed appropriately for offsite transportation. All offsite transport needs to be accompanied by some sort of chain of

custody or manifest that describes the load and its related concerns. Employees should be aware of the importance of related health, safety, and environmental concerns. If appropriate, they should also be trained for properly handling, storing, and transporting hazardous waste. Adequate training curriculums include inspection, spills response, and emergency procedures.

Waste Treatment and Disposal

Implementing waste prevention, minimization, reuse, and recycling activities can reduce a lot of waste from being generated, but the waste that is generated should be treated and disposed of properly. Treatment measures enable proper disposal and prevent potential environmental and public health effects. Treatments may be on- or offsite, and involve biological, chemical, or physical processes. Waste with hazardous characteristics is typically treated to make it non-hazardous before disposal. Some waste may need to be received by a specially permitted facility that is designed to dispose of it properly. An organization should establish acquisition agreements with qualified waste vendors that have obtained the necessary permits, certifications, and permissions from governing entities.

Monitoring and Controlling Waste Generation

All procedures related to hazardous and non-hazardous waste should have controls established and should be monitored. The goal of controls and monitoring is to anticipate, prevent, identify, and verify unintentional releases. Minimal monitoring should include periodic physical inspections of waste generation sources, storage areas, transport apparatuses, waste-related documentation, and proper labeling. When dealing with significant quantities of hazardous wastes, organizations should have comprehensive monitoring and control activities established. Some example activities are below.

- inspection of containment apparatuses and barriers for losses such as leaks and spillage; quality factors such as corrosion, cracks, and damage; and engineering controls such as locks, emergency valves, and safety devices
- verification of functionality of emergency, spill prevention, and safety devices
- set up of documentation controls for testing reliability and monitoring data collection, as well as management of change documentation
- creation of monitoring documentation of hazardous waste that includes
  - name and identification number
  - physical state (solid, liquid, or gas)
  - number, capacity, location, and amount of contents of all storage containers
  - manifest for transportation, storage, and disposal

[1] https://globalcompactselfassessment.org/management/implement

[2] https://www.globalreporting.org/standards/media/2573/gri-306-waste-2020.pdf

[3] http://www.oecd.org/innovation/green/toolkit/o5residualsintensity.htm

[4] http://www.basel.int/Portals/4/Basel%20Convention/docs/text/BaselConventionText-e.pdf

[5] https://www.globalreporting.org/standards/media/2573/gri-306-waste-2020.pdf

[6] https://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr273_main_02.tpl

[7] *Environmental management – Environmental performance evaluation – Guidelines.* ISO 14031:1999. Geneva, Switzerland : ISO.

[8] Organization for Economic Co-operation and Development, "OECD Sustainable Manufacturing Indicators." *O5. Residuals Intensity*. *OECD Sustainable Manufacturing Toolkit*. http://www.oecd.org/innovation/green/toolkit/o5residualsintensity.htm

Air Management

Introduction

Management of air emissions started with pollution control techniques in the 1950s and 1960s in response to potential health effects, impacts on buildings, and obvious agricultural and environmental damage. Air pollutants are compounds that are emitted to the environment either directly from point sources or indirectly from reactions between air pollutants and naturally occurring atmospheric compounds. Pollutants emitted directly from point sources, like smoke stacks and industrial processes, are primary air pollutants, whereas the pollutants emitted indirectly are secondary air pollutants.

Air Emissions from Manufacturing

Primary air pollutants include the following:

- sulfur oxides (SO_x)
- nitrogen oxides (NO_x)
- carbon monoxide (CO)
- volatile organic compounds (VOCs)
- hydrogen chloride (HCl)
- hydrogen fluoride (HF)
- hydrogen sulfide (H_2S)

Secondary air pollutants include the following:

- nitrogen dioxide
- sulfuric acid
- ozone (O_3)
- other photochemical oxidants

SO_x – Sulfur dioxide (SO_2) and sulfuric acid vapors are corrosive, colorless air pollutants emitted mainly from the combustion of fuels containing sulfur and industrial wastes containing sulfur. [1] When emitted into the atmosphere, these contaminants react to photochemical forces and produce sulfuric acid as well as inorganic and organic sulfate compounds. A large proportion of sulfur dioxide eventually falls to the ground as acid rain or is seized by flora and fauna in the process known as disposition.

NO_x – Nitric oxides (NO) and nitrogen dioxides (NO_2) account for NO_x, which are created from the combustion of fuels. NO is an odorless air pollutant, and NO_2 is an air pollutant with a reddish-brown color that is associated to the brown haze of photochemical smog, common to many urban areas. NO_2 contributes to the formation of ground-level ozone, fine-particle pollution, and is linked with a number of adverse effects on the respiratory system. [2]

CO – Carbon monoxide (CO) is a colorless, odorless, and partially oxidized compound that contributes to smog formation. It's formed from the incomplete combustion of fuel and other organic compounds due to insufficient oxygen concentration or low temperature, which may occur in automobiles, boilers, and industrial furnaces. Other partially oxidized compounds may adhere to particulate matter or remain gaseous.

VOCs – Volatile organic compounds (VOCs) are organic compounds that easily volatilize and, when released to ambient air, they contribute to photochemical reactions. Organic compounds with a lack of photochemical reactivity are not considered VOCs. They are primarily emitted from the vaporization of organic compounds used as solvents in industrial operation. Such contained and fugitive emissions consist of numerous VOCs with a range of known health effects.

HCl, HF & H_2S – Hydrogen chloride (HCl) and hydrogen fluoride (HF) are inorganic acidic gaseous compounds released from combustion industrial processes as well as pollution control devices. Their emitted concentrations are related to the concentrations of chloride and fluoride in the substance being combusted. Hydrogen sulfide (H_2S) is a highly toxic chemical that smells like rotten eggs in gaseous form, however the human olfactory bulb quickly acclimates to this odor making it hard to detect even at high concentrations. H_2S and other sulfur compounds contribute to the formation of sulfur dioxide (SO_2).

O_3 – The oxidant O_3 forms in the troposphere due to atmospheric reactions of NO_x, VOCs, and CO, known as "ground-level ozone." As levels of O_3 increase, so do various partially oxidized photochemical oxidants, which are promoted by high temperatures and sunlight intensity. Ozone contributes to what we typically experience as "smog" or haze, which still occurs most frequently in the summertime, but can occur throughout the year in some southern and mountain regions. [3] Ozone is likely to reach unhealthy levels on hot sunny days in urban environments. Ozone can also be transported long distances by wind. For this reason, even rural areas can experience high ozone levels. Ground-level ozone is associated with respiratory difficulties and disease.

GHGs – Greenhouse gases (GHGs) are a group of air contaminants that trap heat in our atmosphere. The most important GHGs released from human activity are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases, such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluorides. Different GHGs vary widely in impacts, but may be measured according to their Global Warming Potentials (GWPs).

HAPs – Hazardous air pollutants (HAPs) are defined in section 112 of the Clean Air Act (CAA) as any air pollutant listed in section (b), which has been amended over time but currently includes 187 pollutants and chemical groups. These chemicals are listed as HAPs due to evidence that they cause or may cause cancer or other serious health effects, or adverse environmental effects. [4] Although ambient air quality standards are not established for HAPs under the CAA to describe their legally acceptable concentrations in ambient air, they are governed by the EPA through the National Emission Standards for Hazardous Air Pollutant (NESHAP) regulations.

Typical Sustainable Supply Chain Scorecard Air Emissions Questions [5]

Scorecard Questions

1. Does your organization employ initiatives and practical activities to reduce greenhouse gas emissions? [6]
2. Does your organization have a program aimed at inventorying, reducing, and reporting the emissions of GHGs from your operations?
3. Does your organization have a climate strategy that identifies opportunities to reduce the organization's emissions of GHGs?
4. Does your organization monitor and record its GHGs?
5. Are reduction targets developed for GHGs and are they met?
6. What aspects of your organization's operations are included in the GHG emission calculation?
7. Does your organization comply with regulations regarding emissions of GHGs?
8. Has your organization defined a baseline for its GHG emissions, which includes a definition of the business operations and activities, and the GHGs that are accounted for (e.g., as described in the Greenhouse Gas Protocol)?
9. What are your organization's total direct and indirect GHG emissions by weight? [7]
10. What are your organization's other relevant indirect GHG emissions by weight? [8]
11. What is your organization's GHG intensity? [9]
    A. Use this formula to calculate the amount: (GHGs released in energy consumption for production + GHGs released in energy consumption for overhead + GHGs released by transport used for business travel + additional GHGs released from production process) / normalization factor

       = Tons CO2e/normalization factor

12. By what percentage have your GHG emissions been reduced on a per capita basis over the last fiscal year? [10]
13. If your organization purchased certified carbon credits in the reporting period, what percentage of GHG emissions were offset? [11]
14. Which of the following types of air emissions are generated by your organization?
    A. volatile organic chemicals
    B. aerosols or mists
    C. corrosive vapors
    D. particulate or dust
    E. ozone depleting substances
    F. combustion byproducts
    G. other emissions (Please specify and describe.)
15. Does your organization have a program and/or procedures for the management of airborne emissions, including monitoring, characterization, prevention, reduction, and treatment?
16. Does your organization generate regulated quantities of airborne emissions from its operations?
17. Does your organization comply with legal emissions-to-air requirements (e.g., air pollution standards and limit values)?
18. Does your organization have the necessary permits for emissions to air?
19. Does your organization provide information and train employees on how to manage air emissions?
20. Are incentives in place to encourage carpooling or the use of public transportation? [12]
21. Does your organization treat relevant pollutants before they are emitted to the atmosphere (e.g., by using filters)?
22. Which of the following methods are used to control airborne emissions at your facility or facilities?
    A. point of use exhaust ventilation
    B. oxidizer
    C. scrubber
    D. electrostatic precipitator
    E. carbon filtration
    F. other methods (Please describe.)
    G. none (Emission levels are below statutory and regulatory thresholds.)
23. Does your organization have a program comprised of resource-reduction methods to reduce the amount of airborne emissions generated?
24. What are your organization's emissions of ozone-depleting substances by weight? [13]

25. What are your organization's HAPs, VOCs, NOx, SOx, and other significant air emissions by type and weight? [14]
26. What is your organization's intensity of pollutant releases to air? [15]
    a. Use this formula to calculate the amount: weight of releases (from production processes and, if available, overhead) to air / normalization factor = tons/normalization factor

Air Emission Indicators & Measurement

To answer these scorecard questions, a company needs to identify which indicators will best provide useful answers and then find a management strategy with established goals and targets for reduction. Below are typical operational performance indicators and methods for measuring air emissions.

Air Emission Indicators [16]

- quantity of each type of air emissions per year or per unit of production
- quantity of GHGs released per month or year
- amount or percentage of air emissions reduced by reduction initiatives
- concentration of a specific contaminant in ambient air at selected areas
  - ambient temperature at locations within a specific range of organization's facility
- frequency of photochemical smog events in a defined local area

Air Releases Intensity

It's important for facilities to measure and monitor their releases of air pollutants, especially ones of concern like (CO), nitrogen oxides (NOx), sulfur oxides (SOx), ozone, volatile organic compounds (VOCs), lead, and particulate matter. Air pollution causes a variety of human health issues such as breathing problems, lung damage, cardiac conditions, and cancer. It also causes a variety of environmental issues such as acidic rain, haze and smog, and thinning the protective ozone layer of the upper atmosphere. OECD recommends their Indicator O6 to calculate a facility's intensity of pollutant releases to air. [17] Note that this formula doesn't account for GHGs.

$$intensity\ of\ pollutant\ releases\ to\ air = \frac{weight\ of\ releases\ to\ air}{normalization\ factor}$$

Units of indicator: tons/normalization factor

Air pollutants that a facility is measuring and monitoring should already include those that are regulated or permitted, but the organization should also identify other air pollutants and decide which ones to prioritize. The numerator should include releases from both production processes and overhead, if possible.

GHG Intensity

To measure all GHGs on a comparable level, each substance's Global Warming Potential (GWP) is defined in relation to the GWP of carbon dioxide (CO_2) by a particular CO_2-equivalence (CO_2e) value. The GWP depends on the average atmospheric lifetime of individual GHGs. The IPCC was created by the UN Environmental Program (UNEP) and the World Meteorological Organization (WMO) to look at this global environmental issue from a scientific perspective while assessing socio-economic affects. The OECD provides their Indicator 04 for calculating an organization's GHG intensity.

$$GHG\ intensity = \frac{(GHGs\ released\ in\ energy\ consumption\ for\ production + GHGs\ released\ in\ energy\ consumption\ for\ overhead + GHGs\ released\ by\ transport\ used\ for\ business\ travel + additional\ GHGs\ release\ from\ production\ process)}{normalization\ factor}$$

Unit of the indicator: tons of CO_2e/normalization factor

This indicator measures the GHG intensity of the facility and overhead of an organization, but not GHG releases related to the shipping of inputs, shipping of finished products, or transportation of employees. OECD calculates the GHG intensity of the product use stage and other indirect emissions (Scope 3) independently, but an organization may simply extend the margins of this formula to include them if desired. This formula accounts for all direct GHG emissions (Scope 1) as well as all indirect GHG emissions from consumption of purchased electricity, heat, or steam (Scope 2). The other indirect GHGs of Scope 3 include releases from raw material extraction, the production of purchased materials and fuel sources, transportation activities related to, but outside the control of, an organization, and outsourced activities not included in Scope 2. An organization just starting to measure and monitor their GHG intensity should focus on their facility initially, but be sure to specify their margins if reporting it.

Air Emission Inventories, Audits, and Assessments

- **Air emission inventories and assessments**

  Air emissions from industrial sources are one of the most difficult releases that an environmental professional may need to determine. The U.S. Environmental Protection Agency (EPA) has published emissions factors and emission modeling guidance for calculating air emissions. (See https://www.epa.gov/technical-air-pollution-resources as an example of available guidance.) There are several local, state and federal regulations for air emissions and many contain the method for calculating the emissions within the regulations. Additionally, EPA has published AP-42 [18] as guidance for many process and operating scenarios at a facility. It is highly advisable to engage with an environmental consultant with an expertise in air emissions calculations and modeling.

- **GHG inventories**

  Although GHGs are released from natural sources, the concentration of their releases worldwide has far exceeded historical levels due to mankind's activities. Such activities are present throughout every industrial sector that depends on the combustion of fossil fuels, generates waste, and emits GHGs. GHGs contribute to global warming beyond natural cycles. The substances classified as GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases listed by the Intergovernmental Panel on Climate Change (IPCC). [19] GHG inventories are calculated amounts of GHG emissions released to or removed from the atmosphere over a given period of time. [20] An organization can use their GHG inventories to identify emission reduction opportunities. If an organization releases greater than the regulatory threshold of CO_2 equivalents annually, it is probably required by law to report their emissions to the U.S. EPA.

  More likely however, a company may be asked by their customers to report their energy consumption and use data and therefore report on the equivalent GHG emissions associated with this energy. Sustainable supply-chain scorecard requests from customers for suppliers have become very popular over the last several years with a primary focus on energy and GHGs. Identifying Scope 1, 2, and 3 GHG emissions can be a daunting task. Many online resources are available, including the GHG
  Protocol's Corporate Standard, as developed by the World Resources Institute and the World Business Council for Sustainable Development, which is the foundation for nearly every GHG standard, inventory, and program in the world. [21]

Air Emission Improvements and Implementation

Source reduction

To prevent or stop creating pollution, such as air emissions, source reduction plays an important role. Source reduction is any practice that

- reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal.
- reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

The term "source reduction" refers to the following:

- modifications to equipment or technology
- modifications to process or procedures
- substitution of raw materials
- improvements in housekeeping, maintenance, training, or inventory control

Green chemistry

Industrial air emissions are often the result of using, combining, or combusting chemicals or materials. By using chemicals that have considered the principles of green chemistry, air emissions can potentially be reduced. Green chemistry is “the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances.” [22] As stated by the U.S. EPA, green chemistry

- prevents pollution at the molecular level.
- is a philosophy that applies to all areas of chemistry, not a single discipline of chemistry.
- applies innovative scientific solutions to real-world environmental problems. □ results in source reduction because it prevents the generation of pollution.
- reduces the negative impacts of chemical products and processes on human health and the environment.
- lessens and sometimes eliminates hazard from existing products and processes.
- designs chemical products and processes to reduce their intrinsic hazards. [23]

Twelve principles of green chemistry should be considered when working with chemicals. These principles, included below, demonstrate the breadth of the concept of green chemistry.

1. **Prevent waste:** Design chemical syntheses to prevent waste. Leave no waste to treat or clean up.
2. **Maximize atom economy:** Design syntheses so that the final product contains the maximum proportion of the starting materials. Waste few or no atoms.
3. **Design less hazardous chemical syntheses:** Design syntheses to use and generate substances with little or no toxicity to either humans or the environment.
4. **Design safer chemicals and products:** Design chemical products that are fully effective yet have little or no toxicity.
5. **Use safer solvents and reaction conditions:** Avoid using solvents, separation agents, or other auxiliary chemicals. If you must use these chemicals, use safer ones.
6. **Increase energy efficiency:** Run chemical reactions at room temperature and pressure whenever possible.
7. **Use renewable feedstocks:** Use starting materials (also known as feedstocks) that are renewable rather than depletable. The sources of renewable feedstocks are often agricultural products or the wastes of other processes. The source of depletable feedstocks is often fossil fuels (petroleum, natural gas, or coal) or mining operations.
8. **Avoid chemical derivatives:** Avoid using blocking or protecting groups or any temporary modifications if possible. Derivatives use additional reagents and generate waste.
9. **Use catalysts, not stoichiometric reagents:** Minimize waste by using catalytic reactions. Catalysts are effective in small amounts and can carry out a single reaction many times. They are preferable to stoichiometric reagents, which are used in excess and carry out a reaction only once.
10. **Design chemicals and products to degrade after use:** Design chemical products to break down into innocuous substances after use so that they do not accumulate in the environment.
11. **Analyze in real time to prevent pollution:** Include in-process, real-time monitoring and control during syntheses to minimize or eliminate the formation of byproducts.
12. **Minimize the potential for accidents:** Design chemicals and their physical forms (solid, liquid, or gas) to minimize the potential for chemical accidents including explosions, fires, and releases to the environment. [24]

Particulate emissions

Particulate matter and dust are the most common air contaminants of fugitive emissions. They are commonly a concern in industrial environments where grinding, milling, and sawing processes take place. They inhibit the efficiencies of pollution control technologies and numerous others. To prevent and control concentrations of particulate matter, an organization's employees should perform dust control practices like covering equipment, water suppression, and increasing the moisture content of material piles. Equipment used to handle materials that emit particulate matter should extract the affiliated air and treat it, such as with a baghouse or a cyclone. Operators should maintain clean equipment and a clean environment. When necessary, employees should utilize personal protective equipment such as dust masks and respirators to avoid human health concerns.

Monitoring and Controlling Air Emissions

Air emissions monitoring

Organizations with a significant amount of air emissions may be required to monitor them in order to show compliance with regulatory requirements. However, organizations with less-than-significant emission quantities should also perform monitoring to compile performance data and get an idea of where they stand in respect to regulated quantities and competitor organizations. The National Emission Standard for Hazardous Air Pollutants (NESHAP) of the Clean
Air Act (CAA) defines monitoring as "the collection and use of measurement data or other information to control the operation of a process or pollution control devices or to verify a work practice standard relative to assuming compliance with applicable requirements."

Monitory emissions from a stationary source consists of four parts: indicators, averaging time, monitoring frequency, and measurement techniques.

- Indicators are the measures of performance criteria, such as air pollution controls, direct emissions, surrogate emissions, opacity levels, efficiencies of emission rates, and pollutant concentrations.
- The time period in which the data is collected is averaged against the release of emissions in order to confirm proper compliance and verify appropriate use of pollution control strategies.
- The monitoring frequency is simply how many times data was collected over a given time span.
- Measurement techniques are the means of data collection related to indicators, and they consist of detection devices, installation specifications, inspection procedures and quality measures. Some measurement techniques include manual inspections, continuous emission monitoring systems, continuous opacity monitoring systems, and parametric monitoring systems.

A continuous emission monitoring system may measure actual emission levels of a pollutant or a surrogate pollutant in place of the pollutant of concern. A continuous opacity monitoring system measures opacity, which is the proportion of visible light attenuated. Opacity is determined by the amount of light dissipated by an emission's particulate matter. A parametric monitoring system may be continuous as well. They evaluate the system's performance by measuring one or more key parameters that serves as a reliable indicator, such as flow rate, temperature, and pressure.

[1] Richards, J. Environmental Research Center, Air Pollution Training Institute (APTI). (2000). *Control of gaseous emissions* (3rd Edition). Retrieved from U.S. Environmental Protection Agency website: http://4cleanair.org/APTI/415combined.pdf
[2] https://www.epa.gov/no2-pollution
[3] https://www.epa.gov/ground-level-ozone-pollution
[4] U.S. Environmental Protection Agency. *Technology Transfer Network Air Toxics Web Site: Pollutants & Sources*. EPA, 2012. Web. https://www.epa.gov/technical-air-pollution-resources
[5] https://globalcompactselfassessment.org/management/implement
[6] https://www.globalreporting.org/standards/media/1012/gri-305-emissions-2016.pdf
[7] https://www.globalreporting.org/standards/media/1012/gri-305-emissions-2016.pdf
[8] https://www.globalreporting.org/standards/media/1012/gri-305-emissions-2016.pdf
[9] http://www.oecd.org/innovation/green/toolkit/oecdsustainablemanufacturingindicators.htm
[10] https://sustainabilityadvantage.com/documents/BCorpImpactAssessment.pdf
[11] http://sustainabilityadvantage.com/documents/BCorpImpactAssessment.pdf
[12] http://sustainabilityadvantage.com/documents/BCorpImpactAssessment.pdf
[13] https://www.globalreporting.org/standards/media/1012/gri-305-emissions-2016.pdf
[14] https://www.globalreporting.org/standards/media/1012/gri-305-emissions-2016.pdf
[15] http://www.oecd.org/innovation/green/toolkit/oecdsustainablemanufacturingindicators.htm
[16] *Environmental management – Environmental performance evaluation – Guidelines.* ISO 14031:1999. Geneva, Switzerland : ISO.
[17] Organization for Economic Co-operation and Development, "OECD Sustainable Manufacturing Indicators." *O6. Intensity of pollutant releases to air*. *OECD Sustainable Manufacturing Toolkit*. http://www.oecd.org/innovation/green/toolkit/o6intensityofresidualreleasestoair.htm
[18] https://www.epa.gov/technical-air-pollution-resources
[19] Organization for Economic Co-operation and Development, "OECD Sustainable Manufacturing Indicators." *O4. Greenhouse gas intensity*. *OECD Sustainable Manufacturing Toolkit*. http://www.oecd.org/innovation/green/toolkit/o4greenhousegasintensity.htm

[20] EPA. *Lean, energy & climate toolkit - achieving process excellence through energy efficiency and greenhouse gas reduction*. Washington DC: U.S. Environmental Protection Agency. (2011) Retrieved from https://www.epa.gov/sites/production/files/2013-10/documents/lean-energy-climate-toolkit.pdf
[21] https://ghgprotocol.org/corporate-standard
[22] https://www.epa.gov/greenchemistry
[23] https://www.epa.gov/greenchemistry/basics-green-chemistry#twelve
[24] https://www.epa.gov/greenchemistry/basics-green-chemistry#twelve

D. Food Industries

Construction

Below is a list of resources that may be helpful for businesses in the construction industry. This compilation of resources is designed to inform decision-making and support the adoption of industry best practices for sustainable supply chain management.

"Green-building is about reducing energy waste and water use; it's about creating jobs and sparking economic growth; it's also about protecting the health of our children for the future," said Julián Castro, secretary of the U.S. Department of Housing and Urban Development, during the Greenbuild 2015 conference. "Green-building is also not a slogan, it really is a solution."

Industry Best Practices

Leadership in Energy and Environmental Design (LEED)

LEED is a green building certification program that recognizes best-inclass building or neighborhood strategies and practices. To receive LEED certification, building or neighborhood projects must satisfy prerequisites and earn points to achieve different levels of certification.

Green Globes

Green Globes is an online green-building rating and certification tool that was developed by ECD Energy and Environment Canada Ltd. and is primarily used in Canada and the U.S.

National Green Building Certification (NGBC)

NGBC is a green building certification program for single- and multifamily construction, and subdivision development.

Building Research Establishment Environmental Assessment Methodology (BREEAM)

BREEAM is an environmental assessment and rating system for buildings primarily used in Europe.

Corporate Reporting and Product Declarations

Environmental Product Declaration (EPD)

An EPD is a Type III Environmental Label, per ISO 14025:2006. An EPD is a third-party certified label that uses a life-cycle assessment (LCA) approach to quantify the environmental impacts of products according to appropriate product category rules (PCR). EPDs are registered by program operators who ensure that all information is transparent, available, and current, and that all the relevant ISO standards are followed.

Health Product Declaration (HPD)

HPDs provide a standardized way of reporting material contents of products and the associated health effects of these materials. The HPD is developed according to the directions set forth by the Health Product Declaration Collaborative, which began in 2010, and is considered to be complementary to life-cycle documentation, such as LCA and an EPD.

U.S. Green Building Council's Greenbuild Consortium

At Greenbuild, four major green-building stakeholder organizations—ASTM International, ICC Evaluation Service, NSF International and Sustainable Minds—launched the first program operator consortium in the industry. The consortium will serve as an expert resource and advocate for creating product category rules, reviewing LCA reports and verifying and publishing environmental product declarations. According to a statement announcing the consortium's formation, members will pool resources; leverage existing relationships; jointly conduct outreach, marketing, education and communications; and promote the overall use of PCRs, LCAs, and EPDs in the marketplace.

Trade Associations or Consortia that Can Offer Support

U.S. Green Building Council (USGBC)

Founded in 1993, the USGBC is a nonprofit, membership-based organization that promotes sustainability throughout the design, construction, and operation of buildings.

Green Building Initiative (GBI)
GBI is a nonprofit organization established in 2004 and is the U.S. licensee of the Green Globes rating system.

National Institute for Standards and Technology (NIST)
NIST is a non-regulatory federal agency within the U.S. Department of Commerce. NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. NIST has developed free, downloadable software that contains life-cycle and cost considerations for the construction industry called Building for Environmental and Economic Sustainability (BEES).

Athena Institute
The Athena Institute is a non-profit research collaborative bringing LCA to the construction sector. The Athena Institute offers LCA-based tools for whole buildings and assemblies.

UK Green Building Council (UKGBC)
The UK Green Building Council has published a guide for building owners and managers to make the built environment more resource efficient.

Electronics

Introduction
Below is a list of resources that may be helpful for businesses in the electronics industry. This compilation of resources is designed to inform decision-making and support the adoption of industry best practices for sustainable supply chain management.

Industry Best Practices

Electronic Industry Citizenship Coalition (EICC) Code of Conduct
The EICC is a coalition of the world's leading electronics companies working together to improve efficiency and social, ethical, and environmental responsibility in the global supply chain.

Basel Action Network (BAN) e-Stewards Certification
Certified e-Stewards recyclers adhere to the e-Stewards Standard for Responsible Recycling and Reuse of Electronic Equipment®. It was written by the environmental community with leaders in the industry to protect human health and the global environment.

R2 Standard

The R2 Standard sets forth requirements relating to environmental, health, safety, and security aspects of electronics recycling. R2 requires e-recyclers to assure that more toxic material streams are managed safely and responsibly by downstream vendors—all the way to final disposition. It also prohibits e-recyclers and their downstream vendors from exporting these more toxic materials to countries that have enacted laws making their import illegal.

Corporate Reporting and Product Declarations

E-TASC (Electronics – Tool for Accountable Supply Chains)

E-TASC is a free web-based tool based on a comprehensive set of ethics, labor rights, health and safety, and environmental criteria. Companies fill in a single questionnaire on E-TASC and can share their responses with multiple participating customers, rather than completing separate assessments from different companies. The tool includes a risk assessment that automatically provides a report identifying potential risk areas and best practice examples to help improve performance. The system is available in Chinese and English.

ECMA 370 - Environmental design considerations for ICT and CE products

This ECMA Standard identifies design practices for Information and Communication Technology (ICT) and Consumer Electronic (CE) products.

Electronic Product Environmental Assessment Tool (EPEAT, Inc.)

EPEAT® is a comprehensive environmental rating and global standard that helps identify greener electronic equipment.

ENERGY STAR

ENERGY STAR is a joint voluntary labeling program of the U.S. EPA and the U.S. Department of Energy that is designed to identify and promote energyefficient products.

Trade Associations or Consortia That Can Offer Support

GeSI Global e-Sustainability Initiative

GeSI, the Global e-Sustainability Initiative, was begun in 2001 to further sustainable development in the Information and Communication Technology (ICT) sector. GeSI fosters global and open cooperation, informs the public of its members' voluntary actions to improve their sustainability performance, and promotes technologies that foster sustainable development.

Food

Introduction

This section contains a list of resources and tools that are food sector specific, in addition to resources that are specific to sustainable agriculture.

The food manufacturing sector can improve its sustainability by following DMAIC process as defined on this website.

The food sector can further improve its sustainability performance by using what is defined as "sustainable agriculture"[1]. Sustainable agriculture means an integrated system of plant and animal production practices having a site-specific application that will, over the long term,

- satisfy human food and fiber needs;
- enhance environmental quality and the natural resource base upon which the agricultural economy depends;
- make the most efficient use of nonrenewable resources and on-farm resources; and
- integrate, where appropriate, natural biological cycles and controls, sustain the economic viability of farm operations, enhance the quality of life for farmers and society as a whole.

Industry Best Practices

USDA National Institute of Food and Agriculture Sustainable Agriculture
Sustainable agriculture seeks to provide more profitable farm income, promote environmental stewardship, and enhance quality of life for farm families and communities. NIFA promotes sustainable agriculture through national program leadership and funding for research and extension. It offers competitive grants programs and a professional development program, and it collaborates with other federal agencies through the USDA Sustainable Development Council. Visit the NIFA website.

Sustainable Agriculture Research and Education (SARE)
Grants and education to advance innovations in sustainable agriculture.

Sustainable Agriculture Initiative Platform
A food industry organization that aims to support the development of sustainable agriculture, involving stakeholders of the food chain.

Food Safety System Certification 22000
Formerly known as ISO 22000:2005, Food safety management systems, it outlines requirements for any organization in the food chain, providing an international harmonized framework on which to build a global approach.

GRI Sustainability Reporting Guidelines & Food Processing Sector Supplement
Food-sector specific guidelines developed by the Global Reporting Initiative (GRI).

Corporate Reporting and Product Declarations

Pepsi Key Performance Indicators (KPIs) for Environmental Sustainability
A set of environmental sustainability KPIs, including direct and indirect GHG emissions, supply-chain GHG emissions, fuel-use reduction, electricity-use reduction, water-use reduction, building efficiency, total water used, water conservation, and percentage of waste sent to landfill.

McDonald's 2011 Global Sustainability Scorecard
A report that was published to give an overview of McDonald's indicators and performance.

Kraft Foods
From the Kraft Foods website: "Once we determine a good fit with a supplier or business partner, we develop a contract that not only provides the core commercial terms but specifically incorporates our corporate responsibility expectations. For example, we would include legally enforceable provisions on child labor and worker safety. Over the next several years, we will work toward having these corporate responsibility expectations in all contracts with suppliers and business partners."

Energy Guide: Opportunities for Improving Energy Efficiency in a Focus Industry
The U.S. EPA provides an ENERGY STAR energy guide for each industry. The guide is a resource on trends in energy use and energy intensity in the industry as well as a systematic analysis and discussion of the energy efficiency opportunities in the manufacturing plants. Energy managers can use the guide to identify areas for improvement, evaluate potential energy improvement options, develop action plans and checklists for the energy program, and educate company employees.

Food Alliance Certified
Food Alliance provides comprehensive third-party certification for social and environmental responsibility in agriculture and the food industry.

Protected Harvest
Protected Harvest is a standards-setting and third-party certifier of sustainably grown food products. Protected Harvest growers are assessed and audited on water, air, and soil quality; wildlife protection; and social impacts on workers and the community.

Rainforest Alliance Certified
Businesses that source products grown on certified farms and farms that meet the Sustainable Agriculture Network (SAN) Standard may apply to use the Rainforest Alliance Certified seal.

USDA Organic
Organic is a labeling term that indicates that the food or other agricultural product has been produced through approved methods that integrate cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity.

Non-GMO Verified
Many in the public have expressed concerns about genetically modified food (GMO) as a risk to human health and biodiversity. The Non-GMO Project Product Verification Program, the only of its kind in North America, comprehensively evaluates products for compliance with a standard developed by industry experts and stakeholders.

Marine Stewardship Council (MSC) Certified
The MSC's fishery certification program and seafood ecolabel recognize and reward sustainable fishing. It is a global organization working with fisheries, seafood companies, scientists, conservation groups, and the public to promote the best environmental choice in seafood.

Fair Labor Practices and Community Benefits
Fair Labor Practices and Community Benefits certification validates socially responsible practices in agricultural production and processing.

Trade Associations or Consortia That Can Offer Support

Certified Naturally Grown
A maintained list of farms in New York State that are certified naturally grown.

New York State Department of Agriculture & Markets Farm Fresh Guide
The Farm Fresh Guide lists nearly 2,000 farms offering food, products, and services directly to the public.

Natural Products Expo East
A trade show featuring natural food producers and vendors.

Natural Products Association Market Place
The official trade show and conference of the Natural Products Association (NPA), it is produced by New Hope Natural Media and is the longest running natural and healthy lifestyle products trade show.

1. See *United States Code (USC) › Title 7› Chapter 64› Subchapter I› § 3103 Definitions*, as a reference for "sustainable agriculture".

Healthcare

Introduction

Hospitals are under increasing pressure to provide high-quality care while reducing costs. In addition to improving the environmental health of their communities, healthcare institutions in the United States are realizing the value of adopting sustainable practices as a way of reducing costs without compromising quality of care.

NYSP2I understands the complexity of the healthcare environment and the importance of patient care outcomes. When addressing NYSP2I challenges, our team works with all key hospital stakeholders to gather relevant operational data and conduct onsite observations of processes and material handling. After identifying opportunities for improvement and/or savings, we may also perform detailed technical and economic feasibility analyses of the improvement options identified to provide estimates for required investments, expected cost savings, and anticipated environmental benefits.

Industry Best Practices - Online Resources

- Healthier Hospitals Initiative (HHI)
- Practice Greenhealth
- Health Care Without Harm
- Sustainable Hospitals Program
- Sustainability Roadmap for Hospitals

Environmentally Preferable Purchasing (EPP)

EPP is growing across industries and, because of the vast quantity of supplies necessary to provide service, opportunities abound in healthcare. EPP is the practice of purchasing products/supplies with environmental impacts that have been found to be less damaging to the environment and human health when compared to competing products/supplies. Many EPP options are available at similar or lower price as the alternative.

Corporate Reporting

- Sustainability Accounting Standards Board
- Healthcare Providers & Services, and Healthcare Technology

Trade Associations

- Physicians for Social Responsibility (PSR)
- American Society for Healthcare Engineering (ASHE)
- Association for Healthcare Resource & Materials Management (AHRMM)

Paper & Printing

Introduction

The resources listed below may be valuable for businesses in the paper manufacturing, printing, and packaging industries. This compilation is designed to inform decision making and support the adoption of industry best practices for sustainable supply chain management.

Industry Best Practices

World Resources Institute Sustainable Procurement of Wood and Paper Based Products

The World Resource Institute (WRI) in conjunction with the World Business Council for Sustainable Development (WBCSD) published "Sustainable Procurement of Wood and Paper-based Products" as a guide to help businesses understand the environmental and social impacts of sourcing wood and paper based products. The guide encompasses the most up-to-date practices for tracing and controlling forest product supply chains with a focus on sustainability.

Forest Stewardship Council (FSC)

Working to protect forests for future generations, FSC has developed many programs that have set the standard for responsible forest management. In the paper and printing industry, FSC paper and printer certification represent your company's commitment to sustainable forest management and maintaining socially responsible values.

Sustainable Forestry Initiative (SFI)

SFI works with conservation groups, local communities, resource professionals, and landowners to promote sustainable forest management. SFI is an independent, charitable organization that issues forest certification through an eternal review panel. Intent on ensuring that wood supplies and paper products are from legal and reputable sources, SFI offers certification in a wide variety of focus areas.

Reducing Environmental Impact: Omniafiltra

Water and electricity are key elements in paper production, and the prices of each are rising steadily. So it makes economic sense to minimize their use wherever possible, which also helps reduce a facility's environmental footprint. For these reasons, Omniafiltra, an Italian-owned company that specializes in manufacturing specialty paper for niche markets, including a variety of filtration media and absorbent boards, recently worked with NYSP2I to reduce their water and power consumption.

NYSP2I engineers, working in collaboration with Omniafiltra and CITEC Manufacturing and Technology Solutions, found significant opportunities for wastewater recovery for reuse as well as reductions in energy use. Our analysis showed that wastewater drained from the forming, pressing, and drying areas is recoverable for reuse since it is comprised of very small amounts of fiber and surfactant. This recoverable water equals about 43,350,000 gallons annually. Also, electricity usage can be reduced by 75,000 kWh, with an annual savings of $10,000 per year by switching to a variable frequency drive and a lower horsepower motor. The upgrade was estimated to cost about $20,000, resulting in a two-year payback. If the plant switches to an identified nonylphenol ethoxylates-free surfactant, Omniafiltra can keep 361 pounds of toxic NPEs from being discharged into the environment annually.

Corporate Reporting and Product Declarations

Environmental Paper Assessment Tool (EPAT)

EPAT is an assessment tool developed by the non-profit GreenBlue. This tool allows paper product buyers and sellers to properly evaluate environmental performance data along the paper supply chain to make informed decisions on paper products. The goal is to make environmentally preferable paper products more widely available.

Paper Profile

Paper profile is a voluntary product declaration helping paper buyers make responsible paper product choices. Important environmental parameters, management technique, and wood procurement information is collected and continually updated regarding individual products. This information is developed into a single-page "paper profile" that provides paper buyers relevant and uniform environmental information.

Nordic Swan Ecolabel

The Nordic Ecolabel is the official ecolabel of the Nordic countries. It is an environmental labeling scheme that promotes the production and purchase of sustainable goods. Evaluation spans throughout the entire life cycle, taking into account climate requirements and carbon dioxide (CO_2) emissions.

European Union (EU) Ecolabel for Paper Products

The EU Ecolabel develops evaluation criteria for a vast range of product groups based on consultation with experts and key stakeholders. In the paper industry, specific criteria have been developed for the newsprint, printed, tissue, and copy/graphic paper.

Trade Associations or Consortia That Can Offer Support

National Council for Air and Stream Improvement, Inc. (NCASI)

The National Council for Air and Stream Improvement (NCASI) is an independent, nonprofit research institute that focuses on environmental topics of interest to the forest products industry. Established in 1943, NCASI is recognized as the leading source of reliable data on environmental issues affecting the industry.

TAPPI

TAPPI is the leading association for the worldwide pulp, paper, packaging, and converting industries and publisher of Paper360º and TAPPI JOURNAL. Through information exchange, trusted content, and networking opportunities, TAPPI helps members elevate their performance by providing solutions that lead to better, faster, and more cost-effective ways of doing business. PIMA operates as the Management Division of TAPPI.

American Forest and Paper Association (AF&PA)

AF&PA is a U.S. trade association focused on advancing public policies that promote sustainability in the U.S. forest products industry. More than 75% of companies in the U.S. pulp and paper industry are AP&PA members. Members range anywhere from small family-owned mills to large multi-product, publically owned corporations. All AF&PA members abide by the association's environmental, health, and safety principles, and are committed to developing a sustainable future.

Sustainable Green Printing Partnership (SGP)

SGP is an independent, nonprofit organization providing product eco-certification in the graphic communications industry. Certification is the industry standard for commitment to improvement of sustainability and best practices within print manufacturing operations. Print facilities, suppliers, and buyers can join the SGP movement and take an active role in promoting sustainability.

Sustainable Packaging Coalition (SPC)

SPC is an industry working group dedicated to building packaging systems that promote sustainable material flows while encouraging economic growth. SPC aims to create a forum where best practices, design guidelines, and new technologies can be shared. With strong member support, supply chain collaborations, continuous outreach and a science-based approach, SPC helps equip businesses with the science and resources to make their products more sustainable.