Sustainable Technology Management

A Guide for Sustainable Entrepreneurs

SUSTAINABLE ENTREPRENEURSHIP PROJECT

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About the Project

The Sustainable Entrepreneurship Project (www.seproject.org) engages in and promotes research, education and training activities relating to entrepreneurial ventures launched with the aspiration to create sustainable enterprises that achieve significant growth in scale and value creation through the development of innovative products or services which form the basis for a successful international business. In furtherance of its mission the Project is involved in the preparation and distribution of Libraries of Resources for Sustainable Entrepreneurs covering Entrepreneurship, Leadership, Management, Organizational Design, Organizational Culture, Strategic Planning, Governance, Corporate Social Responsibility, Compliance and Risk Management, Finance, Human Resources, Product Development and Commercialization, Technology Management, Globalization, and Managing Growth and Change. Each of the Libraries include various Project publications such as handbooks, guides, briefings, articles, checklists, forms, forms, videos and audio works and other resources; management tools such as checklists and questionnaires, forms and training materials; books; chapters or articles in books; articles in journals, newspapers and magazines; theses and dissertations; papers; government and other public domain publications; online articles and databases; blogs; websites; and webinars and podcasts.

About the Author

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Sustainable Technology Management

§1   Introduction

While there are number of different ways to define "sustainable development", a reasonable choice would be to think of it as development that meets the needs of the present without compromising the ability of future generations to meet their needs. Companies seeking to make a contribution to sustainable development must be prepared to change their traditional way of thinking and allow social, environmental and technological considerations to sit side-by-side with economic performance when establishing their goals and objectives. Sustainable companies must also commit to acting in a socially responsible manner toward their stakeholders and maintaining high ethical standards.

Technology plays a big role in their pursuit of sustainability and economic development. Sustainable technologies include technologies that use durable, low-maintenance, recyclable and economic materials and technologies, including materials and technologies that can be locally sourced to reduce transportation costs. Sustainable technologies may be incorporated into sustainable design practices for products that are focused on designing products to leverage materials and technologies that will reduce product life cycle environmental impacts. An effective sustainable technology will facilitate improvements in the appearance, performance, quality, functionality and ecological, social and economic value of the products. From a technology management perspective, companies may consider investing in the development of new technologies that provide alternatives to traditional technologies that have been shown to be being damaging to the health of members of the community and to the environment.

Sustainable technology management is based on the premise that individual companies can and do make an impact on sustainable development through the decisions they make as part of their technology management programs: what products should they manufacture and what technologies should be included in those products; what process technologies should be used; what types and amounts of resources should be used in the manufacturing process; how much should be invested in research and development and which R&D projects should be given the highest priority; and can the company deploy technologies that do not harm the environment and improve the overall quality of life of their employees, customers and members of society in general.

While sustainable technology management obviously impacts the traditional economic "bottom line" that is relevant to investors, it also is important to many of the other key stakeholders of the company[1]:

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[1] OECD Sustainable Manufacturing Toolkit: Seven Steps to Environmental Excellence—Start-Up Guide (2011), www.oecd.org/innovation/green/toolkit, 16.

- Many customers are concerned about whether or not sourced components have been manufactured to meet certain environmental standards and may require that supplier provide the results of audits of their manufacturing processes to verify compliance.
- Employees are concerned about the health and safety aspects of participating in the manufacturing process such as air quality and exposure to harmful materials in the workplace.
- Local communities are concerned about the environmental impact of manufacturing activities including emissions, odors and noise and it is often necessary and prudent to providing information to community members about standards and performance.
- Regulators will be concerned about a company's compliance with applicable environmental laws and regulations as well as progress being made on effort to improve energy efficiency and reduce harmful emissions beyond the levels otherwise permitted by law.
- Consumer action groups will monitor various impacts of the company's finished products such as greenhouse gas emissions and may engage in adverse publicity campaigns to force the company to take steps to improve its performance.

§2   Areas and issues relating to sustainable technology management

Developing and implementing a sustainable technology management initiative begins with identifying and understanding when and how the operational activities of businesses can have an adverse environmental impact. A good starting point would be to think about the following areas and issues[2]:

- *Air Pollution:* Companies should consider and implement technological solutions that increase the efficiency of energy supply and energy use. An effort should be made to reduce dependence on fossil fuels and when such fuels are used it should done in a manner that reduce pollution. Companies can help reduce air pollution, promote climate protection, and save money, by employing energy-efficient technology in their business operations. Companies can make a practice of using Energy Star qualified products and implement strategies to reduce the environmental impacts from commuting, fleet and business air travel. For example, fuel-efficient vehicles should also be a priority when make decisions regarding logistics (i.e., movement of raw materials and finished goods) and transport for the company's personnel while they carry out their job responsibilities.
- *Renewable Energy:*   Companies should consider embracing renewal energy initiatives, sometimes referred to as "green power" or "clean energy", which involve reliance on energy sources that are continuously renewed (e.g., wind, solar, geothermal, hydro and biomass). Companies and products can rely exclusively on renewable energy; however, the more common approach, at least for now, is to use a combination of fossil and renewable resources. Renewal energy technology can be installed at a company's facility or the company can purchase renewable energy from utility companies.

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[2] Examples in this section are adapted from "Pathways to Sustainability", in National Research Council, The Role of Technology in Environmentally Sustainable Development (Washington, DC: The National Academies Press, 1995).

- *Infrastructure:* Companies make decisions relating to technology-based public infrastructure all the time and consideration must be given to selecting communications and transportation solutions that are the most efficient in terms of cost and which have the most modest environmental impact. When companies are identifying sites for manufacturing, research and other activities, consideration should be given to ease of access for personnel. For example, picking a location that is near public transportation will reduce gasoline use among employees if they are able to avoid driving to work.

- *Water:* Companies often engage in activities that raise issues regarding excess water usage and pollution and it is incumbent upon them to operate in a manner that does not harm their surrounding communities. Technologies are available for controlling many types of pollutants and manufacturing processes should be modified to minimize water consumption.

- *Product Design and Manufacturing:* One of the tenets of sustainable development is to create industrial ecosystems that imitate natural ones and companies have been drawn to finding ways to reduce, re-use, and recycle materials and products. The most of innovative companies have used technology to aggressively redesign their products and processes and have formally embraced environmental issues as being just as important as the cost and quality of their products and the safety of their workers. In the manufacturing area, consideration should be given to energy and water use, water generation, emissions, noise and odors, logistics and operations.

- *Materials:* Companies need to consider the environmental impact of the materials that they manufacture and/or use in their products. New technologies have revolutionized the properties of widely-used materials such as steel, concrete and plastic and can also be used by scientists and engineers to design new materials that facilitate the development of products that are more energy efficient, consume less mineral resources for their manufacture, and are lighter, stronger and recyclable.

- *Green Building Design:* Companies realize substantial benefits from applying green design principles to their design and construction projects at their facilities, both new building projects and major renovations of existing buildings. Green building design includes both selecting energy efficient equipment and using natural sources for energy needed to power activities within the facility. Companies can seek LEED ("Leadership in Energy and Environmental Design") certification to benchmark their efforts with respect to resource efficiency in their facilities.

- *Paper Usage:* Paper manufacturing consumes a significant amount of energy and natural resources and companies can contribute to reducing these harmful impacts on the environment by reducing the amount of paper they use in day-to-day activities (e.g., two-sided copying and emphasis on electronic distribution and use of documents), selecting paper with a high recycled content and recycling paper products.

- *Recycling and Waste Management:* All companies can find ways to reduce waste and improve their overall efficiency and productivity while enhancing their public image. Waste reduction begins by tightening up purchasing practices for raw materials, office supplies and equipment including purchasing environmentally preferable products. When designing products and packaging, companies should look

for ways to reduce the amount of materials. Companies should also mandate participation by all personnel in recycling initiatives.

- *Environmentally Preferable Purchasing:* Environmentally preferable purchasing ("EPP") has become popular among governmental agencies and call for procurement of goods and services that have a reduced impact on human health and the environment as compared to other goods and services serving the same purpose. When practicing EPP, governmental agencies and companies must take into account numerous environmental considerations, such as post-consumer recycled content; energy and water efficiency; durability; low/zero air emissions and hazardous substances; easy, non-hazardous maintenance; end-of-life management that keeps materials out of landfills (e.g., reuse, recycling, return to manufacturers); low life-cycle cost and packaging and distribution efficiency.

- *Information Technology:* Companies must track advances in information technology and consider adopting new technologies that will allow them to exert better control over their industrial processes, thereby creating opportunities to make those processes more efficient, safer and less damaging to the environment. Information technology can also be used to collect and analyze data from the supply chain and thus make it easier for companies to manage suppliers and ensure they are acting in a socially responsible manner.

- *Environmental Management Systems:* Companies should consider implementing an environmental management system ("EMS"), such as a system based on ISO 14001, an internationally agreed standard that sets out the requirements for a structure (i.e., an EMS) to help organizations manage and minimize their environmental impacts, conform to applicable legal requirements and improve their environmental performance through more efficient use of resources and reduction of waste, thereby gaining a competitive advantage and the trust of stakeholders. An EMS helps organizations identify, manage, monitor and control their environmental issues in a holistic manner and also includes the need for continual improvement of an organization's systems and approach to environmental concerns.[3]

- *Compliance Programs:* Environmental laws and regulations need to be incorporated into the company's overall compliance programs and companies need to develop compliance programs to ensure that their operations and other activities conform to applicable federal, state and local requirements. Compliance programs not only reduce the risk of monetary penalties, they also can support efforts to reduce costs and produce sustainable products that are favored in the marketplace. In addition, companies seeking to conduct business with governmental agencies should expect to be required to design their products so as to comply with the guidelines for environmentally preferable purchasing, or "EPP", discussed above.

Addressing many of the areas and issues mentioned above will require the development of new processes and procedures and investment in new technologies and platforms; however, sustainable technology, for all of its anticipated benefits, is not the end goal.

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[3] See "Introduction to ISO 14001: 2015"prepared and distributed by the International Organization for Standardization in 2015. For further discussion of implementing an environmental management system, see "Management: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).

When making decisions about sustainable technology management, companies must be satisfied that the technology and processes will make them more productive and efficient can contribute to the overall success of the business. While it is possible to create customized technology solutions internally, it is easier and less costly to rely on the work of others. Companies must create a dedicated team to scan for new solutions and test them before they are seriously considered for full-scale implementation. Any new solution must be adequately supported and training must be available.

§3 Sustainable manufacturing

Many companies have recognized sustainable manufacturing techniques as an important part of their overall strategies for optimizing their businesses.[4] Among the commonly cited benefits of "greening" manufacturing activities are reducing energy consumption reduces energy costs; reducing waste generation and emissions reduces the cost of monitoring, treatment and disposal and reduces the loss of the economic value of materials; reprocessing and/or remanufacturing end-of-life materials will increase the value of material inputs; replacing or upgrading equipment and/or production lines will improve the efficiency of operations; and improving on-site biodiversity and the native habitat will reduce the need for watering, air conditioning and other maintenance.[5] Key areas for businesses to consider when looking to reduce the adverse environmental impact of their manufacturing activities and improve productivity and efficiency include the following[6]:

- *Energy and Water Use:*   Energy and water are important inputs to many manufacturing processes; however, excess use of energy from fossil fuels will cause significant environmental damage from emissions of carbon dioxide.
- *Water Generation:*   Water is often generated as a residual to the manufacturing process and companies will incur expenses to ensure that the water is properly treated and disposed.
- *Emissions:* Manufacturing activities often result in emissions into the air and water that can have a detrimental impact on the health of humans and other species, both locally at the site of the emission and in remote locations if the emissions travel through the air or water and/or enter the broader food chain.
- *Noise and Odors:* Manufacturing activities can also produce noises and odors that have a direct impact on local communities that can go beyond mere annoyance to include significant adverse health consequences.
- *Logistics:* Consideration should also be given to the environmental impact of the logistic methods that are used for delivery of inputs for the manufacturing process and the shipment of finished products including fuel consumption, emissions, noise and adverse impact on infrastructures.

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[4] For discussion of manufacturing activities, see "Product Development and Commercialization: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).
[5] OECD Sustainable Manufacturing Toolkit: Seven Steps to Environmental Excellence—Start-Up Guide (2011), www.oecd.org/innovation/green/toolkit, 25.
[6] Id. at 26.

- *Operations:* Although not directly related to the actual manufacturing process, consideration should be given to the environmental impact of operational activities of members of the production and manufacturing group include furniture, lighting, air conditioning and travel (i.e., commuting to and from the facility and business travel). In addition, management of the facility and the surrounding land should be carried out with an eye on the environmental impact on local communities.

Measurement tools and performance indicators should be developed for water consumption, energy consumption, use of renewal energy, greenhouse gas emissions, waste generation; emissions into the air and water and natural cover. Examples of indicators include water intensity (consumption of water per unit of output); energy intensity (energy consumed per unit of output); renewal portion of energy consumed (the percentage of the company's energy usage that comes from renewable energy sources such as biomass, biogas, solar, wind and hydropower); greenhouse gas intensity (greenhouse gases produced during the production of one unit of output); residuals intensity (generation of wastes per unit of output); intensity of residual releases to air (release of air emission per unit of output); intensity of residual releases to surface water (release of effluents per unit of output); and natural cover (the proportion of land occupied that is natural cover).[7]

§4   Sustainable product design and use

In addition to the manufacturing process, the environmental impact of the finished products themselves needs to be considered, a process that takes into account the composition of the finished products and how they are used and disposed.[8] The quality of a company's product from the perspective of environmental impact can influence the reputation of the company's business, inspire and motive employees in their day-to-day activities and decisions and define the terms of engagement between the company and key stakeholders such as supply chain partners and customers. Some of the ways that companies can make their products more "green", and the potential benefits from taking those steps, including the following[9]:

- Substituting recycled/renewable materials for non-renewables saves material cost and creates a more attractive product for some buyers
- Reducing hazardous substances in products lowers the cost of monitoring, treatment and disposal and makes them appear to be safer and more desirable to consumers
- Improving the recyclability or biodegradability of products enhances the value of material inputs and reduces disposal costs
- Lowering the energy requirements for products reduces the cost of use, improves product desirability and anticipates regulatory requirements and future standards

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[7] Id. at 26-27.

[8] For discussion of product development and design activities, see "Product Development and Commercialization: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).

[9] Id. at 32.

- Improving product durability lessens the need for non-renewable materials and increases product value

Environmental issues and opportunities should be considered early in the product development process, at the design phase, and normally include the composition of the materials to be used in the product and whether they comprise recycled, renewable or reused materials, or are non-renewable or hazardous; the need for the product to be disposed or recycled at the end of its useful life; the intensity of energy consumption and greenhouse gas emissions of the product; and the potential ability of the product to help customers and consumers reduce their own environmental impact by the way that they use the product throughout its life.[10] Tools, such as the Cradle to Cradle® product design framework, are available to help companies integrate sustainability into their product development and design processes and showcase their efforts to prospective customers.

Measurement tools and performance indicators should be developed for each of the key indicators of the environmental performance and impact of products such as recycled/reused content of products (proportion of products that is recycled or reused); recyclability of products (proportion of products that is made up of renewable materials); renewable materials content of product (proportion of products that is made up of renewal materials); non-renewable materials intensity over product lifetime (annual use of renewable materials in products); restricted substances content of products (proportion of products made up of restricted substances); intensity of energy consumption of products (amount of energy the product requires during a typical year's use per unit of output); and intensity of greenhouse gas emissions from products (amount of greenhouse gases generated by a product during a typical year's use per unit of output).[11]

Cradle to Cradle®: A Framework for Sustainable Product Design

Cradle to Cradle®, which was developed by Braungart and McDonough, has been promoted as a beneficial design approach integrating multiple attributes, including safe materials, continuous reclamation and re-use of materials, clean water, renewable energy, and social fairness. In October 2005, Braungart and McDonough launched the Cradle to Cradle CertifiedCM Program, which is now managed by the Cradle to Cradle Product Innovation Institute as a third party not-for-profit organization. The aim of Cradle to Cradle® is "to set a positive course for product and process design and development in a way that will allow natural and technical systems, products, and processes to support the diverse living population on earth". Cradle to Cradle® acknowledges and approves of efforts by businesses to become more efficient and reduce the bad environmental footprint of their activities by optimizing existing systems; however, Cradle to Cradle® advocates more than just being "less bad" and pushes companies to become "more good" with respect to the methods they choose to produce a positive environmental outcome. For example, while it is commendable to reduce the use of fossil fuels, the primary goal should be pursue and achieve successful adoption of renewal energy sources.

Cradle to Cradle® is based on the premise that the design of goods and the provision of services can and should be achieved with the following principles in mind:

- *Elimination of the concept of waste*: Nutrients become nutrients again and all materials should be seen as potential nutrients in one of two cycles: technical and biological. This means that materials should

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[10] Id. at 33.
[11] Id. at 34.

be designed for use over and over in either technical or biological systems and that materials and products should be designed to be safe.

- *Using renewable energy*: The quality of energy matters and energy from renewable sources (i.e., solar, wind, hydropower, biomass (when not in competition with food supplies), geothermal, and hydrogen fuel cells) is paramount to effective design.
- *Celebrating diversity*: Social fairness should be used to guide a company's operations and stakeholder relationships. Staff should be encouraged to participate in creative design and research projects, different technical options should be explored in order to identify creative solutions and attention should be paid to supporting local biodiversity to help the local ecosystem flourish.

Products for which Cradle to Cradle® certification is sought will be evaluated against criteria in five categories:

- *Materials health*: Products should be manufactured using materials that have been optimized and which do not contain any materials/chemicals assessed as environmentally hazardous and/or harmful (referred to as "X or Grey assessed materials/chemicals"). Increasingly high levels of certification are available as the percentage of optimized materials in the finished product increases and the ultimate goal is to encourage manufacturers to phase out their use of dangerous substances such as carciogenic substances.
- *Material reutilization*: Products are evaluated for their nutrient potential and nutrient actualization, as well as the role the manufacturer plays in material/nutrient recovery. The goal is to improve the product's design for recyclability and/or compostability, and the larger the percentage of a product and/or its components that remain in a technical and/or biological metabolism, the better the score for this category.
- *Renewable energy and carbon management*: Products should be manufactured in a way that positively impacts the world's energy supply and ecosystem balance and success in this category is measured by the percentage of renewably generated energy that is utilized in the manufacture of the product.
- *Water stewardship*: Manufacturers are evaluated against their understanding of and responsibility for water withdrawals, consumption, and releases within the local ecology, and are rewarded for innovation in the areas of conservation and quality of discharge.
- *Social fairness*: The intention of this category is to provide a qualitative measure of the impact a product's manufacture has on people and communities and ensure that manufacturers are engaged in sustainable business operations that protect the value chain and contribute to all stakeholder interests, including employees, customers, community members, and the environment.

The program is not based on the primary, pass/fail method, but instead seeks to incorporate the concept of continuous improvement by splitting certification results for each category into five levels: basic, bronze, silver, gold and platinum. The final overall certification level is determined by the minimum level of achievement in any of the five categories (e.g., if a company meets the silver level in one category and gold in all other categories the overall certification level will be silver, thus motivating the company to improve in its "weakest" area to achieve a higher overall certification level in the future).

Source: The description of Cradle to Cradle® in this section is based on Cradle to Cradle Certified™ Product Standard: Version 3.1 (MBDC, LLC 2016).

§5 Sustainable information technology management

Sustainable, or "green," information technology ("IT") has been broadly defined to include effort to manufacture, manage, use and dispose of IT equipment in a way that

minimizes damage to the environment.[12]   For IT manufacturers, sustainable IT includes the methods that care used to produce their products in ways that do not harm the environment (e.g., reducing the amount of harmful chemicals and toxic substances in the products, making the products more energy efficient and packaging the products in recycled materials). When the focus is management and use of IT assets in day-to-day business activities, consideration needs to be given to purchasing energy-efficient equipment, managing the power consumption during the use of the equipment and making sure that the equipment is disposed at the end of its life cycle in a manner that is not damaging to the environment. Sustainable IT is important to the world because power consumption by computers accounts for a significant percentage of global carbon dioxide emissions and is important to individual companies because IT accounts for a large portion of their overall energy consumption. Practicing sustainable IT is also a way for companies to become more efficient and productive and enhance their image in the eyes of employees, consumers, community groups and other stakeholders. Finally, companies are encountering more regulatory requirements relating to their use and disposal of IT equipment.

Erbschloe focused on how technology producers, governments and computer users can and should follow certain core principles of "socially responsible information technology management" in order to control the potential negative impact of IT.[13] These principles were defined and explained as follows:

- *Appropriately staff IT departments*: Socially responsible IT management requires attention to building an in-house knowledge base by recruiting and retaining highly qualified, experienced and motivated IT professional. In order to do this, companies must develop a professional work environment, hire the right people for a workplace, align job responsibilities with IT worker skills, evaluate and mentor IT workers, implement professional development programs for IT workers, balance the workload of IT workers, implement cross-training programs and evaluate staffing needs.
- *Fairly compensate IT workers*: Companies should establish a fair compensation plan for IT employees, including assuring equal pay regardless of gender, into order to mitigate turnover and the loss of key personnel, both of which can knock projects off schedule and disrupt the activities of other departments and business groups. Compensation plans should include transparent linkages of compensation to performance and structured performance evaluations that identify ways for employees to improve their skills.
- *Adequately train computer users*: The IT department can play a valuable role in achieving the best return on the company's investment in IT equipment by proactively training computer users and providing an infrastructure that allows users to obtain help in resolving problems they encounter while working with the

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[12] K. Walsh, "Environmentally Sustainable IT: Definition and Solutions", CIO.com (October 29, 2007), http://www.cio.com/article/2437751/energy-efficiency/environmentally-sustainable-it-definition-and-solutions.html [accessed October 5, 2016]

[13] M. Erbschloe, Socially Responsible IT Management (Amsterdam: Elsevier, 2003). The descriptions of the various principles were adapted from abstracts of the chapters in the book available at http://www.sciencedirect.com/science/book/9781555582906 [accessed October 8, 2016].   See also http://www.computereconomics.com/article.cfm?id=684, [accessed October 8, 2016]

equipment. Trained users allow IT staff to spend more time on critical issues and promote more creative uses of IT tools since the users are more confident about their skills. IT department leaders should ensure that there is an adequate budget for hiring a good training coordinator and experienced trainers.

- ***Provide ergonomic user environments*:** The IT department should promote worker health and safety by providing ergonomic user environments including special equipment and extensive work training to workers to reduce injuries that will result in long-term damage to workers' careers and quality of life and reduced productivity. Creating and maintaining ergonomics programs has also become a regulatory compliance issue for many companies and the IT and human resources departments will play an important role in ensuring compliance.

- ***Maintain secure and virus free computer systems*:** One of the key roles of the IT department is maintaining secure and virus-free computer systems, a goal that has become increasingly more challenging in recent years as hackers have become more proficient at overcoming even the most sophisticated and costly security plans. The IT department should be involved in developing procedures for installing applications, e-mail and Internet practices, IT user policies, password protection, downloading data considerations, and network monitoring.

- ***Safeguard the privacy of information*:** The IT department has an important role to play in the protecting the privacy of sensitive and personal information collected by the company during the course of its activities. Information can be a valuable trade secret of the company and will often be the subject to national, state and local privacy laws that mandate safeguarding procedures and impose serious penalties if privacy is breached and information is publicly disseminated without the consent of the persons to which the information pertains.

- ***Ethically manage intellectual property*:** The IT department must strive to ethically manage the use of the intellectual property rights of others in the workplace and ensure that employees do not knowingly or inadvertently violate the copyrights of others by improperly using copyrighted works such as video, audio, text files, or computer software. The IT department should implement procedures relating to purchase of software and training programs for employees to ensure that they understand potential piracy issues and can work more productively.

- ***Utilize energy efficient technology*:** The IT department can make a significant contribution to the company's sustainability initiatives by leading efforts to use energy- efficient technology to reduce carbon dioxide emissions. For example, the IT department should purchase ENERGY STAR-labeled computers that automatically power down when not in use and generate less heat than conventional models. Energy efficiency can increase the useful life of equipment and reduce cooling costs. The IT department should continuously track new developments and opinions of technical experts to identify opportunities to enhance the company's energy efficiency.

- ***Properly recycle used computer equipment*:** The IT department should implement and oversee a program to ensure that used computer equipment is properly recycled at the end of its useful life to the company. Such a program not only reduces harmful environmental and health impacts, it will serve as an organized way to make sure that the company does not suffer damage due to the failure to address inadvertent

disclosure of confidential information, user names, passwords, and other sensitive information on discarded equipment.

- *Support efforts to reduce the digital divide*: The IT department can also contribute to the company's sustainability initiatives by identifying and implementing ideas for ways in which the company can reduce the digital divide in the communities in which the company operates and in society as a whole. Companies can support programs that seek to computer literacy and Internet access by contributing funds or equipment to local and regional programs, providing internships for local schools that have IT programs and encouraging employees to volunteer in programs that provide education and training to inexperienced technology users in local communities.

While the IT department can and should play a leading role in implementing each of the principles described above, success will depend on the cooperation and support of other departments. The chief information officer, or chief technology officer, as the leader of the IT department, will need to reach out to other departments to ensure that collaboration goes smoothly and that all relevant policies and procedures have been centrally vetted to identify and remove redundancies and clearly establish responsibilities and communications channels. The chief information or technology officer should also champion socially responsible IT among the other members of the executive team and the board of directors and establish performance metrics that can be easily tracked and reported upon on a regular basis. The IT department should also be well represented in outreach efforts and other communications to the company's stakeholders: employees, customers, value chain partners, regulators and community members. Finally, the chief information or technology officer should make socially responsible IT a positive and motivating endeavor the members of the IT department, helping them to feel that what they are doing is a valued contribution to the company's sustainability efforts, their colleagues in the workplace and society generally.

§6 Chief information officer's contribution to sustainability

In order for sustainability initiatives to be effective, sustainable business practices must be embedded in business operations such that sustainability is no longer seen as a separate initiative but as part of the essence of how things are done on a day-to-day basis within the company. In order for this type of embeddedness to occur, companies must adopt sustainable business practices and systems that integrate the environmental and social impact of products and operations with the ways in which the company creates economic value for its owners.[14] The chief information officer ("CIO") is ideally placed to assist in this process because he or she has experience in developing and implementing business systems and relationships that extend throughout the organization.[15] Moreover, sustainability initiatives depend on gathering and analyzing

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[14] V. Baya and B. Mathaisei, "The CIO's next leadership opportunity: Sustainability", PWC Technology Forecast, Issue 4 (2011), 56,
http://www.pwc.com/us/en/technology-forecast/2011/issue4/features/feature-sustainability-cio.html
[accessed October 6, 2016]
[15] For further discussion of the role and responsibilities of the chief information officer position, see "Management of Technology Activities" in "Technology Management: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project.

information, using advanced technological methods, to measure progress within the company and outside of the company in its supply chains and customer networks. While the challenges are different—traditionally, IT supported collecting of information on financial and human resources and sustainability initiatives require information for new metrics on issues such as usage of energy and various types of natural resources—the CIO has the tools to make a valuable contribution to the success of the company's sustainability strategy.

The CIO should already been working closely with all departments and business units within the company on various initiatives to optimize business processes and thus should be well positioned to expand those collaborations to include development and implementation of technical solutions that reduce energy costs and embedding sustainability in a wide range of activities across the organization include product design, facilities operations and transportation and logistics.[16] In addition, the CIO is uniquely experienced to provide support for the extensive changes that come from sustainability initiatives since process redesign is a fundamental requirement for many of the changes that the IT department works on when seeking to improve information flow and processes throughout the organization.

Baya and Mathaisei, writing on behalf of PwC, suggested that the CIO's contributions to sustainability efforts could be described in three dimensions that included activities that could be done almost entirely within the IT department and activities that would require collaboration with other departments within the organization and with business partners outside of the organization in its value chain[17]:

- **Embedding sustainability in IT:** Often referred to as "Green IT", this dimension includes the actions that can be taken by the IT department to measure, monitor, and manage the environmental and social footprint from the use of IT resources, both within and outside IT operations. Green IT is the cornerstone of CIO involvement, given that it is largely under his or her control, and provides the credibility needed in order to influence other departments and make contributions on the other dimensions.
- **Embedding sustainability in the enterprise:** This dimension focuses on how the IT department can assist in establishing the internal systems and processes needed to enable the rest of the enterprise to monitor, measure, and manage their environmental and social footprint. For example, internal systems and processes are commonly used to manage energy and water usage throughout the company and waste production across all facilities and internal operations.

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[16] M. Greenlaw, "Why the CIO Should Be Your Sustainability Champion" (August 3, 2011), https://www.greenbiz.com/blog/2011/08/03/why-cio-should-be-your-sustainability-champion [accessed October 7, 2016]

[17] V. Baya and B. Mathaisei, "The CIO's next leadership opportunity: Sustainability", PWC Technology Forecast, Issue 4 (2011), 56, http://www.pwc.com/us/en/technology-forecast/2011/issue4/features/feature-sustainability-cio.html [accessed October 6, 2016]

- **Embedding sustainability in the value chain**— The IT department can collaborate with other to collect and analyze the data needed to measure, monitor and manage the environmental and social footprint in the company's value chains. Studies have shown that members of the company's value chain have a substantial impact on the sustainability performance of the company and it is important to gain the support and cooperation of value chain members in order for the sustainability initiatives to be successful.

Specific sustainable technology activities and projects might include the following:

- IT equipment can be used to help companies design more eco-friendly products and databases created and maintained through the IT support function can make it easier for other department to assess and analyze information on materials and other inputs (i.e., "data mining") that can be used to develop sustainable products.
- Within the IT department itself, the CIO or CTO can encourage personnel to engage in conservation activities including simple things like shutting off their computers and the lights when they leave the office for the day. Such behavior also serves as a good example for other departments. The CIO should seek and analyze information from the company's facilities manager in order to identify issues with the energy efficiency of the IT equipment and make energy efficiency a performance metric of the IT group.
- Environmental impact should be a primary consideration when making IT investments and companies should take advantage of technologies and techniques that will reduce energy consumption. Examples include virtualization technologies, server consolidation, PC power management, deployment of more efficient equipment (i.e., Energy Star-certified equipment), data center efficiency, changing the configuration or layout of equipment to use lighting and air conditioning more efficiently and eliminating redundant applications.
- The IT department should be an active participant in developing tracking and reporting tools that the company needs in order to comply with its obligations under environmental regulations. For example, the IT department should be able to recommend, install and maintain customized software that is available to help companies track, manage and report the material content of their products and overall resource consumption.
- The CIO should improve asset life cycle management by implementing a formal IT asset disposal policy and take advantage of "take back" programs offered by IT equipment manufacturers and engage with life cycle asset disposal companies.
- The CIO should work with the COO and other members of the executive team to create and implement programs that make operational activities more environmentally efficient. The IT department can develop systems that reduce the amount of paper that employees need to use in order to print out documents and other records using printer consolidation and managed print services; deploy tracking systems to measure plant emissions; provide the technical infrastructure to support more telecommuting (e.g., online portals, video conferences and remote, mobile access), which reduces the amount of office space needed and reduce vehicle usage

by employees that would otherwise harm the environment); and install systems that save energy by controlling heat and air conditioning in the office.

- The CIO can mobilize the IT department to support the company's activities with respect to measuring and reporting performance on its sustainability activities.[18] Among other things, IT can develop or acquire the software and other technology that eases the process of monitoring and collecting data need for analysis of sustainability performance and the analytical tools can be used to identify opportunities and problems to be addressed in the company's sustainability strategies. Key technological tools include sensing technology, data tagging, real-time monitoring and analysis, security/privacy and cloud computing.

- The tools available from the IT department can also be deployed to contribute directly to the company's sustainability initiatives in a number of areas outside of environmental impact. For example, technology-based tools can be used to support compliance systems (e.g., supply chain management, environment, health, safety etc.), employee and customer satisfaction tracking systems, product safety programs, customer knowledge improvement systems, customer engagement via social media and mobile services. In addition, the CIO can develop ways to measure performance that go beyond compliance alone and incorporate economic, environmental and social dimensions.

- The CIO and other members of the IT department can collaborate with organizations outside of the company to promote sustainability. For example, the IT department can assist in the development of design tools for supply chain partners to ensure that design for inputs to the company's products meet its sustainability standards. Companies should also track and adopt relevant standards from industry groups that will enhance their ability to measure their own performance, and the performance of their suppliers, on use of hazardous materials, equipment and materials efficiency and socially responsible business practices. The CIO may even participate in the deliberations leading to development of standards, thus enhancing his or her reputation in the industry and gaining access to best practices of other organizations.

Given the broad range of potential activities under each of the dimensions described above, the CIO will often create a program office under his or her scope of authority to specifically schedule and manage sustainability changes. Specialists in the program office would be responsible for developing the specific tools and processes necessary for the sustainability activities to be effective and the metrics required to assess the success of the initiatives. A dedicated program office is highly recommended when the sustainability initiatives are first launch; however, the need for such an office will hopefully diminish as sustainability becomes more embedded throughout all parts of the organization and other departments assume more responsibility for measurement.

§7   Planning and implementing the sustainable technology initiative

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[18] For discussion of measuring and reporting on the effectiveness of sustainability initiatives, see "Governance: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).

A company's efforts regarding sustainable technology management should be carried out in an organized manner to ensure that the principles and goals of the initiative are clearly understood and widely disseminated within the organization and among the company's important external stakeholders. The board of directors and members of the executive team, led by the executive with responsibility for technology management (i.e., the CIO or CTO), should prepare and adopt a mission statement that includes the guiding principles for the initiative, the goals of the initiatives and guidelines for the operational procedures that will need to be implemented in order for the initiative to be successful and for progress to be measured. The mission statement should be distributed to all employees and should be emphasized repeatedly by the top leaders of the organization.

The company should scan the available models for a mission statement to develop ideas and this process includes principles developed and published by networks of socially responsible companies and environmental interest groups and mission statements that have already been created by similar companies. One good place to start is with Ceres (www.ceres.org), a non-profit organization formed in 1989 to advocate for sustainability leadership that has developed the Ceres Principles, a ten-point code of environmental conduct for business that has been widely endorsed and adopted by companies as an environmental mission statement or ethic. The Principles, which are reproduced below, obligate companies to engage in an ongoing process of continuous improvement, dialogue, and comprehensive and systematic reporting on their environmental management structures and results.[19]

(1) Protection of the Biosphere: We will reduce and make continual progress toward eliminating the release of any substance that may cause environmental damage to the air, water, or the earth or its inhabitants. We will safeguard all habitats affected by our operations and will protect open spaces and wilderness, while preserving biodiversity.
(2) Sustainable Use of Natural Resources: We will make sustainable use of renewable natural resources, such as water, soils and forests. We will conserve non-renewable natural resources through efficient use and careful planning.
(3) Reduction and Disposal of Wastes: We will reduce and where possible eliminate waste through source reduction and recycling. All waste will be handled and disposed of through safe and responsible methods.
(4) Energy Conservation: We will conserve energy and improve the energy efficiency of our internal operations and of the goods and services we sell. We will make every effort to use environmentally safe and sustainable energy sources.
(5) Risk Reduction: We will strive to minimize the environmental, health and safety risks to our employees and the communities in which we operate through

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[19] http://www.ceres.org/about-us/our-history/ceres-principles. See also "The 21st Century Corporation: The Ceres Roadmap for Sustainability" published by Ceres in 2010 as a comprehensive platform for sustainable business strategy and for accelerating best practices and performance. For further discussion of corporate social responsibility, see "Governance: A Library of Resources for Sustainable Entrepreneurs" prepared and distributed by the Sustainable Entrepreneurship Project (www.seproject.org).

safe technologies, facilities and operating procedures, and by being prepared for emergencies.

(6) Safe Products and Services: We will reduce and where possible eliminate the use, manufacture or sale of products and services that cause environmental damage or health or safety hazards. We will inform our customers of the environmental impacts of our products or services and try to correct unsafe use.

(7) Environmental Restoration: We will promptly and responsibly correct conditions we have caused that endanger health, safety or the environment. To the extent feasible, we will redress injuries we have caused to persons or damage we have caused to the environment and will restore the environment.

(8) Informing the Public: We will inform in a timely manner everyone who may be affected by conditions caused by our company that might endanger health, safety or the environment. We will regularly seek advice and counsel through dialogue with persons in communities near our facilities. We will not take any action against employees for reporting dangerous incidents or conditions to management or to appropriate authorities.

(9) Management Commitment: We will implement these Principles and sustain a process that ensures that the Board of Directors and Chief Executive Officer are fully informed about pertinent environmental issues and are fully responsible for environmental policy. In selecting our Board of Directors, we will consider demonstrated environmental commitment as a factor.

(10) Audits and Reports: We will conduct an annual self-evaluation of our progress in implementing these Principles. We will support the timely creation of generally accepted environmental audit procedures. We will annually complete the Ceres Report, which will be made available to the public.

As companies identify the areas of interest for their sustainable technology management initiative, they need to develop methods for measuring performance and commit to reporting the progress that the company is making against its performance goals. Metrics and benchmarks are the best way to ensure that everyone in the organization keeps the initiative at the top of their priority list and allows the company to quickly identify areas where more work is needed. Metrics for measuring performance on environmentally-related sustainability efforts are suggested elsewhere in this chapter and the leader of the initiative should ensure that information gathering tools are in place to generate those metrics. Performance reports, which include a clear statement of the goals and the means for measurement, should be prepared and published on a regular basis, no less frequently than annually, and should explain to readers what the company is doing and what effect the initiatives are having on the company's environmental impact, the traditional economic "bottom line" (i.e. reduction in costs) and the reputation of the company among its employees, customers and other stakeholders. Distribution should be broad and include all of the company's key stakeholders: employees, customers, suppliers, investors, regulators, environmental groups, industry associations and members of the communities in which the company operates and/or markets and sells its products.

Companies should proactively involve employees from all parts of the organization in the sustainable technology management effort by forming teams with members from

different departments to coordinate certain activities such as reduction of waste, recycling and reducing/prevention pollution. These teams, sometimes referred to as "green teams", are a great way to roll out an initiative across the company and ensure that all departments are following similar guidelines and that best practices are shared quickly and disseminated throughout the organization. In order to be successful, however, green teams need to be given the same status as other important projects such as product development and provided with support from the top of the organization as well adequate financial and human resources and opportunities to communicate directly with employees and educate them about their responsibilities. When forming the teams, provision should be made for encouraging all employees, not just team members, to make suggestions about improvements that can be made about how the company goes about basic but important tasks such as using paper products, turning off lights and equipment, recycling and waste disposal and setting thermostats. Employees should also be asked to weigh in on how the company can be more energy efficient and environmentally conscientious when design and manufacturing products. Many companies expand their reward and bonus programs to include ideas from employees that lead to demonstrable financial and social benefits. Environmental activities should be one of many ways that companies provide opportunities for employees to live healthy lives and benefit from working with the company.

Another fundamental piece of an effective sustainable technology management initiative is training and education for executives, managers and employees. It is not only important for everyone to understand how they can participate in day-to-day activities that reduce the environmental impact of the company's operations, but an effort should be made to make sure that they have current information about the economic, environmental and social trends that are driving decisions about sustainability within the company. Well-informed employees will be more motivated to participate and will have a better idea of exactly what they are doing. Educating executives and managers makes them better prepared to engage with employees and other stakeholders of the company. In particular, when company representatives are armed with the most current thinking on sustainability issues and practices, they can have more effective engagements with supply chain partners, regulators, industry groups and local communities on the company's goals and activities relating to the environment. Education can include formal training classes, distribution of articles, webinars and videos and guest speakers. Another part of education is ensuring that there is a constant stream of communication on sustainability efforts including regular staff meetings, in-house newsletters and e-mail bulletins and managers who are accessible to employees with questions or suggestions.

Finally, while engaging and communicating with external stakeholders has been referred to several times already above, there are several specific issues that companies need to consider when developing plans for interacting with customers, community members and other important players in their industries and markets. First, the company should ensure that all company representatives are adequately educated and trained on how to communicate with customers and community members about the company's sustainability efforts and environmentally-related aspects of the company's products (e.g., how they are designed, what materials are used, how they operate and how they

should be disposed). Second, companies can and should demonstrate their commitment to sustainability by getting involved with community activities including encouraging volunteerism by employees and making contributions to support local environmental groups and activities. Third, the leader of the sustainability technology management initiative, and other people from throughout the organization, should getting involved with industry groups working to develop best practices for socially responsible technology management. This is a great way to build a reputation as a leader in the field and tap into the expertise of other companies and consultants to develop ideas for improvements to the product design, procurement, manufacturing, waste management and assessment/reporting practices. Fourth, companies should continuously look for opportunities to partner with other organizations that have developed a reputation for being innovative contributors to sustainable technology.

§8   Sustainable technology ideas for small businesses

Small businesses are often surprised to discover relatively simple ways that they can modify the way they carry out their businesses to contribute to improving the environment in which they operate. Among the possibilities are the following[20]:

- Reducing consumption of energy, water and other natural resources, and emissions of hazardous substances
- Using or producing recycled and recyclable materials, increasing the durability of products, and minimizing packaging through effective design ("reduce, reuse and recycle")
- Training and encouraging staff to look for additional ways to reduce the company's environmental footprint
- Using "green" (i.e., renewable energy) power electricity suppliers and energy-efficient lighting
- Joining or starting a local "green business" club that can help local firms access conservation grants and expertise for reducing waste, water use and energy
- Considering using video-conferencing to meet a potential supplier or customer rather than always physically travelling to meetings
- Establishing an environmental management system with objectives and procedures for evaluating progress, minimizing negative impacts and transferring good practices

References and Resources

The Sustainable Entrepreneurship Project's Library of Resources for Sustainable Entrepreneurs relating to Technology Management is available at https://seproject.org/technology-management/ and includes materials relating to the subject matters of this Guide including various Project publications such as handbooks, guides, briefings, articles, checklists, forms, forms, videos and audio works and other resources; management tools such as checklists and questionnaires, forms and training materials; books; chapters or articles in books; articles in journals, newspapers and magazines; theses and dissertations; papers; government and other public domain publications; online articles and databases; blogs; websites; and webinars and podcasts. Changes to the Library are made on a continuous basis and notifications of

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[20] P. Hohnen (Author) and J. Potts (Editor), Corporate Social Responsibility: An Implementation Guide for Business (Winnipeg CAN: International Institute for Sustainable Development, 2007), 30.

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