



Encyclopedia of Environmental Management

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Sustainable Development

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Abstract

Sustainable development includes all business and community planning and operating decisions with due consideration for: (1) people—employees, customers, shareholders, community residents, or anyone that is involved or affected; (2) planet—material and energy resource management that does not hurt the environment; and (3) profits—or economics or prosperity. Sustainable development takes a different, more caring look at how people interact with themselves and how their activities affect the planet and the general well being of life for sustained economic growth.

INTRODUCTION

This entry defines sustainable development and its three basic aspects. Because sustainable development is a relatively new concept, a short history and description of the drivers that lead to sustainable development are described. Then, a sustainable energy future is presented. To be sustainable as a society requires cooperation and collaboration rather than command and control management. A very key aspect of sustainable development, social synergy, is covered. Also, because sustainable development is relatively new but essential to build a better and viable future, children from the earliest age through college need to learn to understand and apply the concepts of sustainable development. A paragraph is included that describes current efforts in the United States to incorporate education in sustainable development (ESD) in K–12 and college curricula.

Sustainable development encompasses stewardship of many areas of human and planetary life. In business, one of the key motivators is to implement sustainable development measures to be profitably successful indefinitely. To do this requires that businesses show their due diligence to both society and the environment while maximizing profits. Sustainability reporting assists businesses in assessing their efforts. Sustainability reports are both management and public relations tools. An innovative, very effective, time-tested form of sustainable development, “renting a service” rather than “selling a product,” is covered. Then, sustainable development for community vitality is described. As the sizes, types, and socioeconomics of communities vary considerably, so do all of the related aspects of evolving them to be sustainable. Reference is made to a web site that thoroughly describes all aspects. Some of the subjects covered on the web site are briefly summarized in this entry. The final section covers the vast, opening market of sustainable development in developing countries.

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WHAT IS SUSTAINABLE DEVELOPMENT?

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their needs. Sustainable development has three aspects:

1. Social (people)
2. Environmental (planet)
3. Economic (profits)/prosperity

All development affects all three aspects. All three aspects are interdependent. Thus, being mindful of these interdependencies in management and leadership decisions will result in the best overall solution—a win–win–win solution that maximizes success and minimizes any negative social, environmental, and economic costs. This is called managing the triple bottom line of people, planet, and profits. This is also called whole systems thinking^[1,2] because all relevant factors are considered as a whole. The role of engineers is to help their clients be successful. This requires integrated whole systems thinking that covers all related liabilities that a company or community (their client) may have and provides the most efficient and profitable solution to the challenge. Often, the best whole system solution is also the most efficient and most sustainably profitable.

The environmental (planet) aspect is significantly affected by energy consumption and management, including: the entire national power infrastructure and distribution, transportation, plus the construction and renovation of all residential, commercial, and industrial facilities.

HISTORY, ENVIRONMENTAL DEGRADATION, AND NATIONAL SECURITY

During the last century, while fossil fuels were abundant and cheap, those fuels fulfilled a majority of our energy

conversion needs. The mounting problem is that combustion emissions have fouled the environment in a number of ways, resulting in increases in respiratory illnesses, mercury pollution, and a rise in global temperatures. The quantity of easily retrieved fossil fuels is significantly depleted. Coal is still relatively abundant, but it does not burn cleanly. Technologies need to be developed to both mine the coal safely and to burn it cleanly. Regarding petroleum, many countries that are not friendly to the United States control most of the remaining easily extractable sources. Many national security advisors have indicated the urgency of severing our dependence on foreign oil as a part of an overall strategy for the security of the United States and as a means to prevent oil-related conflicts.^[3,4] It is also apparent that there is a need to protect and allow the environment to regenerate. The effect of using fossil fuels extensively and inefficiently is that we are simultaneously poisoning the environment and ourselves. Nuclear power emissions are clean, but the nuclear power industry has significant obstacles such as storage of radioactive wastes for many thousands of years. In addition, there are security concerns to safeguard radioactive material from being stolen for production of atomic weapons.

Governors and mayors are taking action to implement clean energy technologies. In response to clear signs of increased cost from continuing to use fossil fuels and scientific evidence showing that by burning fossil fuels we are initiating a possibly devastating global warming trend^[5] that could flood coastal cities, disrupt the food chain, and change climate patterns significantly, many states have taken the initiative and enacted renewable energy portfolios to fund the transition to renewable energy resources. Many remaining states are in the process of developing their own renewable energy portfolios. These renewable energy portfolios provide significant state- and utility-sponsored financial incentives for the commercial, industrial, and residential use of renewable energy systems and fuels. On the city level, many mayors from major cities around the world have made commitments to cut greenhouse gas emissions to slow the rate of global warming.^[6] Many of these cities are coastal and could be severely impaired or destroyed from rising sea levels from global warming. So, civic action to switch to cleaner energy options is beginning in earnest.

ENERGY FUTURE

What this means to energy engineers is that petroleum-derived fuels are on their way out over the next half century. Hydrogen (where the hydrogen is derived from renewable energy sources), ethanol, biodiesel, and other forms of renewable fuels are on their way in. Direct and indirect conversion of solar energy, including wind, biomass, wave/tidal power, and small-scale hydroelectric power will increasingly be part of the energy infrastructure

that energy engineers will design and build. The bottom line with energy is that it needs to be relatively nonpolluting and indefinitely available. It is a very dynamic time for energy engineers as the entire, worldwide energy picture transitions to clean renewable technologies. This will eventually add a lot of stability to the world economy, the world political environment and to everyone's lives. The stability will come from the fact that renewable energy technologies can be used to tap the natural energy resources that are available everywhere. Stability will also come, as the environment regenerates, the climate stabilizes and resources remain available for our sustenance.

HOW WE SOCIALLY AND PROFESSIONALLY INTERACT WITH EACH OTHER DETERMINES OUR DEGREE OF SUCCESS

Another aspect of sustainability has to do with how well we interact and collaborate. In the past, management of most activities was by a top-down hierarchy. Now humanity is evolving and it is driven by high levels of sophistication in technology and communications, which has resulted in individual knowledge and skill level increases. Plus, many families are now structured such that individual adults and children are taking more independent responsibilities for the many aspects of their lives. This has all created a desire by many people to be more intimately involved in solutions rather than just letting someone else do the thinking. In this new economy, teamwork and open communication are important to bring all stakeholders together, whether in a business or community, to manage by consensus and cooperation. Everyone affected should have the opportunity to be involved in the solution, even if just by being informed as the planning and decision-making are in process. The outcome then is one that promotes efficiency, for the simple reason that all persons affected are involved, which promotes enthusiasm and "buy-in." Typically with this process, more work and time are invested up-front such that all aspects are considered and thus everything proceeds more efficiently down-stream.^[7]

CREATIVE, COOPERATIVE, DESIGN AND PLANNING TEAMWORK^[2]

The ASHRAE GreenGuide recommends "integrated design teams" that have all of the design, economic, planning, and other related disciplines involved up-front to create better designs. If this process is not used, design typically proceeds in a series of "handoffs" that tend to compound problems, as each succeeding team designs "around" any incompatibilities that the previous designers have already finished. This adds unnecessary complexities and inefficiencies, which increase construction and life-cycle costs. Through coordination and the collaboration of designers,

architects, engineers, and key players, an integral design can be created that functions as an efficient system and not as a collection of parts that are force-fit together. This approach has enabled design teams to design very energy efficient, comfortable, aesthetically and environmentally friendly buildings at or less than the conventional price per square foot of traditionally designed buildings. So, working as a team from the beginning is the most efficient way of designing because potential conflicts are resolved up-front rather than later at a higher cost. Effectually, when people are creating and they know that their contributions are respected, superior planning and designs are achieved. The upfront work of coordinating planning and brainstorming sessions with many people of diverse backgrounds can be a challenge. However, the results and life-cycle costs are almost assuredly optimal.

EDUCATION

The United Nations has declared the decade from 2005 to 2014 as The Decade of Education for Sustainable Development.^[8]

There are many national teams around the world that have taken the lead to work across the educational spectrum—including public and private education, primary and higher education, independent, charter, and home-schooling—to incorporate ESD in their curricula. The U.S. Partnership for The Decade of Education for Sustainable Development^[9] was formed to facilitate implementation of ESD in the United States.

Effective education can demonstrate the inter-relationship and interdependence of people, planet, and profits in all life activities. We have the technology to transition to a clean energy future and to manage materials in a cyclic manner. We know that pollution is causing global environmental change. We also know that teamwork and cooperation get better results than working in a hierarchical or isolated manner. Education in sustainable development will show that the current “consume and throw away” economy no longer works for the benefit of humanity and life. Rather, there is a need for cyclic, whole-systems thinking that integrates all relevant factors into the best, longest lasting results.

SUSTAINABILITY REPORTING

Realizing the importance of being “sustainable” and understanding that they are good long-term investments, many companies are developing sustainability reports. These reports are strong management tools that show how well a company is progressing with their sustainability, their corporate social responsibility (CSR), and their goals to continually improve. They provide an openness that stakeholders (employees, stockholders, regulatory agencies,

customers, and community leaders) expect so they know if a company is a good place to work, a good investment, or a good neighbor. These reports are available to the public (free download).^[10] For engineers, preparation of sustainability reports involves the collection and analysis of energy and environmental data. Demonstration of energy savings plans and associated pollutant emission reductions can have significant public relations and market share value. This can promote higher sales and flow of investor capital as companies prove their social responsibility and long-term viability.

“High 5!—Communicating your Business Success through Sustainability Reporting—A Guide for Small and Not-So-Small Businesses,” from the Global Reporting Initiative, describes the benefits of sustainability reporting:

Sustainability reporting has many advantages that benefit different areas of your business. Some benefits are purely financial while others deal with customer or employee satisfaction. Sustainability reporting helps organizations identify and address their current and potential risks, saving time and money in the short and long term. As the public becomes more aware of your efforts, customer loyalty and credibility of your business will greatly increase. When you take a deeper look into your daily business operations through sustainability reporting you will be able to discover new opportunities.

Businesses continuously seek to generate income and acquire a competitive edge by identifying new market opportunities and determining current and potential risks. When your organization embraces a sustainability perspective, i.e., simultaneously addressing social, environmental and economic issues, you can benefit from cost-savings and improvements in product quality and employee performance.

When considering how to improve financial performance, many organizations only look at financial aspects, such as the cost of purchasing goods, personnel costs, or tax payments. However, working on environmental and social issues can also positively affect your financial bottom line.

Sustainability reporting is the way to identify these potential benefits and realize the economic gains. It helps you achieve your business goals by setting up a continuous improvement process based on target setting and progress measurement. All in all, sustainability reporting helps you to acquire that competitive advantage.

RENTING VS. BUYING (A SUSTAINABILITY INNOVATION)^[11,12]

Here is an example of systems thinking to ensure that a product has minimal environmental impact plus high social and economic value:

In today’s consumer/throw-away economy, typically a product is manufactured and sold. There is producer incentive to minimize the use of labor and material resources put into a product, thus saving on cost. The

product is sold as cheaply as possible to maximize sales. The product eventually wears out and is disposed of. A product that breaks and is disposed of soon after its warranty period is best for sales, so that a consumer will go out and buy a replacement. This is obviously a wasteful scenario, which is prevalent in commerce today. However, that is changing.

A more efficient scenario that many companies have successfully deployed for years is to manufacture and rent a product. Then, there is an incentive to maximize the utility and life of the product, thus ensuring an income to the owner/renter for as long as possible into the future. (This is what sustainable development is all about—maintaining economic flow for as long as possible into the future.) When this product is manufactured, due care in manufacturing processes and sufficient material are used to maximize durability, reliability, and longevity. Customer satisfaction is high from having a reliable product, which also builds name recognition and increases desirability. The product is designed to be easily maintainable, again, to maximize longevity, and also to facilitate dismantlement of the product when it has come to the end of its useful life. Thus, the parts can be easily remanufactured and reused or segregated for efficient recycling of the raw materials. So, maximum utility and income is achieved from the product, and most of the resources that went into manufacturing and maintaining the product throughout its life are recycled with minimal impact to the environment.

So, engineers with sustainable development in mind might be thinking of the “rented” product scenario, which is inherently efficient, rather than the “sold” product scenario, which is inherently wasteful. For example, Interface, Inc., the largest carpet manufacturer in the world and a company that has committed itself to be as sustainable as possible, is using this renting concept in its products. They rent carpet tiles. As the carpet eventually wears, tiles are replaced and recycled to make new tiles.

COMMUNITY DEVELOPMENT TO DECREASE ENERGY COSTS^[13]

Over the last three-quarters of a century, there was an assumption that gasoline and diesel fuel would be cheap and plentiful, indefinitely. Thus, urban sprawl developed because of the low cost of owning and operating one or more cars. This is not the case anymore! Now, with the realization that cars are expensive to both purchase and operate, there are efforts by many cities to re-establish neighborhoods that have all of the amenities needed for occupants all within a short distance that can be covered on foot, with a bicycle, or with convenient public transportation. These cities are excluding automobiles from certain areas and some are charging admission fees for cars to enter semirestricted areas. This has helped to revitalize many city commercial districts because of the park-like feeling of being in these areas without the noise and exhaust from

cars. With the economic benefits that have been realized by these arrangements, more and more urban and suburban cities are pursuing these types of commercial district renovations in their cities.

Obviously, society has made a major investment that established urban/suburban sprawl. That investment now needs to be made sustainable. Consequently, there will be major investments in clean fuels such as biodiesel, ethanol, and renewably derived hydrogen to power the huge fleet of vehicles in the United States. A remaining economic burden to maintain suburban living is the maintenance of roads. However, that may be relieved as convenient, modern, and cleaner public transit busses, trains, and other guided vehicles are developed into transportation networks, thus decreasing the number of cars on the road. Energy engineers will be integral to this transition in transportation.

So, the paradigm for energy engineers will evolve as community structures around urban and suburban cities change and improve for energy efficiency. There will probably be a tendency to create nodes, where residents have a majority of the amenities nearby. Then, clean, comfortable, energy-efficient public transportation and express lanes for cars will connect each node.

OVERVIEW OF THE MANY ASPECTS OF SUSTAINABLE COMMUNITIES INFRASTRUCTURE AND NATURE

The web site <http://www.conservationaleconomy.net/INDEX.CFM> (courtesy of the Ecotrust) summarizes the many and various aspects of sustainable communities and preserving our natural assets. Many social factors that play a role in the culture and systems changes associated with sustainable development are thoroughly explained on the web site. Engineers should know these social interactions, which are cohesive and essential to sustainable communities. Readers are encouraged to visit the web site to get a flavor of all of the aspects of sustainability or to narrow in on aspects that are of particular interest to them. The following is a narrative summary of some of the entries on the web site:

A conservation economy describes how social capital, natural capital, and economic capital can be synergetic and sustainable.

Social capital covers fundamental needs, which include: the strong need for local sources of food; accessible, healthy shelter; healthy environment and access to healthcare; plus access to knowledge about the interconnectedness of us to our environment and to each other. The section on community discusses collaborative processes that honor: social equity, which promotes prosperity for all; security from fear and violence; recognition of the wealth and strength in our cultural diversity and establishment of a will to preserve it; plus, local celebrations to honor a sense of place with the community and environment. It

proceeds to describe the importance of enjoying beauty and play, to relieve stress from our busyness; learning to welcome transitions that improve communities as a whole; and establishment of civic society where all residents can manage their communities collaboratively.

Natural capital includes the atmosphere, biosphere, and earth. To sustain it requires ecological land use, which includes connected wild lands, in which indigenous animals, plant and people can coexist together. Protected core reserves can be set aside for native plants and animals to thrive, without interference. Wildlife corridors can connect reserves such that animals may migrate freely and parks can be established to act as buffer zones between developed and undeveloped areas. Productive rural areas can be re-established through: sustainable agriculture, which does not cause runoff of pollutants into streams and is more in harmony with natural processes; sustainable forestry, which thins rather than clear-cuts stands of trees; sustainable fisheries, which establish quotas, such that species are not depleted; and eco-tourism, to provide natural getaways and education for people that want to learn more about sustainability and to be close to nature. Compact towns and cities, with human scale neighborhoods, green buildings, convenient transit access, ecological infrastructure, and urban growth boundaries will create healthy, vibrant communities.

Economic capital in healthier communities and commerce will tend to expand through synergies with social and environmental capital, thus building prosperity.

ENERGY ENGINEERING FOR DEVELOPING COUNTRIES^[14]

Approximately four billion of the six and one half billion people on the planet live in extreme poverty, where a poor sanitation infrastructure results in disease, there is minimal economic productivity, and there is significant economic burden on governments and aid agencies. However, recently, it has been found that given some of the modern necessities such as water wells, electronic communication, and dependable energy, people that are impoverished can quickly and enthusiastically become productive to their communities and not be an economic burden.

The use of small photovoltaic power systems in villages has literally energized villages into minieconomic zones of relative wealth and flow of capital, thus creating self-sufficiency rather than dependence. Just providing electricity for lighting, water pumps, and small power tools can tremendously boost the productive capabilities of a village.

The establishment of cell phone repeaters and wireless infrastructure is much less expensive than running miles of telephone cable. A limited number of cell phones in villages have also promoted prosperity because farmers and

merchants can effectively communicate and market their products.

As developing countries continue to develop, water, energy, and communication will be vital to their success. So, energy engineers will be a key part of this process. Many multinational and small companies and financial institutions are tapping into bringing these four billion people into the world of commercial success and out of the world of poverty. So, engineers will play an important part in this next major step toward a sustainable world.

CONCLUSION

Though we are just now seeing the start of a transition to sustainable development, it is clearly economically, ecologically, and socially advantageous to choose this means to success, prosperity, well-being, stability, and peace. We have an abundance of all of the material and energy resources we need. We have the ability, knowledge, and conscience to do the best for humanity, all of life, and the planet. We have the inspiration and insight to transition to a sustainable world. Now all it takes is the willingness to accept change and make the transition to sustainability. The outcome will be a world that is more prosperous and stable than it is now. Sustainable development is a goal to embrace and make part of our daily decisions.

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