GSA Office of Governmentwide Policy

APPENDIX

The New Sustainable Frontier

PRINCIPLES OF SUSTAINABLE DEVELOPMENT

September 2009

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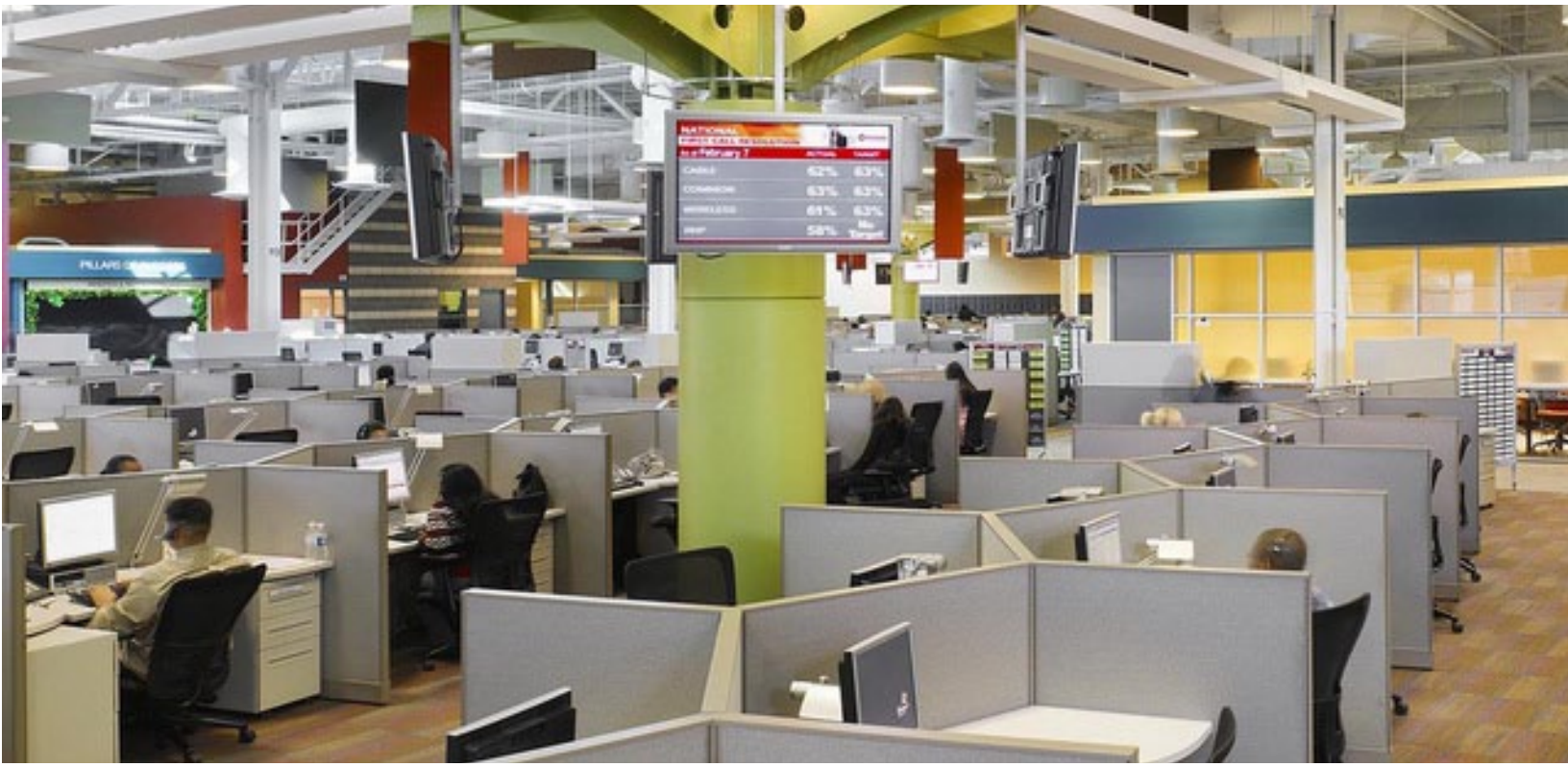

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introduction

Since the original "GSA Real Property Sustainable Development Guide" was published in 2000, we have seen education and awareness increase public understanding and add a sense of urgency to the idea that sustainability is not just a better way to do business, but an absolute necessity. And while new product and building rating systems are helping to transform the way we live and work, we remain far from achieving a steady state of sustainability.

Operating sustainably will require reexamination of our everyday practices and tools with our closed-world limitations in mind.

In this section, we begin to consider case studies and tools in the context of the principles of sustainability:

1. Sustainable Scale – defined by the Earth's finite limits, in which efficient allocation and just distribution must be maintained, if a stable, steady-state economy is to be attained,
2. Just Distribution – that allocates the Earth's finite resources so that all can live with respect, and,
3. Efficient Allocation – the basis of traditional economics, which maximizes the utility of resources through a properly functioning marketplace.

While we were unable to identify examples that systematically apply all of these principles, we hope those that follow will help to illustrate ways these ideas can be applied to a more comprehensive approach. Future case studies should deliver the closed-world system we envision.

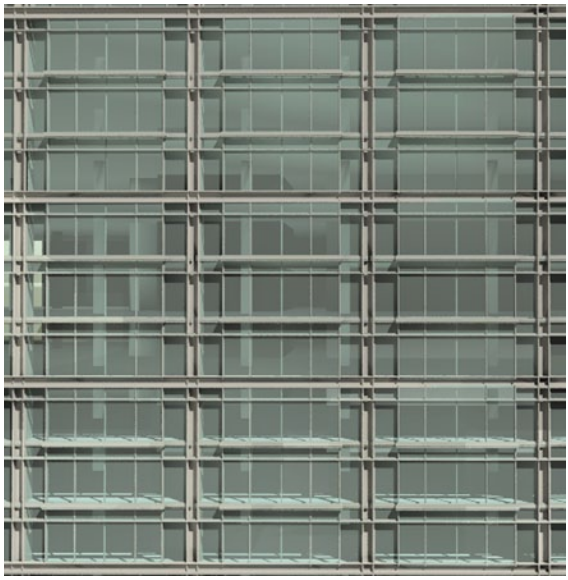
"Achieving sustainable government operations and a sustainable world, depends on eliminating our adverse impacts on the environment – getting to "net zero" - by reducing natural resource and energy use, eliminating toxics and greenhouse gas emissions, and restoring public goods such as ecosystem services. It also depends on achieving environmental goals in a manner that supports the Government's social goals.

Once we understand the principles of sustainability, we can begin to incorporate them into our daily practices. This does not mean that we must have a complete knowledge of every aspect of every product or service we use, but it does require that we understand the principles of sustainable development, articulate our goals clearly, and ask the right questions of those who should know every aspect of every product or service: the producers and providers."

"The New Sustainable Frontier: Principles of Sustainable Development" (September 2009)

buildings

700 sixth street



700 Sixth Street is an office building in a dense, mixed-use neighborhood with easy access to amenities: shops, restaurants, housing, major bus routes and a Metro Station.

By locating this 12 storey office building downtown, Akridge was able to provide future occupants an abundance of commuting and housing choices potentially helping tenants retain staff, and minimize carbon emissions by promoting sustainable modes of transportation. Bike racks and a gym with showers were included, as well as ten percent of parking reserved for alternative fuels and car sharing vehicles.

The 700 Sixth Street site was originally a brownfield, with underground gasoline tanks, which required removal and remediation of 8,700 tons of contaminated soil. Commercial development on brownfield sites and within urban centers minimizes use of greenfields and natural resources, and maximizes use of existing infrastructure, reinforcing the maintenance and improvement of existing development. Additionally, its location is more convenient for visitors and contributes to the support of nearby businesses.

At approximately 13,000 sq. feet, 700 Sixth Street's green roof is the largest green roof on a privately developed building in Washington, DC. The green roof will capture, filter, and re-use rain water for landscaping, diverting it from the municipal sewage system. Washington, DC, like many older cities, has a combined sewage and storm water system. During storm events, the system is often overwhelmed and sewage is released into the local waterways causing environmental damage and creating a public health hazard. Use of the green roof reduced the amount of impervious surface area previously on the site, thereby reducing the burden on infrastructure.

The green roof also mitigates the heat island effect - an increase in temperature due to the concentration of surfaces that absorb the heat from the sun. In some cases, temperatures can be 15 degrees hotter than the surrounding areas. An added benefit is the outdoor deck, which provides for the enjoyment of building occupants adjacent to the green roof area.

Thermal performances of the building envelope, specification of efficient light fixtures, and the use of occupancy sensors and timers for lighting controls, contribute to a 17.5% reduction in energy use below the ASHRAE/IESNA standard 90.1-2004. Low flow plumbing fixtures, waterless urinals, and automatic controls reduce water usage by 40%. This project is currently targeting a LEED CS v2 Platinum rating.

Architect/Designer
HOK Architects

Owner
The John Akridge Company

Developer
The John Akridge Company

Completed
Spring 2009

Project Area
300,000 sq. ft.

birmingham social security center

The Birmingham Social Security Center is a nine-storey commercial building anchoring the edge of Birmingham's Civil Rights District.

The Social Security Administration (SSA) redeveloped an existing Brownfield lumber yard using a multi-criteria assessment process to guide the building's design toward achieving LEED Silver certification. As a result, the project team realized fundamental elements such as open work areas, refurbished work stations, daylighting, and a highly efficient mechanical system were essential to a sustainable space.

High ceilings allow for ease of flexibility in re-configuring the interior layout and the design meets its target of a 30% reduction in energy use from the baseline model. The mechanical system includes an energy recovery entropy wheel with under-floor delivery and controls for approximately every 2.5 people. The exterior horizontal shades on the south facing elevations of the building reduce the cooling load without diminishing the daylight and views. The lighting fixtures use daylight responsive lighting controls to maximize the energy savings. The client's requirement for blast windows also benefits the staff because of additional acoustical insulation from the outside and it is a better filter of UV light than standard glazing.

The final product enhances collaboration amongst staff by integrating different types of meeting spaces. Dubbed, the "Main Street," a double height concourse traverses the site from which the staff can access the cafeteria, bank, shops, business center, etc. At each floor there is a staggered floor plate area adjacent to the elevator core to provide double height shared amenity spaces called "Neighborhood Centers" or "Family Rooms".

Low flow fixtures and automatic controls reduce potable water-use by 50%. Fabric canopies at the top deck of the parking structure give architectural interest, shade parking spaces, and divert rainwater to an underground cistern. The water is then used for landscape irrigation.

The lower roof is planted with an extensive green roof to reduce storm water runoff and reduce wear and maintenance on the roofing membrane.

Architect/Designer
HOK Architects

Owner
GSA

Developer
Opus Architects and Engineers, Inc.

Project Area
595,338 sq. ft.

Completed
February 2008

college of dupage health & sciences center

Located in Glen Ellyn, Illinois, the College of DuPage (COD) is the largest single campus Community College in the US. The new consolidated laboratory and classroom reflects the College's Facility Master Plan which mandates energy and water reduction targets and requires environmental stewardship through the use of the LEED Rating system.

Use of prairie and native plants throughout the project ties the Health and Sciences Center into the surrounding prairie system that serves as both dedicated open space and as a teaching tool for the natural environment. The prairie system also plays a vital role in the university's overall stormwater master plan. Its design slopes to a campus-wide storm water detention pond system, treating the water along the way and eventually providing 100% of the campus' irrigation needs. All site irrigation is provided from the rain water detention ponds located just south of the building. The design team specified native and adaptive species of prairie grass to ensure conservation of the non-potable water source. The native vegetation and rain water detention ponds effectively treat pollutants and suspended solids from all site rainfall before it can be reused for irrigation.

The building is oriented for solar design; together with shading, punched windows, and efficient window glazing, the Health and Sciences Center has reduced cooling loads in the summer and heating loads in the winter. The lighting fixtures adjacent to the exterior walls have daylight sensitive controls; there is a displacement of ventilation system at the atrium and, heat recovery wheels as a best management practice; and photovoltaic panels are on the roof. Such strategies allow the energy management system to realize a 26% improvement from the ASHRAE 90.1-2004 baseline.

The use of low flow bathroom fixtures throughout the building results in a 34% potable water-use reduction from EPA baseline numbers. The College of DuPage Health and Sciences Center is targeting a LEED NCv2.2 Gold rating.

Architect/Designer
HOK Architects

Owner
College of DuPage

Developer
Gilbane Building Company

Project Area
595,338 sq. ft.

Completed
Summer 2009

constitution square

One and Two Constitution Square are commercial office buildings that comprise part of the initial phase of a 2.5 million square foot mixed-use project at the heart of the NoMa (North of Massachusetts Ave) neighborhood in Washington DC.

This site was previously a contaminated train yard requiring extensive soil re-mediation. Today, workers and visitors have multiple travel options as alternatives to driving. The newly opened New York Avenue Metro stop and elevated bike trail is adjacent to the site as well as major bus routes conveniently located within a couple of blocks. Designers made available bicycle storage, changing rooms, showers and a gym as well as preferred parking spaces for alternative and fuel efficient vehicles.

Both buildings feature extensive green roofs. They cover more than 50% of the building footprint and divert 25% of stormwater from the municipal system. At the ground level, low impact development (L.I.D.) planting beds capture and treat all of the stormwater routed from hardscape areas. Potable water demand is reduced 40% below the building's baseline through the use of low flow plumbing fixtures and by taking advantage of condensate captured from the roof top air handling systems and cooling towers. This water is used as an onsite greywater reclaim system to flush water closets and urinals in the building's core. Electricity use is reduced with the installation of energy efficient lights with daylight sensitive light controls and there are motion detectors to control the lights and CO2 detectors to control the HVAC settings both of which reduce energy use.

The facades feature high-performance glazing in aluminum-framed windows and curtain walls. The curtain walls primarily face North to limit excessive heat gain. The East, South and West facades feature large punched windows and pre-cast concrete columns and spandrels to provide shade and thermal mass. All of the buildings' exterior materials are quarried, sourced and fabricated within 500 miles of the project site. 74% of the construction waste will be reused or recycled and diverted from landfills. Finish materials such as: gypsum board; tile; carpet; and fabric wall panels; have a high post consumer recycled content, are sourced regionally, and contain low volatile organic compounds (VOCs) to improve the indoor air quality. Both Constitution Square One and Two are targeting a LEED CS v2 Gold rating.

Architect/Designer
HOK Architects

Owner/Developer
Stonebridge Associates

Project Area
367,230 sq. ft. (One CS)
642,230 sf (Two CS)

Completed
Spring 2010

fairfax village neighborhood center

The Fairfax Village Neighborhood Center is the first military project to attain LEED NCv2.2 platinum status. The master plans entails a smart growth design to reduce automobile usage as well as the preservation and restoration of open land. Additionally the design fosters a sense of community by creating a central core that encourages interaction. Compact development was essential; Fort Belvoir was expected to gain an estimated 19,300 additional employees in response to the Base Realignment and Closure Act (BRAC) of 2005.

Through the use of bio-retention ponds, extended detention basins, stormwater is naturally filtered and reduced through planted areas before being released into the municipal system. The enhanced quantity and quality stormwater controls reduce the flow of phosphorous and other contaminants and prevent erosion. Cleaner storm water for this site ultimately means cleaner streams and rivers to the Chesapeake Bay watershed.

The residential design include soy products to provide insulation. Energy-efficient compact fluorescent lamps provide lighting and solar panels and geothermal heat further reduce energy consumption. Granite-looking countertops are made from recycled aluminum shavings and cabinet faces come from wheat stalk while the units are made from sunflower husks.

Every new home is an Energy STAR certified house which means that the exterior envelope is better insulated and has less air infiltration than a house built using contemporary standards.

Fairfax Village is a 3,770 square foot building that incorporates features such as: floors made of salvaged wood, furniture that is salvaged and refurbished, kitchen cabinet doors made of sorghum stocks, kitchen countertops made of recycled metal shavings, millwork made of sunflower seed hulls, and counter tops in the great room made of recycled paper.

Architect
Torti Gallas and Partners

Interior Designer
HOK Architects

Owner
US Army Corps of Engineers

Developer
Clark Realty Capital and Pinnacle of Seattle

Completed:
Summer 2009

The terrazzo tile on the bathroom floors contains recycled glass, the lobby floor is made of recycled porcelain tile, and the bathroom countertops are made of recycled plastic. The conference room floor is made of bamboo, 50 percent of the wood used in the project was Forest Stewardship Council (FSC) wood and brick was salvaged from existing buildings on site.

Energy saved is 60 percent below the ASHRAE standards. The on-site solar-generated electricity provides 22 percent of the electricity used by the building. Highly reflective roofing and a ground-source heat pump HVAC system with on-site vertical wells also contribute to the savings, along with efficient control systems and thermostats. Interior lights are controlled by occupancy sensors, while on the exterior full cut-off lights promote dark skies and reduce light pollution.

All paints, carpets and sealants were low-emitting. All of the composite wood products used contain no added urea-formaldehyde. Carbon dioxide monitoring devices ensure proper outside air ventilation, while potential contaminants are contained in areas such as the janitor's closet or the copy/fax room. Refrigerants and other chemicals used in the building are also low-ozone depleting.

nasa building 29

Architect/Designer
HOK Architects

Owner
NASA

Developer
Gilbane

Completed
EST Fall 2009

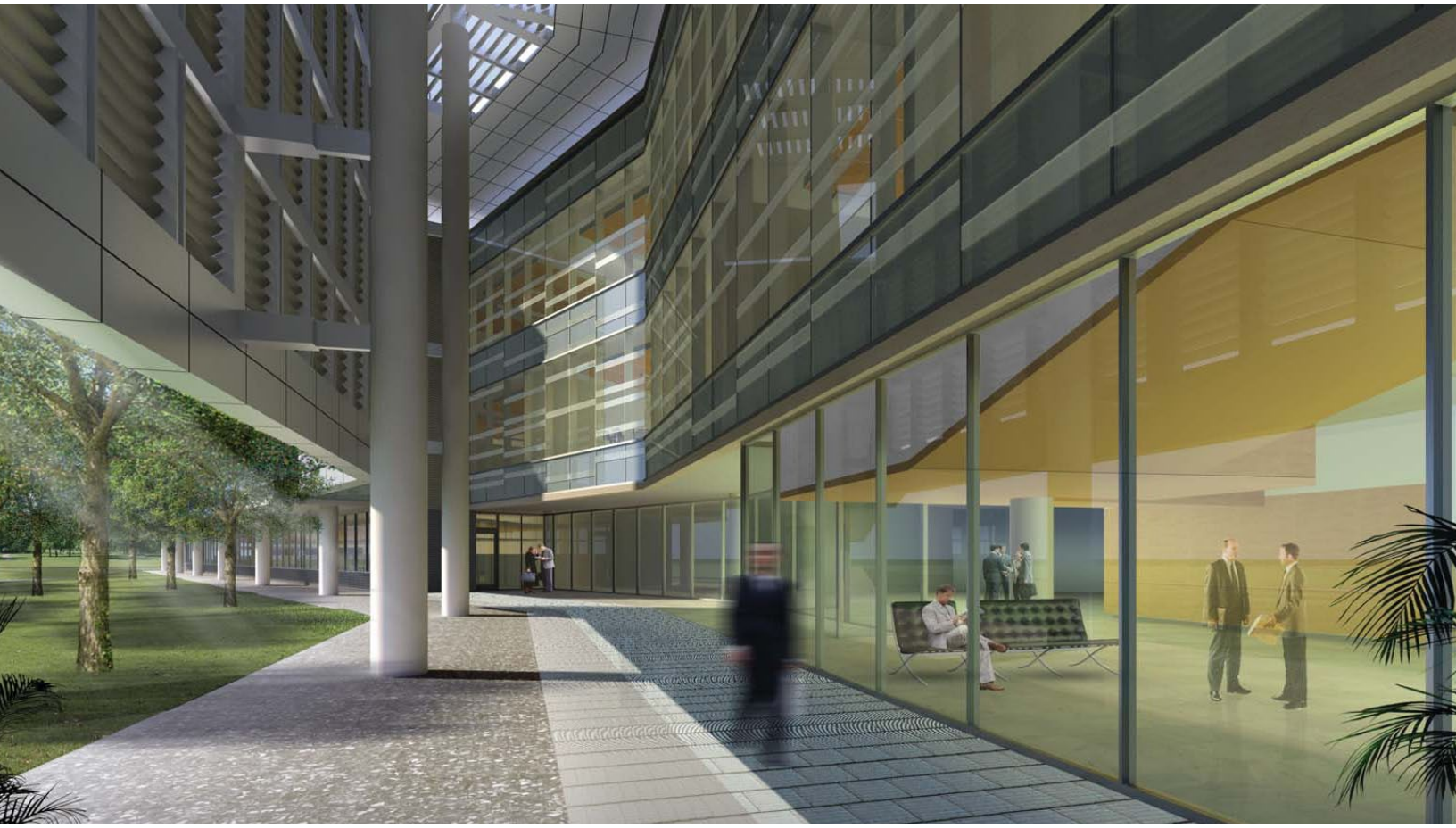
Project Area
88,500 sq. ft

Building 29 is the first new construction as part of the 2004 Implementation Plan expansion at the Johnson Space Center (JSC). The office building will provide space for approximately 520 people. One third of the space in the new building is for permanent relocation and the other two thirds will act as swing space for transitional employees as other buildings located at the Space Center are renovated.

The client initially assumed the new building would be over 100,000 square feet; however, through efficient planning, close analysis and deep understanding of the client's needs, the design team reduced the programming area by over 10%.

The site was carefully selected to be in the middle of the JSC campus located on what was a large existing surface parking area near shuttle routes and amenities in lieu of available Greenfield space. Parking spaces for building 29 were reduced and enhanced with landscaping to provide shading and pervious pavement. A bio-retention zone adjacent to the building will manage stormwater and provide a garden for building occupants.

The building floor plate is a bent bar with the long facades facing North and South and reduced glazed areas on the smaller East and West elevations. Glazed areas were minimized and exterior sun shades will further reduce the cooling load needs. There are solar panels on the roof which provide 100% of the domestic hot water heating. The thoughtful passive approach to the exterior envelope and building orientation works with the highly efficient mechanical system to exceed the target energy savings to 57.8% better than then ASHRAE 90.1-2004 baseline.



The Mechanical system includes an under floor delivery system, a heat recovery wheel, night temperature setback, ventilation demand using CO2 sensors, and direct digital controls.

The lighting design was also developed to minimize energy use with the incorporation of daylight responsive controls, occupancy sensors, timers, sensors, override switches, energy efficient lamps and high efficiency fixtures.

Water reduction and reuse were also goals. Low flow fixtures are planned throughout the building and condensate will be collected from air handling units for irrigation use. It is expected that during the hottest times of the year as much as 1000 gallons a day can be captured during peak cooling demand in the summer. This strategy coupled with the use of native and adaptive vegetation means that no potable water is used for irrigation. NASA building 29 is targeting a LEED NC v2.2 Silver rating.

noaa

NOAA's series of curving wings mimics natural systems. Accordingly, the project's objectives include an environmentally sensitive, architecturally innovative and distinguished design using sustainable principles and best practices. Vertical and horizontal circulation, shared-use functions and the atrium are designed to encourage informal interaction between scientists and administrators.

The Design enhances the mission and values of the building user by minimizing the environmental impact of the new facility through a series of sustainable design strategies: water-sensitive site design; bio-retention; optimizing energy performance; daylighting and views; increased thermal comfort and control; enhancing indoor air quality and selecting building materials and finishes with a low life-cycle environmental impact.

Although there are no naturally occurring water features on the site, the landscape design creates a series of "Rain Gardens." These consist of pools, bioswales, rock gardens and planted areas in a semi-natural configuration that are both decorative and functional. The gardens and bioswales collect surface water runoff from the parking areas as well as overflow from the green roofs is needed. Depending upon the amount of rainfall these gardens can be wet or dry, and the water is designed to flow from one area to the next.

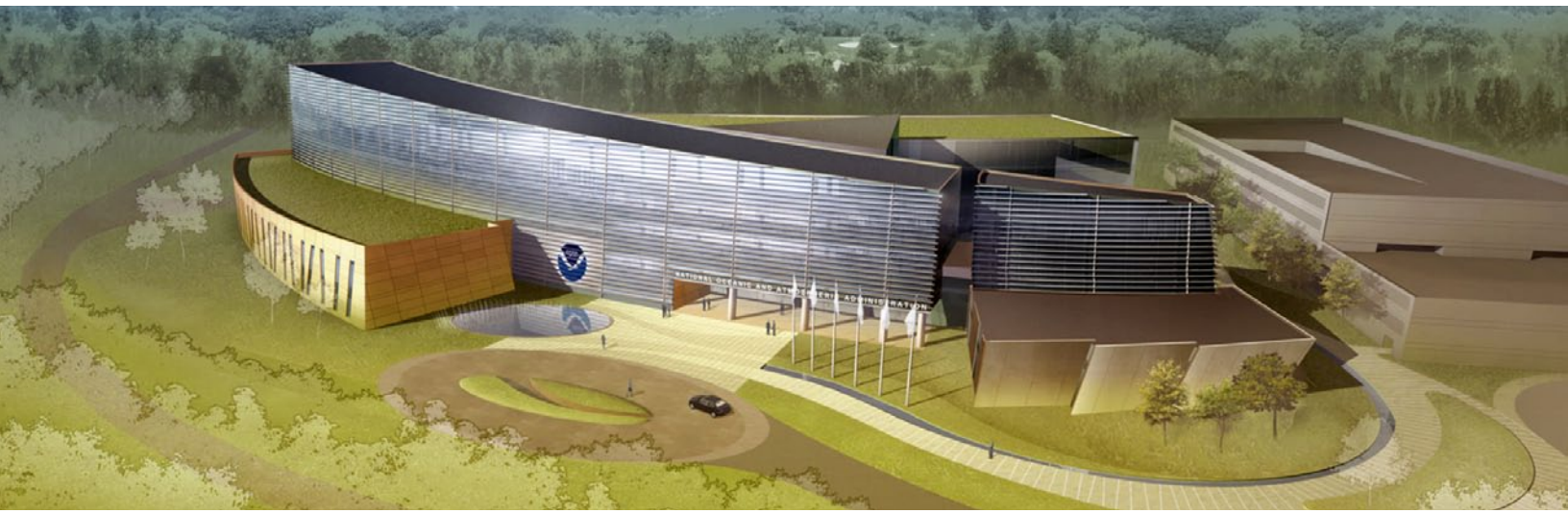
Architect/Designer
HOK Architects

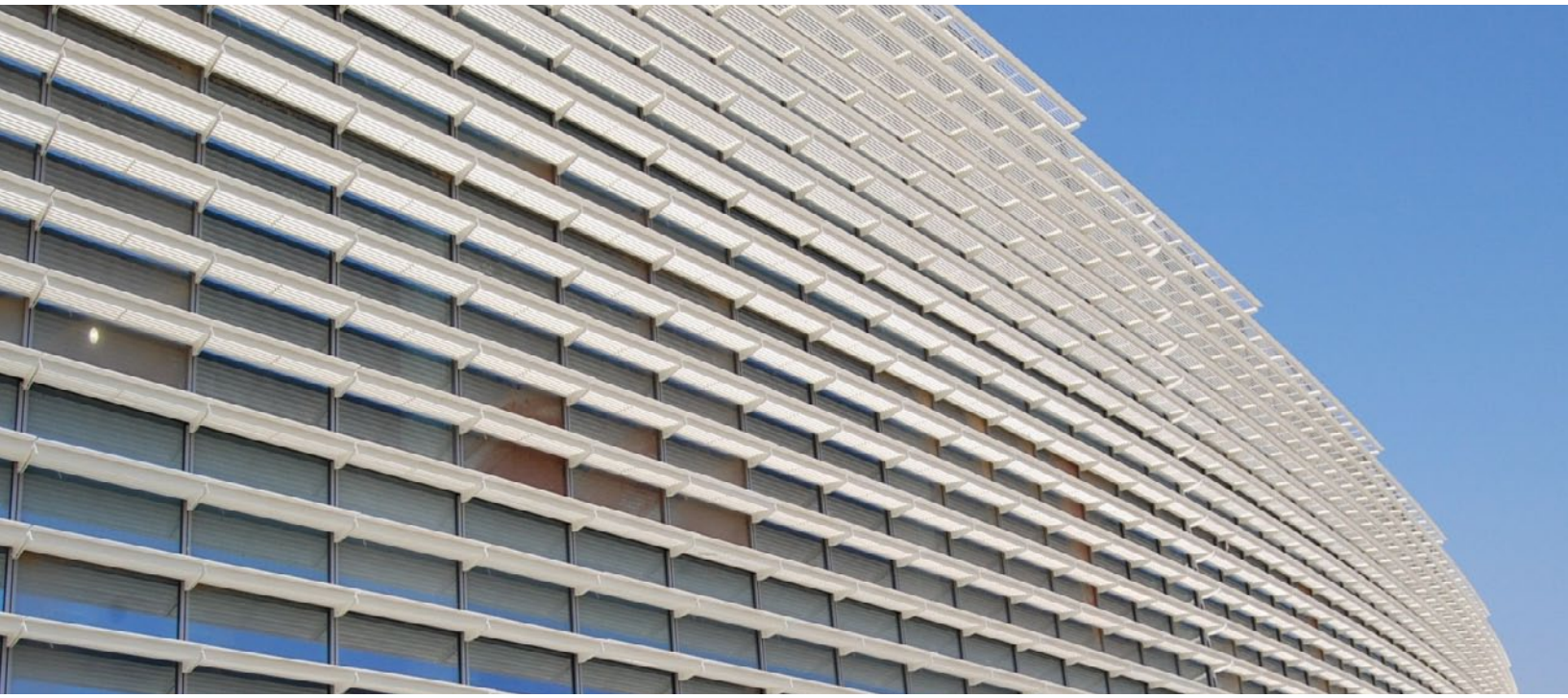
Owner
NOAA

Developer
Opus Architects and Engineers

Project Area
268,762 sq. ft.

Completed
EST Fall 2009





The main point at which water from the roof is collected is a unique waterfall scupper designed as a piece of landscape art and located between the main entry to the facility and the central atrium space. Over 50% of the roof surface is covered with an extensive green roof and the roofs are designed with as much consideration as the facades.

The project is in the watershed of Paint Branch Creek which is a tributary of the Anacostia River. In conjunction with the bio-retention areas on site, the green roof will improve the quality and decrease the quantity of the stormwater that enters the local systems. Maryland and Virginia as well as the District of Columbia view green roofs as one of the best strategies to help meet the EPA clean water rules.

Intelligent building technologies will actively respond to its occupants and environment. All of the engineering and data systems within the building will be integrated and controlled by the Building Automation System. Photoelectric dimming controls, occupancy sensors and sun shading devices are expected to reduce energy costs significantly. The whole building design including efficient light fixtures and mechanical equipment will have 32% energy savings below the ASHRAE 90.1 1999 standard. Energy saving is further enhanced by the basic orientation of the building which is primarily North-South and the design of the facades including two feet deep exterior horizontal sunshades which will minimize the use of energy for cooling in summer and heating in winter.

The control systems also give individual users more control of their immediate work environment providing improved comfort levels to the 700-800 staff. The underlying design concept is the notion of a building that actively responds to environmental conditions, just as its users observe and predict surrounding and natural conditions. NOAA is targeting a LEED NCv2.2 Silver certification and an ENERGY STAR performance rating.

santa clarita maintenance facility

Architect/Designer
HOK Architects

Owner
City of Santa Clarita, CA

Project Area
66,700 sq. ft.

Completed
May 2006

Santa Clarita is located northwest of Los Angeles and 45 miles from the Pacific Ocean coastline with a population of 177,000. An eco-charette identified sustainable goals and strategies such as energy efficiency and water conservation. Although the initial interest to use straw bale construction was its high R value, ultimately, the decision arrived by way of multi-criteria analysis (MCA). For instance: straw bale helped to create a healthy work environment absent of harmful chemicals or VOCs, it diverted local agricultural waste from the landfill, it was locally available, and it produced an aesthetically pleasing and low maintenance long lasting building for the owner at a cost that was comparable to standard wood framing. At the end of the building's life, straw bale can be composted.

The team was able to produce a design that exceeds California Energy Code Title 24 requirement by 44%. The client also participated in the "Savings by Design" program offered by Southern California Edison, the local utility company. Through this program the owner is able to receive monetary incentives based on the buildings energy

performance. In part, the above goal was met by the design of a very efficient mechanical system; a series of water source heat pumps supplied by chilled water generated at an onsite cooling plant, a super insulated envelope to reduce cooling loads, and an under floor delivery system to only cool the first seven feet of air above the finished floor.

In addition, a night time outside air flush takes advantage of the 40 degree difference between daily high and low summer temperatures to pre-condition the air, and natural daylighting reduces the reliance on electric lighting. As a result, the associated heat loads minimizes energy use.

The facility installed low flow fixtures and a xeriscape garden design. The bus washing station filters the water with a cyclonic filter and reuses it for bus washing therefore greatly reducing water use in a water intensive activity.

Prompted by the fact that it had one of the worst measured air qualities of any city in California and the enactment of the new State's Clean Air Rules, Santa Clarita set goals to reduce its air pollution. The facility included publicly available CNG fueling stations on site to encourage the popularity of private vehicles fueled by CNG as well as 28 bike racks and 6 showers to promote bicycle commuting for staff. The Santa Clarita Maintenance Facility achieved a LEED NC Gold rating from the USGBC.

usda

USDA requested a new laboratory to house up-to-date research and testing techniques and consolidate its three major divisions: Animal and Plant Health Inspection Service (APHIS), Agricultural Research Services (ARS), and Center for Veterinary Biologics (CVB). Their goal was to promote enhanced collaboration amongst the different departments.

The new BSL-3 laboratory building is adjacent to existing buildings. A cost analysis in early design assessed that an atrium would be less expensive than constructing an additional area of exterior wall. The circulation on the upper floors is open to the atrium which can be used as a flexible meeting space to accommodate up to 800 people. Directly under the glass ceiling are baffles with sensors that track the sun and decrease glare in the atrium.

The offices, training rooms, conference rooms, dining area, libraries are designed with access to natural daylight; the artificial lighting in these areas have controls that are sensitive to the amount of daylight entering the spaces. Daylight modeling tested various strategies to optimize daylight into the building using aperture sizes, locations and light shelves.

Prior to construction, the groundwater on site was discovered to be contaminated with 1.4-dioxane. Several conventional technologies were studied or tested to determine best treatment options. It was decided that the groundwater should be removed and treated within an advanced phytoremediation system to improve and accelerate remediation. This process allowed USDA to bioremediate without the need to excavate the contaminant material and dispose of it elsewhere. The ground water was placed in a containment structure north of the building where naturally occurring organisms remediate and preserve the natural state of the surrounding environment

The site was designed with bioswales and the building has a green roof to reduce the quantity and improve the quality of stormwater runoff. The planting list was selected with drought tolerance in mind to eliminate the need for using potable water for irrigation.

The USDA building is LEED NC certified by the USGBC.

Architect/Designer
HOK Architects

Owner
USDA

Project Area
530,000 sq. ft.

Completed
2009

noaa coastal services center's habitat priority planner

NOAA's Coastal Services Center provides a tool to review alternatives for coastal development that quantifies economic, environmental, and social impacts. The "Habitat Priority Planner" looks beyond smart growth and towards a perfect balance between the natural and built environment by preparing and analyzing hypothetical development scenarios.

For example, in coastal Georgia, NOAA worked to integrate life cycle concepts, consensus-based standards, and performance measurement and verification methods into three hypothetical designs: conventional, new urbanist, and conservation scenarios. The approach used local partners and science-based skills and technologies to evaluate each. From there, the team began with a list of potential economic, environmental, and social indicators to measure hypothetical impacts from the various scenarios on the surrounding environment. Factors such as whether or not the site location was within a region or watershed were important. As the project moved forward, the team discussed and refined its indicators - life cycle analysis, local consensus, performance measurements and verification methods all influenced the achievement of a sustainable development.

Rather than jumping to an assumed "less bad" approach, this process focused on a coalition of views and indicators in order to omit dictation of judgment from a single stakeholder category. This structure assesses multiple value systems and objectives, not easily quantified, to develop a scenario that works best for the community and its surrounding environment.

You can view these project results on NOAA's Web site at: (http://www.csc.noaa.gov/digitalcoast/tools/hpp/). The Web site is structured to allow users to walk through the project processes and results. It is a valuable educational tool that provides information and promotes dialog with local government officials, planners, developers, and citizens in the communities they serve.

the wild center

Architect/Designer
HOK Architects

Owner
Natural History Museum Of Adirondacks

Project Area
54,000 sq. ft.

Completed
2008

The Natural History Museum of the Adirondacks or the Wild Center is located on a 32-acre site that was previously an open cut sand quarry. The team minimized disturbance to the existing natural habitat and restored more than 55% of the quarry's site. Today, the center is a living museum that provides interpretation and observational experience for its surrounding environment. The vision for the Wild Center is a building fully integrated within the natural setting of the Adirondacks; blurring the division between the outdoor environment and the interior space and exhibits.

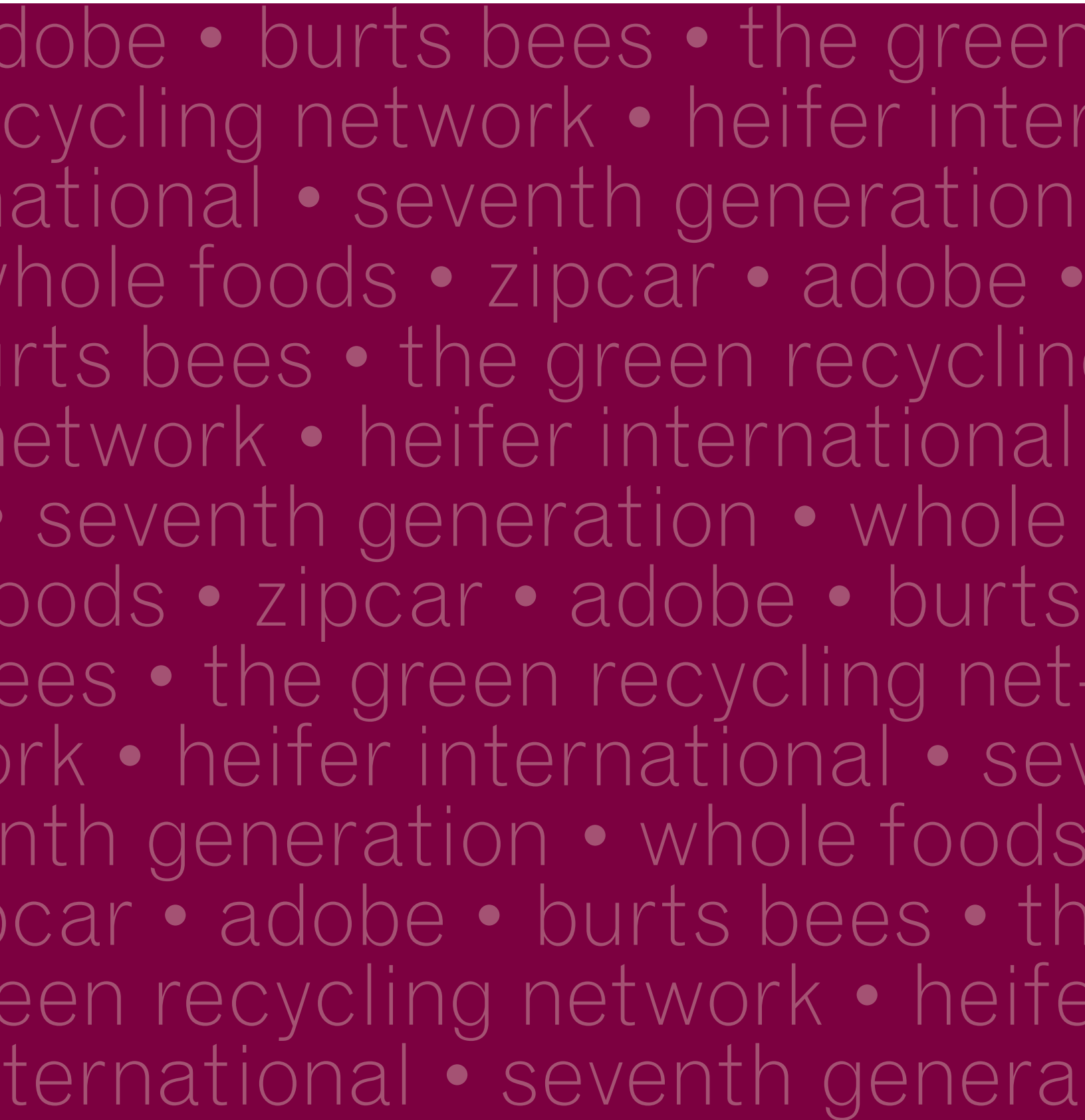
Water is the central, organizing element of the museum's conceptual and technical design. A three acre pond serves as the anchor to the functional and aesthetic design of the building. It is linked to the Wild Center's four water based exhibits to organically break down the nitrogen cycle within the 5000 gallons of exhibit water. The direct adjacency of the building to the pond minimized piping so that more of the site could be restored to its natural habitat.

The pond is also an integral part of the storm water management system. It provides a primary phase in the water cycle. For example, 1,823 cubic feet of stormwater is annually reduced via evaporation - recycling the stormwater naturally deters the potential burden upon the local municipal system. The 2,400 square foot vegetated roof, pervious pavement, and infiltration trenches, filter the remaining stormwater of pollutants and further reduces runoff volume.

The museum is designed in an indigenous Adirondacks style using nearly 22% locally available materials. White pine for the exterior siding was harvested and milled in Tupper Lake, less than 10 miles away; Red Garnet and Champlain stone come from quarries in the park. The metal roofing, concrete and structural steel were supplied and fabricated in local plants. Nearly 50 percent of construction waste was diverted from local landfills and GreenSeal certified finish materials provide a healthy indoor environment.

10% of the museum's power comes from a 40kw photovoltaic array on the roof of the Bio-Building. The museum's design and orientation maximizes the use of year-round natural light. Energy-efficient lighting and controls combine with a well-insulated building envelope contribute to create a highly energy-efficient building. A building management system allows for constant monitoring and improvements. Composting toilets help reduce water consumption by more than 30,000 gallons annually. Overall, these and other strategies have reduced water usage by more than 30%. The Wild Center achieved a LEED NC Silver rating from the USGBC.

organizations



adobe

Adobe is committed to conserving natural resources and minimizing their impact on the environment. They actively implement measures to increase efficiency, conserve energy and water, improve air quality, and reduce waste.

Where possible, Adobe uses recyclable materials. Adobe communicates environmental policies and programs to Adobe employees to ensure that all employees are aware of their role and responsibility to fulfill and sustain Adobe's environmental commitment.

Three key initiatives within Adobe's environmental sustainability effort are their office building operations, waste management program, and their product packaging.

Office buildings

Adobe's headquarters spans three office towers that comprise over one million square feet of office space, making it the largest corporate presence in downtown San Jose. Over the past several years, Adobe has initiated over 70 separate energy and water conservation projects to improve the site's environmental sustainability. The effort has reduced indoor water use by 22%, landscaping water use by 76%, electricity by 35%, and natural gas by 41%.

These documented improvements earned the site three Platinum LEED Certifications from the U.S. Green Building Council, ranking it as one of the most environmentally sound business facilities in the world.

Waste management

The approximately 2,100 employees headquartered at Adobe's San Jose campus actively engage in recycling and composting programs that divert up to 95 percent of the site's solid waste from landfill. Paper, cardboard, plastic, glass, cans, printer toner, and batteries are recycled, and food waste is composted.

Similar programs are being deployed and expanded where possible throughout Adobe's more than 80 facilities worldwide. Additionally, Adobe has established PDF as an ISO standard to promote paperless business processes.

Product packaging

As one of the largest providers of boxed software in the world, Adobe is uniquely positioned to reduce the impact of product packaging in their industry. The company recently launched an environmentally sensitive redesign of its software packaging based on a comprehensive evaluation of packaging materials, production, transport, use, and disposal.

The resulting packaging, which is being phased in across the Adobe product line, combines recyclable cardboard derived from sustainably managed forests, a die-cut production method and folding inserts to minimize glue use, and reduced size and fewer inserts to limit materials use.

burt's bees

Burt's Bees released their first Corporate Sustainability Report (CSR) in 2009. While there was a shortage of hard core measures in some of the operations, Burt's Bees wasn't discouraged from writing their first account. They recognized that when it comes to practical metrics, consistent measures and grounded goals were priority.

In 2006, Burt's Bees partnered with Sunoco to recycle all of their company waste through their company-wide recycling program. Now, not only is all office waste recycled, but much of the waste from manufacturing is picked up for recycling by Sunoco.

Burt's Bees 2009 Sustainability Goals:

- Water Reduction: <700,000 gallons non-product water, <750,000 gallons waste water
- Energy Reduction: <5GWh of total electricity consumed across all buildings
- Waste Reduction: <90 tons of solid waste to landfill

Burt's Bees 2020 Sustainability Goals:

- Zero waste
- 100% Employee Engagement
- 100% Natural Products
- 100% Post Consumer Recycled (PCR)/Biodegradable packaging
- 100% Renewable Energy/Zero Carbon LEED Certified Buildings

Burt's Bees is committed to business and manufacturing processes that supports their pledge to do the right thing when it comes to products, the environment and fellow living creatures.

Green Buildings

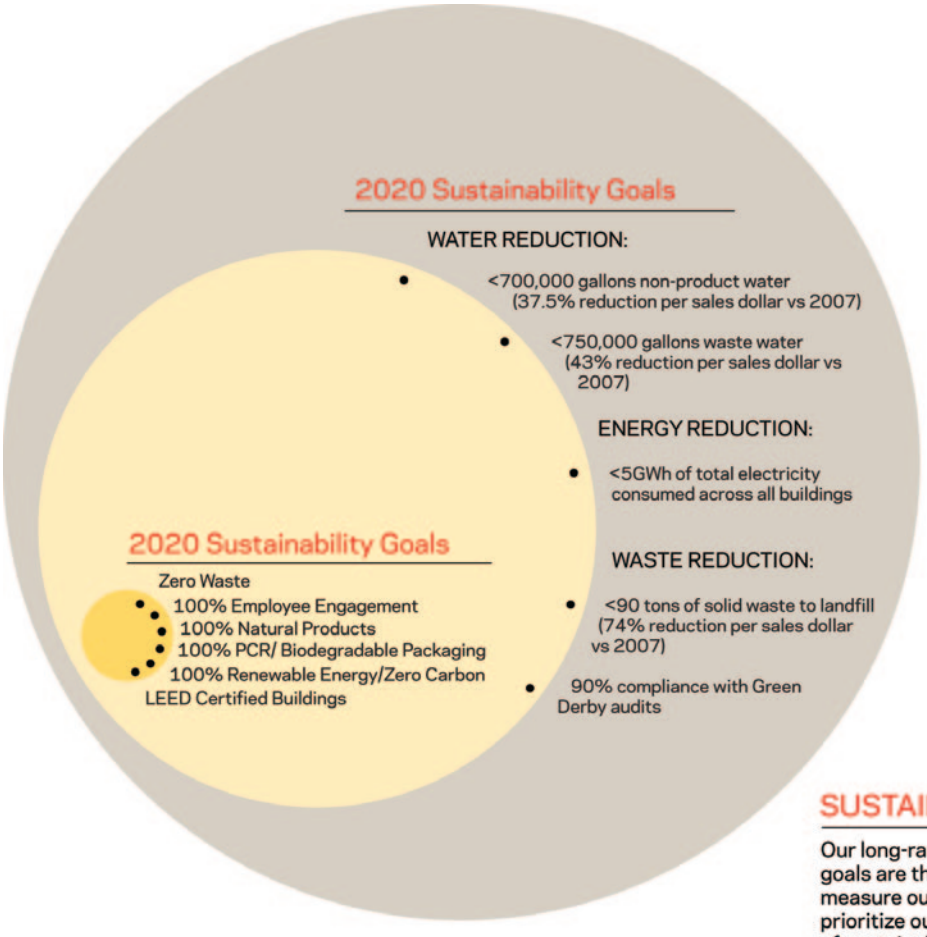
Currently, Burt's Bees leases their office, factory, and warehouse buildings which puts some restrictions on their efforts toward ensuring they're LEED certified. However, they are working with their office management to make improvements where possible; in 2008, they added new office space in a former distribution warehouse that is much greener. Updates will be provided in their CSR.

Waste

Burt's Bees recently hosted a "dumpster dive" event to teach employees about waste reduction. It was quite an education when they combed through every inch of their waste!

Until 2007, they were only recycling their used white paper and mixed plastic, glass and aluminum. They had also been sending certain organic by-products from their production processes off-site for compost.

Today, in addition to all of the items above, they also recycle wood, corrugated cardboard, shrink wrap chipboard, and fiberboard. And, they've begun composting the residue from their wastewater pre-treatment process. Even their offices, break rooms now have composting bins, as well as reusable and compostable utensils—they're made from potatoes!



SUSTAINABILITY GOALS

Our long-range and short-term sustainability goals are the framework within which we measure our impact as a business and prioritize our efforts and actions in support of sustainable practices.

SCOTT SHEPARD :

the green recycling network

Green Recycling Network (GRN) provides full deconstruction services of commercial buildings using a disassembly process with the objective of recovering materials for re-use. The costs and methods are competitive with traditional demolition methods, but the recycling results are more extensive. GRN landfill diversion rates regularly exceed 90% of materials such as such as carpeting, drywall, metal, ceiling tile, stained/painted wood, glass, etc. while following EPA's comprehensive guidelines for construction, and renovation. Deconstruction of buildings requires that each new employee study continued safety and efficiency standards. Deconstruction is a closed-loop process that uses less energy, raw materials, and generates less pollution than the average demolition and continues the life of the material. GNR takes advantage of its sister recycling/waste company, ACE Recycling, and partnerships with manufacturers to create additional opportunities for recycling where re-use is no longer an option.

GRN's process is cost effective relative to traditional demolition because of their ability to avoid costly land disposal fees by leveraging the expertise of the Green Recycling Network. Thus, no matter the job or the mix of materials, clients get green results even when a project involves a diverse mix, such as reusable items, painted drywall, unusable furniture, carpet, ceiling tile, and even mixed debris.

GRN uses their own recycling facilities, equipment and labor in combination with their network to find the most efficient and financially beneficial outlet for all materials from a project. These facilities are designed to efficiently process a diverse range of construction and demolition materials for recycling, and salvage materials for reuse. These facilities handle significant volumes of recycling and reuse materials which result in further efficiencies.

The materials include salvage, such as building materials, electrical and mechanical equipment, furnishings and other materials. Items that cannot be salvaged at a higher value than scrap are recycled at prices less expensive than landfills.

Green Clean

Green Recycling Network "Green Clean" services are an innovative method by which materials are removed from buildings without demolition. Many commercial buildings store materials and equipment that are no longer used but could be recycled or reused by other organizations. GRN crews remove all unnecessary items and prevent them from going to landfills, maximizing their value in back-end markets. Items such as mechanical and electrical equipment, furnishings, office equipment and building materials can raise significant revenue that is shared with the building owner. Other items that have no reuse value can be recycled by the GRN recycling facilities.

A sample list of materials that GRN was able to place in reuse markets:

- 500 rolls of carpeting from an old abandoned warehouse. The cost to the building owner was zero while a landfill would have incurred thousands of dollars in disposal costs. From an environmental standpoint, carpeting is plastic and simply will not decay in landfills causing permanent harm to the ground.
- Raised IT flooring systems. Raised flooring systems are often filled with wood or concrete cores in order to reduce noise which prevents recycling in many cases. GRN has developed a reuse market for these flooring systems.
- 13,000 sq. ft. mezzanine system. This mezzanine systems was planned for metal recycling, but GRN more than quadrupled the value by finding a reuse market for it.

Photos courtesy of the Green Recycling Network.

- Electrical and Mechanical equipment. GRN has sold hundreds of mechanical and electrical equipment items–the market value far exceeding recycling values. Frequently, the reuse market can result in extensive cost savings, by requiring buyers to pay for the removal and shipping of items in addition to the item purchase.
- Laboratory equipment and furnishing. GRN has sold hundreds of lab equipment components and furnishing to the highest paying buyers. GRN network of buyers are located throughout the world which results in values that far exceed normal expectations.
- Often value is achieved by finding a reuse market that is not able to recycle efficiently. Lighting is a common example. The bulbs of 2 x 4 recessed lights that are found in office buildings contain mercury and the ballasts may obtain PCBs. The hazmat costs result in an expensive disposal. GRN has sold thousands of these fixtures and attached lights to reuse markets, with zero disposal cost.
- Doors and windows. GRN finds reuse markets for these materials versus recycling.
- GRN customers receive the direct benefits of GRN's buyer network. The reduced cost or revenue results in significant dollar value and the added benefit of knowing materials are being reused or recycled and therefore, diverted from landfills.

Waste Audit

GRN's waste stream audit service is used to identify the quantities of materials that come out of buildings. Initially, a baseline audit is conducted and provides a benchmark by which future improvements against waste produced and volumes recycled are gauged.

Interview with Scott Shepard
The Green Recycling Network, June 8, 2009

heifer international

www.heifer.org

Heifer International is a non-profit organization that provides livestock to poor families in developing nations to use for farming, food production, and fertilizer. In addition, they teach animal husbandry and skills for flexible and sustainable rural farming. The idea: empowering communities with resources and education toward self-sufficiency is a better long-term solution than handouts for fighting hunger.

Heifer International is headquartered in Little Rock, Ark.; however, more than 125 locations worldwide serve as "home base" to 600 office and field staff. Striving to end hunger and poverty while caring for the earth is a full-time job, and the success of Heifer's mission depends on a far-reaching network of committed individuals working together to fulfill their mission.

Two and a half years ago, ground was broken on an abandoned brownfield next to the Arkansas River for Heifer International's new World Headquarters. Former President Clinton praised Heifer's more than 60 years of work helping the hungry by saying, "You have to have a world with more partners and fewer enemies - and one by one, that's what Heifer does."

The opening of the four-story, 94,000-sq.-ft.. office building accomplishes the first phase of a three-phase development of the 33-acre Heifer International Center campus, which will eventually include an educational facility, the Polly Murphy and Christopher Keller Jr. Education Center, and a Global Village to educate the public about pragmatic solutions to hunger and poverty here and abroad.

Green or Sustainable Features:

Sustainable concepts apparent in the building are extensions of Heifer's approach to ending world hunger, guided by a belief that education comes through environmental connections. Reclamation and use of damaged land, collection and reuse of water, and equality and access for all people to healthy conditions were key goals that created the intended symbiotic relationship between building and land.

A stated goal that zero water leave the site led to a process of restoring a wetland on an abandoned railroad switching yard that would collect and clean stormwater for reuse. A connection is drawn architecturally between the movement of people and the movement of harvested rainwater. The connection between people and building continues through vertical circulation design and facade fenestration, recycled materials used from on site, and carved breezeways under the building, all interrelated with building systems.

The narrow, semi-circular floor plan results in daylight and views for all 474 employees. The views focus on the adjacent riverfront park and wetland.

The building is designed to use up to 55 percent less energy than a conventional office building.

Heifer International Headquarters is a LEED NC 2.1 Platinum Building. Building tours are available twice daily, Monday through Friday, beginning at 11 a.m. and 3 p.m.

Practicing What They Preach

"If we're going to have a lasting impact on ending world hunger, then everything we do must renew the earth and not deplete it," said Jo Luck, Heifer's president and CEO. "It's true whether we're working with people who want to be self-reliant or managing their own worldwide operations. Nurturing the environment while combating hunger has always gone hand-in-hand at Heifer."

Recycling from the Ground Up

So they started with the earth itself, purposely selecting land that had once been a railroad switching yard but at that time lay dirty and dormant, with abandoned warehouses and industrial structures blighting the landscape.

They cleaned the existing brownfield, by removing 75,000 tons of earth; and transformed it into a wetland area that controls, stores and reuses surface groundwater. And an innovative, permeable-surface parking lot next to the building eliminates common stormwater runoff problems.

Even the abandoned buildings nearby received a second chance: almost all of the masonry was crushed into gravel and reused, along with recycled steel, in the new construction. And instead of wood from old-growth forests, some of the building's flooring is made of recyclable, fast-growing bamboo, and the rest is covered with recycled carpeting.

Relying on Mother Nature's Water...

Along with the wetlands' collecting and filtering systems, the new headquarters includes a water collection tower. With the roof sloping to direct rainwater to drains and then stored in the tower, the center is able to rely on the water falling on the property, instead of on the municipal water system.

...And Sunlight

And the headquarters' narrow, 60-foot-wide design and glass skin allow staff to work in natural light, with "light shelf" overhangs minimizing heat in summer and maximizing it in the winter. As darkness falls on the day, sensors adjust interior lighting to maximize energy savings. Energy-saving ductwork and modular electrical conduits and mechanical systems run beneath the floors.

Bottom line? The building uses 52 percent less energy than a conventional office building of similar use and size. And this design has already attracted the attention of architects and builders.

Sound Business Decision

For Heifer's far-flung Little Rock staff, the new building enables everyone to convene in one place, saving money spent on inhabiting three separate facilities, and permitting more efficient administration. Based on current projections, the project should pay for itself in ten years.

"Bernalilo, New Mexico."
Photo Credit: Jonathan Herz

But perhaps best of all, the Heifer International Center will become a focal point for hunger education in America – a place where they'll host seminars, conferences and working sessions on world hunger issues. Each visitor who enters the campus will see firsthand how they can all help end hunger and poverty by becoming better stewards of the planet.

"It's important that what we profess and what we do are in agreement," said Gerald Cound, former facilities director for Heifer. "[With this building], we are assured that we can tell our story with integrity, and that we are taking a leadership position in this important movement to decrease our footprint on the earth."

Agroecology and Sustainability

In a world where land is overused, community members need to learn how to protect and rejuvenate their land, water and other natural resources. Heifer helps by teaching environmentally sound agriculturally sound techniques.

Awards

- Heifer International received the 2006 Social Capitalist award from Fast Company magazine.
- Heifer International also received the 2004 Conrad N. Hilton Humanitarian Prize for its efforts to eliminate hunger and help communities become self-sustaining. It was the first US-based organization to win the $1 million award since 1997.
- In 2003, Heifer International was named one of Forbes magazine's top 10 charities.
- In 2007, the Heifer International Headquarters building was named one of the American Institute of Architects Committee on the Environment Top Ten Green Projects.
- In 2008, the Heifer International Headquarters building was named a National AIA (American Institute of Architects) Institute Honor Award Winner
- In 2008 the Heifer International Headquarters building was awarded a LEED NC 2.1 Platinum certification by the USGBC.

seventh generation

Seventh Generation, a manufacturer of natural household and personal care products, has sustainability and corporate social responsibility woven deeply into the fabric of their business. For the last several years Seventh Generation has identified global imperatives which they can affect in order to focus these efforts. While there have always been sustainability related initiatives happening across the company, Seventh Generation is now using this process to develop more specific longer term companywide sustainability goals which will be used to prioritize initiatives through developing departmental goals for the next 1-2 years. All of these goals will dovetail with the annual strategic planning cycle.

While most of the sustainability initiatives are initiated internally, Seventh Generation is involved with many associations that help foster them. Partnerships with organizations like Greenpeace and Healthy Child Healthy World have been very beneficial. Also enlightening has been the certification process for their headquarters building which has recently been awarded LEED Gold for Commercial Interiors.

As an alternative to buying carbon offsets, Seventh Generation has invested in reducing their carbon footprint and using renewable energy. Seventh Generation has launched the 20/20 program which sets a goal of 20% reduction in carbon emissions and to use 20% renewable energy by 2010. While these are goals for their business, Seventh Generation encourages their employees to continue their sustainable thinking outside of the office by offering incentives for employees who use public transit or bicycles to commute. All employees are provided a free home energy audit and a carbon tracker to monitor their carbon information, and various incentives for home energy efficiency improvements and purchasing fuel efficient vehicles.

Manufacturing of Seventh Generation products happens through a network of partners, and not in their own facilities, so they look beyond their own direct consumption when considering environmental and social goals. Seventh Generation maintains a hands-on approach by performing sustainability audits of manufacturing partners in their supply chain. The audit looks at 14 categories related to sustainability and social responsibility. Criteria evaluated include environmental considerations as well as social such as how

the companies treat their workers. Seventh Generation likes to work with manufacturers as partners and uses the audit process to drive improvements in corporate consciousness practices of those companies. Because other large consumer brands are manufactured in the same facilities as their products, Seventh Generation only has so much power over the way the supply chain facilities do business. That doesn't hinder the company from using the audit process to drive change. David Rapaport, the Senior Director of Corporate Consciousness says "If they are making products for us that are not using any toxic components, we know that we are making a difference in improving the work environment for the manufacturing plant as a whole."

Seventh Generation completed their first ever traceability study for all cleaning products and traced 95% of all cleaning ingredients to find out where they come from to create a greater understanding of environmental impacts throughout the supply chain. This supplements extensive standards for the health and environmental characteristics of products used in selecting ingredients and formulas. Distribution is studied closely by the logistics team; reducing miles travelled and increasing post-consumer recycled content used for packaging are continuous efforts.

On the social front donations increased by 91 percent in 2007 and established a corporate giving program to donate 10% of pretax profits annually. The company also gives interest-free loans to help employees become more energy efficient and reduce their carbon footprints. All employees have access to a $5,000 forgivable loan towards the purchase of fuel-efficient cars and for home improvements. There is also an annual $500 award for Energy Star purchases that employees make for their own homes.

Behind the scenes at Seventh Generation, there is an extensive orientation that all new hires receive. Topics ranging from green chemistry to systems thinking - employees are reflecting on sustainability in everything they do.

> *"This notion of having sustainability embedded into the core purpose of the business is very important. It has enabled us to do what we have done. We've been able to do things we never would have had sustainability been an add-on to our business model...*
>
> *Seventh Generation feels that the real opportunity to make progress on sustainability is while fundamental business decisions are being made."*
>
> *Interview with Dave Rapaport - Senior Director, Corporate Consciousness, Seventh Generation*

Due in large part to these initiatives, in 2007 Seventh Generation helped the environment by:

- Saving 118,000 trees;
- Reducing water use by 42,000,000 gallons;
- Saving 29 billion BTU's of energy;
- Saving 213 billion gallons of petroleum;
- Decreasing normalized greenhouse gas (GHG) emissions by 34% from 2005.

whole foods

Their motto — *Whole Foods, Whole People, Whole Planet* — emphasizes that their vision reaches beyond food retailing. In fact, Whole Foods believes its deepest purpose as an organization is helping support the health, well-being, and healing of both people — customers, team members, and business organizations in general — and the planet.

The mission of Whole Planet Foundation is to create economic partnerships through microcredit with the poor in communities that supply Whole Foods Market stores with products, with a focus on the developing world.

Wind Power

In January of 2006, they made their first landmark purchase of renewable energy credits from wind farms to offset 100% of the electricity used in all of their stores and other facilities in the United States and Canada. This green action and others earned them the Environmental Protection Agency Green Power Partner 2006 and 2007 and Power Leadership Award in 2004, 2005, and 2006.

Solar and Biomass

Individual stores from several regions supplement their wind credit purchases with power from solar panels and power generated by biomass. Whole Foods feels that a typical solar installation can:

- Produce and save more than 2.2 million kilowatt hours over 20 years
- Result in more than 1,650 tons of CO2 emissions avoided, the equivalent of removing 440 cars from the roadways
- Reduce the impact on the country's power grids

In 2002, their Berkeley store became the nation's first major food retailer to introduce solar energy as its primary lighting power source. More of their stores followed suit; for example their Brentwood, California, store uses solar energy for 24% of its power source and their Edgewater, New Jersey, store boosts an impressive array of 14,000 square feet of solar panels providing more than 20% of the store's power needs.

Green Building

Green building techniques conserve natural resources by reducing the use of virgin raw materials and minimizing the amount of toxic resins and volatile organic compounds (VOCs) off-gassed by traditional building materials such as laminates, paint and carpeting. Their store in Sarasota, Florida, received LEED Silver Certification by the United States Green Building Council (USGBC), the first environmentally-friendly supermarket designed in accordance with the LEED Green Building Rating System®.

New store construction includes innovative green materials such as MDF (medium density fiberboard), made from 100% recovered and recycled wood fiber, Marmoleum, a natural linoleum product and FSC (Forest Stewardship Council) Certified Wood.

Other Green Initiatives

In addition to the major efforts listed above, Whole Foods is also committed to:

Biodegradable food packaging — They are in the process of replacing traditional plastic and paper prepared food containers and utensils with all-natural fiber packaging that is environmentally friendly. Made from renewable resources such as sugar cane pulp, corn starch and bamboo, they are completely compostable and, because they are unbleached, free from chlorine and dioxins.

Biodiesel — They are gradually converting their truck fleet to biodiesel fuels, reducing CO2 emissions into the atmosphere. Their fleet is also being fitted with aerodynamic aprons to cut down on wind resistance resulting in less fuel consumption. These trucks also use a fuel-saving (and emissions-cutting) system that allows the engine to be turned off completely at loading and delivery, rather than idling.

Water Conservation — Some stores have converted to flush-less urinals; each will save approximately 40,000 gallons of water per year (average use).

5% Day Donations — 5% Days are Whole Foods' way to give back to the community. On designated days throughout the year a total of 5% of the day's net sales are donated to a local non-profit organizations.

Cleaning Supplies — Some stores are using Green Seal certified cleaning supplies and others are transitioning to the use of environmentally friendly cleaning and maintenance products.

Printing Standards — They carefully evaluate the need for everything they print, and when they do print, they insist on recycled paper, soy inks and solvent-free printing processes.

Local Producer Loan Program

Whole Foods Market's Local Producer Loan Program (LPLP) provides up to a total of $10 million in low-interest loans to small, local producers.

Loans range from $1,000 to $100,000 and can be for things like purchasing more animals, investing in new equipment or converting to organic production. They minimize fees, interest rates and paperwork.

Current loan recipients range from ranchers and beekeepers to ice cream makers and bakers.

WHOLE FOODS MARKET®

Whole Foods,
Whole People,
Whole Planet

Seafood Sustainability

Whole Foods is committed to responsible seafood practices, including:

- Buying seafood from responsible, certified fisheries.
- Using the blue Marine Stewardship Council sticker on seafood packaging is a good place to start.
- Supporting fishing practices that ensure the ecological health of the ocean and the abundance of marine life.
- Partnering with groups that encourage responsible practices and provide the public with accurate information about the issue.
- Operating their own well-managed seafood facilities.
- Helping educate their customers on the importance of practices that can make a difference now and well into the future.
- Promoting and selling the products of well-managed fisheries.

Locally Grown: The Whole Foods Market Promise

Where available, Whole Foods is committed to buying from local producers whose fruits and vegetables meet specific standards, particularly those who farm organically and are themselves dedicated to environmentally friendly, sustainable agriculture.

Courtesy of Bigg Riggs Farm

Additional efforts in process:

http://blog.wholefoodsmarket.com/author/loftusk/

- Supporting Marine Stewardship Council seafood and Forestry Stewardship Council wood.
- LEED gold for one of their recently opened stores and have 20 plus stores registered with USGBC for certification at various levels.
- Banning plastic bags and polystyrene from packaging.
- Installing the world's first fuel cell at a supermarket (Glastonbury, CT),
- Numerous solar installations in the works.
- Partnering with Department of Energy (DOE) to develop the Commercial Lighting Solutions Program and a host of other programs
- Moving closer to zero waste with many regions diverting more than 80% of waste by recycling and composting.
- Conducting Sustainable Packaging Forums with vendors and providing compostable food containers for their prepared foods venues.
- Implementing many energy efficiency programs: near real time enterprise energy monitoring and reporting (some sub-metering), installed doors on some medium temperature cases, testing LED lighting in refrigerated cases and other applications
- Feasibility testing of an on site wind turbine for the Pigeon Cove Seafood Processing Facility in Gloucester, MA
- Site renewable (waste to energy) energy project for the North Atlantic Region's Commissary in Everett, MA

"San Mateo County Sheriff's Forensic Laboratory and Coroner's Office, San Mateo, California." Photo courtesy of HOK.

zipcar

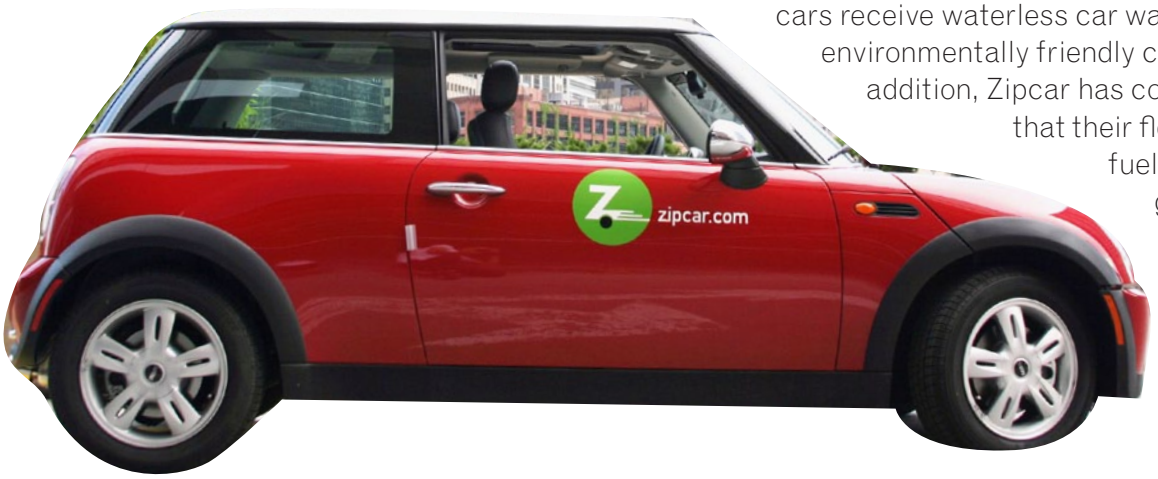
Zipcar started in September 1999 in Cambridge, Massachusetts and is the world's largest and fastest growing car sharing club. Over the last 6 years the company's annual revenues have grown from $2 million to $100 million. Zipcar currently has 300,000 members and approximately 6,000 cars in London and North America. Carbon emissions from transport account for a significant proportion of the global total, so the more travelers that can hop on a bus or choose to walk the better. However, for the times when a car is necessary, Zipcar steps in.

Behind the scenes, every Zipcar office has a recycling policy to cover paper, cans, bottles, etc. Additionally, all offices make a concerted effort to do as much electronically as possible in terms of communications and processing. Zipcar has utilized relationships with Clean Currents, USGBC, and UrbanTrans to further position themselves as an environmentally friendly company.

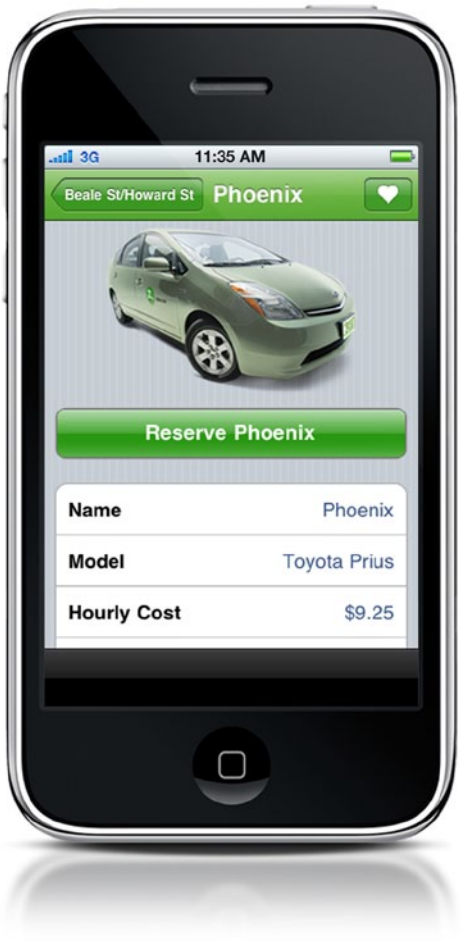
Zipcar rolls out a quarterly survey to gather member feedback that ultimately results in many of the forward facing programs that have been initiated. Zipcar continuously alters its behavior based on client feedback. A great example of this is that many members have recently expressed a desire to reserve and edit reservations via text message. In response, Zipcar has developed software to incorporate a 2-way text message system into the reservation process, and this will soon include reminders of Zipcar's "6 Rules of the Road" which provide guidance to members on car treatment policy. Zipcar is also developing an iPhone application that will be available soon for a free download as yet another avenue for members to make reservations.

Zipcar has an extremely active membership and is continuously hosting events ranging from member appreciation nights to "Green Confessions". "Green Confessions" is a social event where members write down their "secrets" or "confessions" on what they've done recently that wouldn't qualify as environmentally friendly behavior. These confessions are then written on a whiteboard for all to see. Another interesting program is Zipcar's "Low Car Diet" which encourages members to ceremoniously donate their keys for 30 days and in return, receive rewards like free Zipcar use for a month, or a discounted membership to a public bike sharing program called SmartBike.

Zipcar's sustainable policies carry over to their fleet management as well. Zipcars in Washington, DC are cleaned every nine days using environmentally-friendly cleaning products and a maximum of three gallons of water per wash. In Alexandria, Virginia, cars receive waterless car washes using only environmentally friendly cleaning products. In addition, Zipcar has committed to ensuring that their fleet maintains an average fuel efficiency of 28 miles per gallon. Beyond filling a niche of urban and sub-urban dwellers who don't want to own a car, Ellice Perez of



Zipcar notes that, "Zipcar is actually creating its own niche by changing behavior." Users are more likely to take a walk or bicycle to get to their destination, resulting in a healthier population. While cars are not going to disappear from city streets overnight, a steady reduction in road use will help the planet and could give people a better quality of life.



Interesting Zipcar Statistics:

- Zipcar members consume approximately 220 less gallons of gasoline per year than when they owned their own vehicle. An estimated 16 million gallons of gasoline has been saved between Zipcar's 300,000 members and 6,000 cars.
- Zipcar works hand in hand with public transport often locating Zipcars close to mass transit stations. Among members, there is a 47% increase public transportation use.
- Customers are more likely to coordinate their efforts while driving a Zipcar to make more efficient trips, thus resulting in less driving.
- Members who give up their cars save an average of $600 a month. Zipcar estimates that ninety-five percent of people living in the 13 largest cities don't need to own cars. If just five percent of those people sign up, there will be 1 million members.
- The company estimates that for every Zipcar introduced into an area, 15-20 cars are taken off the road, which reduces the use of land and financial resources used to provide parking infrastructure.

FastFleet

In addition to programs for personal use, Zipcar has just launched "FastFleet" which is a new service that enables government and other fleet managers to save money, reduce risk and promote sustainability. With FastFleet, for the first time, fleet operators may leverage the same technology that powers Zipcar's consumer fleet. Washington, DC, which is the first city to adopt the system, estimates it has saved more than $300,000 during a four month pilot of FastFleet. As expansion plans are underway, the District of Columbia estimates it will save more than $1 million in the first 12 months.

There are approximately 4 million vehicles currently deployed across thousands of fleets within local, state and federal governments. Typically, fleets are sized to meet peak demand, which means on a daily basis thousands of fleet cars and trucks sit idle. FastFleet allows fleet administrators to have a highly efficient shared fleet of vehicles with no reduction in availability for drivers.

"Sharing a fleet of small, new, fuel-efficient cars helps keep pollutants out of our air and water", said George S. Hawkins, Director of the District Department of the Environment.

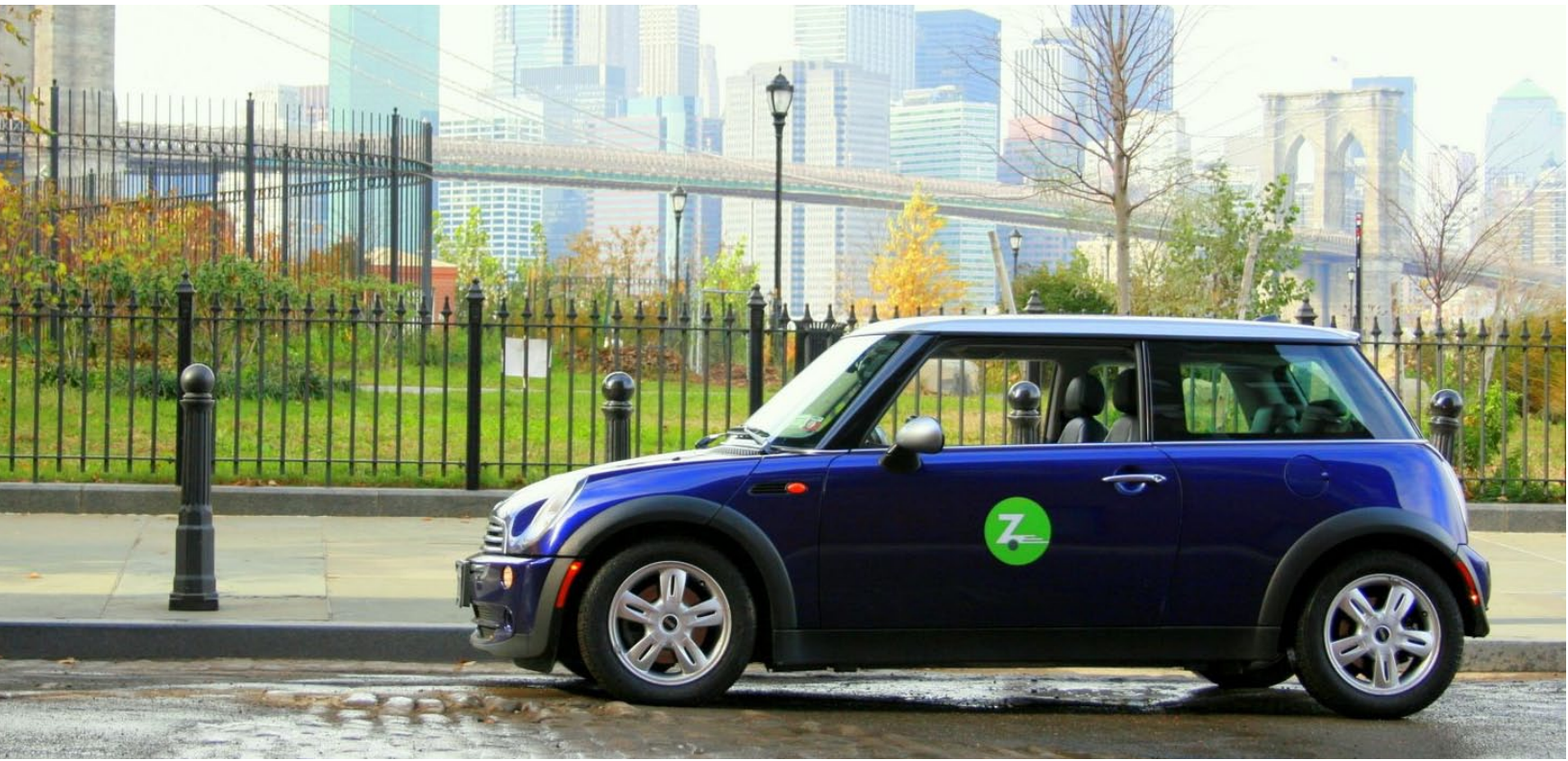
Unlike the traditional Zipcar business model, FastFleet does not supply the vehicles. Instead, client fleet administrators determine the numbers, types and locations of vehicles, which are then equipped with FastFleet's in-vehicle technology, wirelessly linking them to a dedicated FastFleet server. While FastFleet makes reserving and driving a vehicle a snap for employees, the benefits to fleet managers are even more significant. Fast Fleet's administration console enables unprecedented visibility and control over the vehicles in the fleet.

Fast Fleet allows administrators to:

- Design and configure their fleet footprint in real time for optimal utilization.
- Locate and track vehicles through a global positioning system.
- Manage hundreds of critical activities including preventive maintenance, fueling, and billing.

Interview with Ellice Perez, General Manager, Washington, DC Zipcar on May 7th, 2009
– Zipcar May 7, 2009

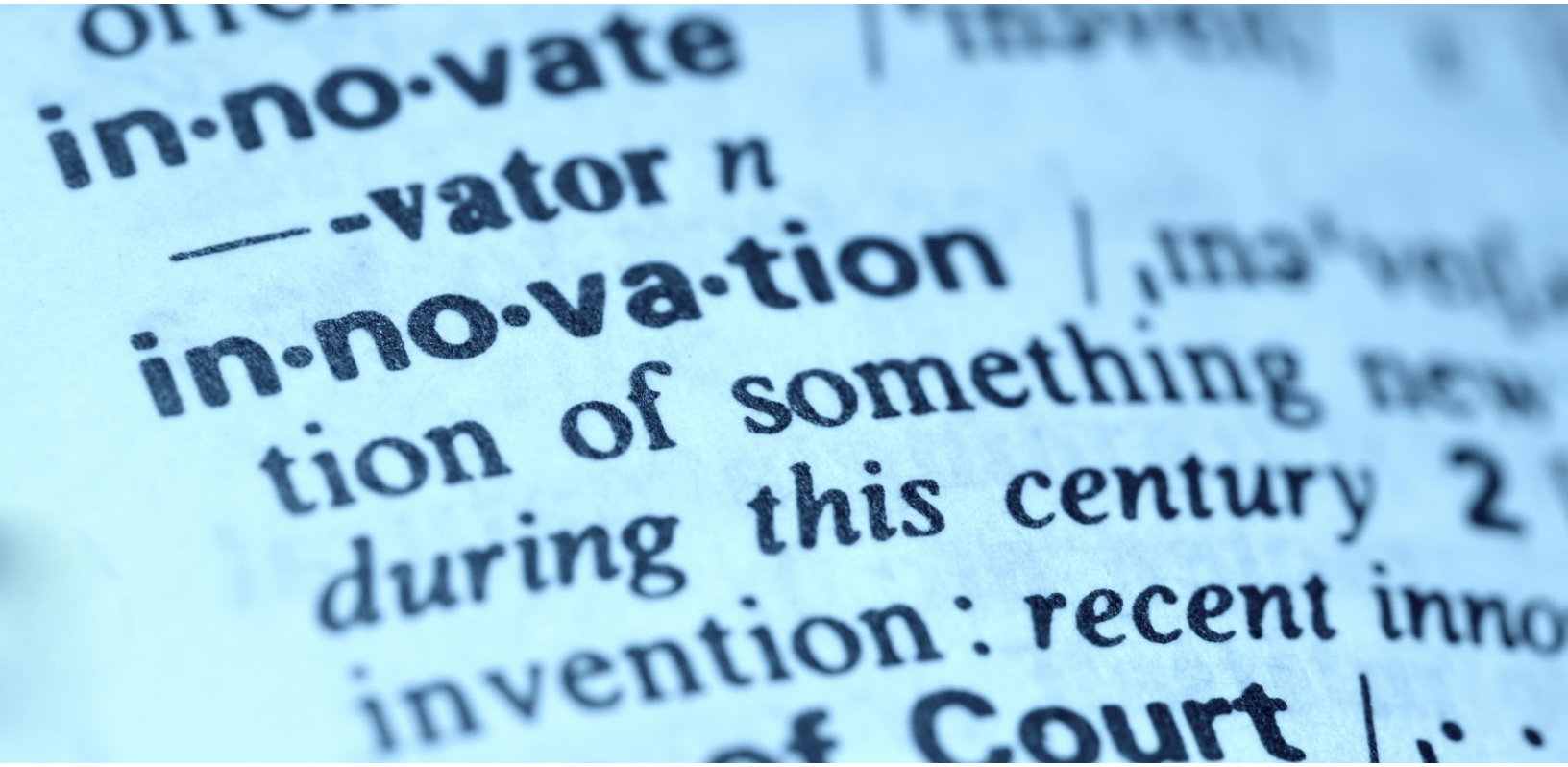
Photos courtesy of Zipcar.



"Sharing a fleet of small, new, fuel-efficient cars helps keep pollutants out of our air and water"

George S. Hawkins,

Director of the District Department of the Environment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invention: recent

tools and strategies

international tools and strategies

How are International Governments Responding to the Sustainable Challenge?

Governments around the World are responding to the challenges of sustainability through their own policies and rating systems.

While many responses are comprehensive, they generally do not consistently address the principles of sustainability:

1. Sustainable Scale,
2. Just Distribution,
3. Efficient Allocation.

Nor do they all provide for continued, balanced measurements and comparability with a level of scrutiny for all products, systems and buildings, both new and old that will promote continuous improvement.

The following is a representative sample of international efforts to respond to the global sustainability challenge.

"… over the past 35 years alone the Earth's wildlife populations have declined by a third. Yet our demands continue to escalate, driven by the relentless growth in human population and in individual consumption. Our global footprint now exceeds the world's capacity to regenerate by about 30 per cent. If our demands on the planet continue at the same rate, by the mid-2030s we will need the equivalent of two planets to maintain our lifestyles."

James P. Leape, Director-General, WWF International

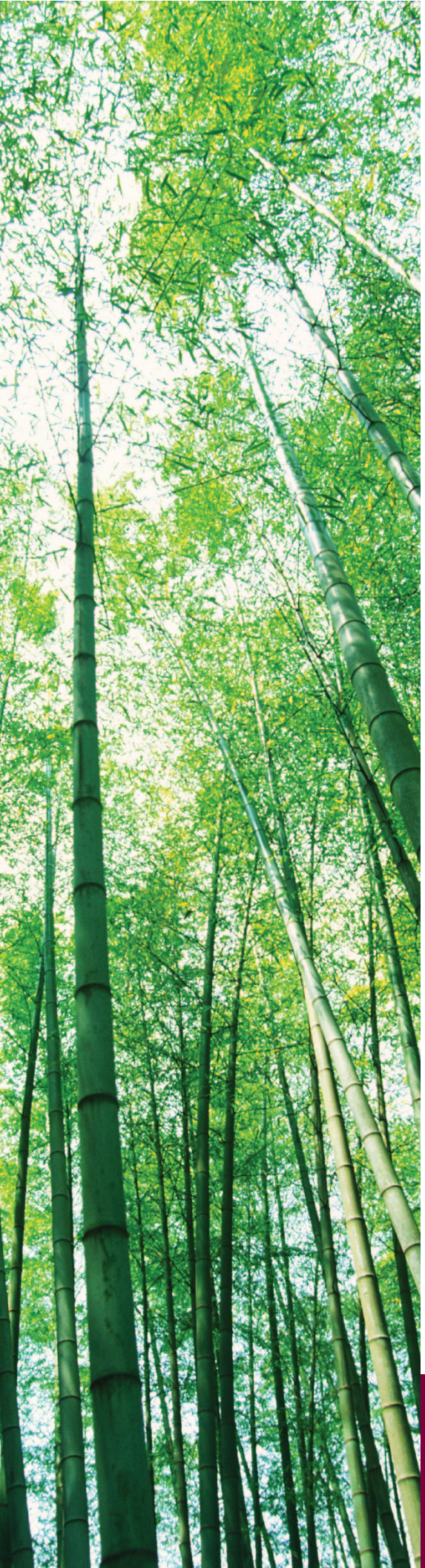
Japan

To address current sustainability issues, Japan is looking to the past for answers. The Edo Period (1603 to 1868) has become a model of sustainability for Japan. In a time of mandated isolationism, the people of the Edo period relied upon a closed-loop system where reuse and recycling practices nourished their survival. Today, Japan is mirroring Edo practices through recycling efforts and a focus on end-of-life products and materials that will reduce waste and prevent dioxins and other toxics from entering incinerators.

Japan is also taking advantage of new rating systems such as ECOLEAF and CASBEE. ECOLEAF, an eco-label that reflects a life cycle assessment (LCA) of a product, internationally signifies that the manufacturer has carried out an LCA report with the findings sent to the ECO-LEAF corporation. The Eco-leaf site publishes Product Category Rules (PCR) for 53 categories. PCRs function as criteria for LCA calculations for each product category, originally developed by a PCR working group following to the "Requirements for the EcoLeaf PCR", then reviewed/authorized by the PCR committee. The PCR works as the cornerstone of EcoLeaf. All of the PCRs are available to view at http://www.jemai.or.jp/english/ecoleaf/pub_psc.cfm).

CASBEE is Japan's green building rating system. It is based upon the quality of the building divided by its load impact upon the environment. It was developed in adherence to the following policies:

- The system should be structured to award high assessments to superior buildings, thereby enhancing incentives to designers and others.
- The assessment system should be as simple as possible.
- The system should be applicable to buildings in a wide range of applications.
- The system should take into consideration issues and problems peculiar to Japan and Asia.



CASBEE differs from the USGBC's LEED certification process in that LEED certification starts at the beginning of the design process, with review and comments taking place throughout the design and construction of a project. A CASBEE ranking is dependent upon pre-design tools and site visits after the building is completed.

CASBEE exhibits Japan's growing interest in green building and works with Japan's recently adopted Energy Saving Act, a mandate for effective use of energy and other resources in transportation and related activities.

Lastly, to promote and expand the use of LCA technology in order to meet its climate and sustainability challenges, Japan is implementing JEMAI-LCA Pro, an LCA software developed by the Research Center for Life Cycle Assessment, National Institute of Advanced Industrial Science and Technology (AIST) and Japan Environmental Management Association for Industry (JEMAI).

The JEMAI-LCA series collects data on specific products from industrial companies and other organizations to calculate the environmental burden at each stage of their life cycle, and to advance the calculation method for the environmental impact of products and related systems. The data obtained through this project is added to an LCA Database which is intended to educate people on eco-products and services available.

In 1999, eight domestic program body organizations from eight countries formed the Global Environment Product Declarations Network (GEDnet), which is working to broaden the use of type III environmental labels. Efforts are underway to create international standards for these type III environmental declarations.

Currently representatives from Japan, Germany, Norway, Denmark, Republic of South Korea, China, Taiwan, Australia and Sweden are participating within GEDnet. http://www.gednet.org/

The United Kingdom

In 2006, the Prince of Wales' Accounting for Sustainability Project released the *Connected Reporting Framework,* a sustainability reporting tool for corporations and government agencies. The Framework made use of existing financial and non-financial information and satisfied what had been a lengthy gap in comprehensive sustainability tools.

The *Framework* is a tool and guideline that helps to embed sustainability into a corporation's daily operations by helping them to "understand the issues, set overall direction, make a plan, and understand what [they] are doing" within four priority areas:

- scale,
- sustainable consumption,
- environmental performance, and
- competition.

Rather than a one-size-fits-all approach, the framework is a sustainability decision-making model, a step-by-step guide to ensure that reporting is comprehensive yet understandable and useful. *(see http://www.sustainabilityatwork.org.uk/strategy/report/0).*

The *Connected Reporting Framework* guides organizations to meet key principles of reporting quality: balance, comparability, accuracy, timeliness, clarity, and reliability.

Partners in the project included the Sustainable Development Commission, National Audit Office (NAO), and the Department for Environmental Food and Rural Affairs (Defra).

Australia

Australia is the driest inhabited continent on earth. As the impacts of climate change intensify, Australia faces increasingly acute and long-term water shortages in its cities and regional areas – lower rainfall, rivers drying and dam water levels falling. Tackling the existing water crisis is a long-term priority for the Australian Government.

The National Water Initiative (NWI) is Australia's blueprint for water reform. Through it, governments across Australia have agreed on actions to achieve a more cohesive national approach to the way Australia manages, measures, plans for, prices, and trades water.

The Intergovernmental Agreement on a National Water Initiative was signed at the 25 June 2004 Council of Australian Governments meeting. Under the NWI, governments have made commitments to:

- prepare water plans with provision for the environment
- deal with over-allocated or stressed water systems
- introduce registers of water rights and standards for water accounting
- expand the trade in water
- improve pricing for water storage and delivery
- meet and manage urban water demands.

The NWI plans to achieve a national, regulatory and planning based system for managing surface and groundwater resources that optimizes economic, social and environmental outcomes. *(http://www.nwc.gov.au/www/html/117-national-water-initiative.asp?intSiteID=1)*

Currently, certain products are registered and labeled with their efficiencies, in accordance with the standard set under the national Water Efficiency Labelling and Standards Act 2005 (WELS); similar to the energy rating label (which clothes washing machines and dishwashers must carry). This allows consumers to compare products and rewards manufacturers and retailers who make and stock water efficient models.

The label displays a zero to six star rating for a quick comparative assessment of the product's water efficiency. The more stars, the more efficient the product. It is expected that by 2021, Australians could save more than $600 million through reduced water and energy bills and help to:

- reduce domestic water use by 87,200 megalitres (23,035,802,966 gallons) each year (5%); and
- save a total of 610,000 megalitres (161,144,951,940 gallons) of water

Nearly half the water savings are expected to come from more efficient washing machines, 25% from showers, and 22% from toilets.

Other Australian Government initiatives

- Energy Efficiency in Government Operations (EEGO)
- Assisting Government agencies to develop and introduce environmental management systems
- Environmental purchasing
- Encouraging the consideration of relevant environmental policies, programs, costs and benefits in Australian Government purchasing by the provision of voluntary environmental purchasing tools.
- Water efficiency guide: office and public buildings The Australian Government, with the governments of Queensland, New South Wales, the Australian Capital Territory, Victoria, South Australia and Western Australia, has developed a new guide for improving the water efficiency of office buildings and public buildings. This guide contains case studies from water efficient buildings, and provides practical guidance on how to reduce water use and water wastage. The guide covers both technical and behavioral opportunities.
  - » The state of New South Wales (NSW) offers a Green Business Program is providing $30 million throughout five years for projects that will save water and energy in business operations locally.
  - » South Australia Water's Business Water Saver Program works to identify opportunities to reduce water consumption and minimize wastewater production.
- National Water Intensity Benchmarks: the governments of Queensland, New South Wales, the Australian Capital Territory, Victoria, South Australia and Western Australia, are developing water intensity benchmarks for office buildings and public buildings. Water intensity refers to the water consumed per square meter of space. The benchmarks provide guidance to building owners, managers and tenants on how their buildings measure up against similar sites nationwide.

"South San Francisco Bay, California." Photo Credit: Jonathan Herz

Canada

In 1995, the *Guide to Green Government* reinforced Canada's commitment to sustainability. It laid a foundation for departments to prepare a comprehensive framework.

Sustainable development has long been a part of Canada's governmental policies and laws. Federal departments and agencies are legally required to table or report on a Sustainable Development Strategy (SDS) in Parliament every three years. As a result, Canada has benefited from continually evolving, new, and more accountable approaches for sustainable development strategies.

The most recent, SDS strategy, created an opportunity to establish government-wide priorities, accountabilities, targets, timelines and reporting requirements that include:

- Reductions in energy resources consumption
- Reduction in greenhouse gas and other air polluting emissions
- Green procurement
- Remediation of contaminated sites
- Waste management
- Environmental performance of vehicle fleet

Sustainable development "...is a continually revolving concept based on the integration of social, economic and environmental concerns, and which may be achieved by, among other things,

a) the integration of the environment and the economy; b) protecting the health of Canadians; c) protecting ecosystems; d) meeting international obligations; e) promoting equity; f) an integrated approach to planning and making decisions that takes into account the environmental and natural resource costs of different economic options and the economic costs of different environmental and natural resource options; g) preventing pollution; and h) respect for nature and the needs of future generations."

Canadian Auditor General Act (amended in 1995)

The Office of the Commissioner of the Environment and Sustainable Development has also reported and continues to report every year on the Government's performance regarding environment and sustainable development matters, with a particular focus each year on progress and challenges (reports of the CESD can be found at *www.oag-bvg.gc.ca).*

Additional involvement includes international conventions/protocols/agreements, the Federal Sustainable Development Act, and the Sustainable Development Strategies Management Review.

Other Initiatives: Enviroclubs

The Enviroclub initiative was developed by three federal government agencies (Canada Economic Development for Quebec Regions, Environment Canada and the National Research Council Canada) to bring together organizations from similar regions or sectors to carry-out pollution prevention projects. The projects generate cost savings while reducing emissions, energy, and raw material consumption.

Between 2000 and 2004, ten Enviroclubs were established and saw immediate results. From 2000 to 2005, 14 Enviroclubs from the Quebec region alone enabled 168 enterprises collectively to make recurring savings of $10.5 million a year while reducing on a yearly basis their consumption of:

- petroleum products, representing more than 4,000 barrels of oil
- propane, sufficient to fill 85,500 barbecue gas cylinders
- natural gas, sufficient to heat 1,350 mid-sized houses
- water, representing consumption by 8,000 people
- wood, equivalent to 6,210 cords
- and their discharge of:
- greenhouse gases, equivalent to the emissions from 6,217 cars
- hazardous waste, enough to fill 58 garbage trucks
- some 500 tonnes of chemicals, many of them toxic.

(Canada Economic Development for Quebec Regions, SDS 2007-2010 principles, targets and approaches, http://www.dec-ced.gc.ca/eng/publications/agency/dev/59/page-4.html).

India

India's traditional architectural foundation generally reflects sustainable design principles. But more popular and modern demand shifted design and construction towards an unsustainable Western style such as poorly performing glass boxes.

Such structures are particularly unsustainable because India's booming population and growing economy coupled with expected climate impacts will place some of the world's most intense stresses upon its local environment and natural resources. A booming resource demand will only intensify this resource strain. Thus, creating sustainable Indian buildings is crucial for progress.

New voluntary rating systems and enhanced building codes are beginning to transform the built environment.

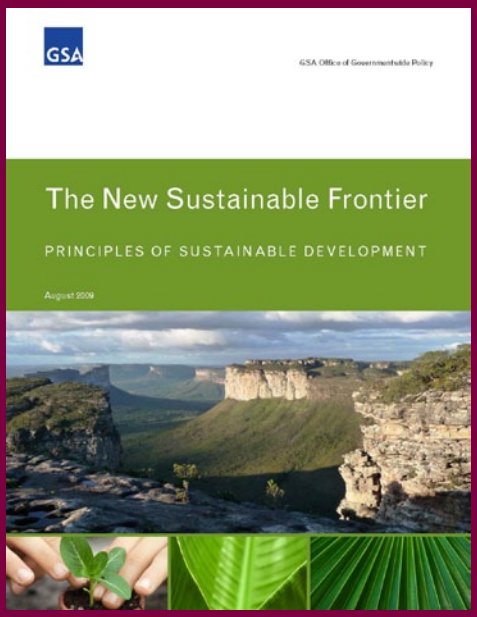
In 2001, India launched its own LEED rating system, through the India Green Building Council (IGBC). The Leadership in Energy and Environmental Design (LEED-INDIA) Green Building Rating System is a nationally and internationally accepted benchmark for the design, construction and operation of high performance green buildings. LEED-INDIA provides building owners, architects, consultants, developers, facility managers and project managers the tools they need to design, construct and operate green buildings specific to India's climate culture in the following areas:

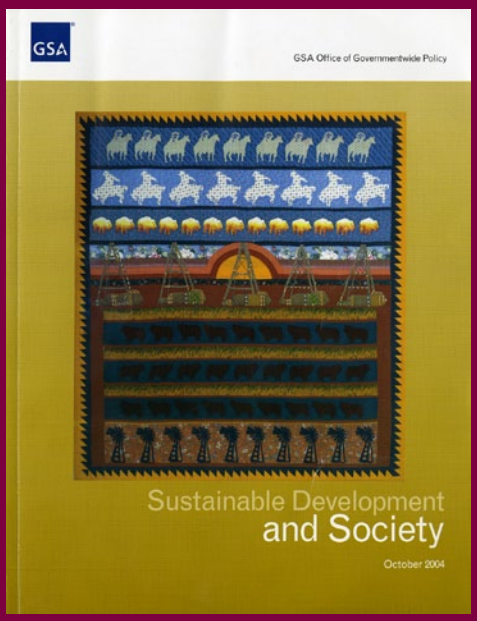
Sustainable site development

- Water savings
- Energy efficiency
- Materials selection and
- Indoor environmental quality

The programs include LEED India for New Construction (LEED India NC),LEED India for Core and Shell (LEED India CS), the IGBC Green Homes Rating System, and IGBC Green Factories. In addition, other rating programs including such as the BEE Star and the Green Rating for Integrated Habitat Assessment (GRIHA) encourages energy efficiency and the minimized use of air conditioning except under extreme cases. (*"Greening India", GreenSource, May|June 2009.*)

"Lavasa Hill Station Master Plan Design. Warasgaon Dam, India." Photo courtesy of HOK.





tools

Introduction

There aren't many things more frustrating than attempting to make a decision about a "green" product, material, or service from amongst the multiple market choices:

- Should I buy the energy consuming, regional product or the energy-efficient, international product?
- This product helps to achieve LEED® points but does it contain toxics?
- Should I specify the non-renewable, local product or the renewable bamboo from China?

So what do we really need to know about products and services? And how do we ensure that the choices we make are sustainable?

Existing U.S. Environmental Protection Agency (EPA) programs work to eliminate toxics, promote recycling, and identify life-cycle cost effective goods, services, and building practices that protect human health and the environment. With the U.S. Department of Energy (DOE), the EPA identifies energy efficient products, technologies and systems that reduce energy consumption and greenhouse gas generation.

The Department of Labor promotes economic well-being and just distribution through oversight of wage and working conditions, and the Small Business Administration helps promote advancement of small and historically disadvantaged businesses.

While these and many other programs support progress towards the goal of sustainable Government operations, existing economic decision-making models can sometimes undermine that progress. With careful and appropriate modifications, these models can help lead to sustainable solutions.

New tools, such as backcasting and multi-criteria analysis can identify sustainability goals and the strategies needed to achieve them. If the Government is to operate sustainably, existing policies and economic decision-making models need to be changed to reflect the realities of a closed world.

As a rule, a necessary but complex component in operating sustainably is the capacity to calculate the impacts of complex

production processes involved in the everyday operations and use of materials. Although the process can be resource, time, and labor-intensive, life cycle assessments are useful for this. Current sustainability tools generally try to incorporate lifecycle cost and lifecycle assessment thinking and fill in the information gaps that can lead us to the unsustainable options. They provide a method to measure the amount of energy and raw materials consumed at each stage of a building and product's life.

However, life-cycle assessments should not be viewed as the silver bullets toward sustainability. While they are helpful in analyzing a theoretical, environmental footprint, LCA's alone are not enough. A new perspective is needed where products and materials are measured in terms of throughput - to minimize the use of natural resources and reduce waste.

The Ideal Tool

An ideal sustainability tool needs to help us understand operational choices in the context of scale, distribution, and allocation. It would:

- Perform a life cycle analysis that accounts for human health and acknowledge the limitations of current knowledge and practices.
- Be comprehensive and comparable.
- Account for energy balance and resource flows from a product.
- Apply backcasting to monitor whether or not the tool is helping to meet goals.

The goal of an ideal sustainability tool would be to rate products, buildings, and services on their ability transform open, throughput-oriented systems into closed-loop systems. In the end, raw materials would be recycled and wastes eliminated. *To achieve this, the ideal tool would need to integrate multiple components: life-cycle assessments, multi-criteria analysis, new sustainable indexes, and backcasting.*

New Tools and Strategies: Backcasting and Multi Criteria Analysis are Tools that Can Identify Sustainable Goals and Strategies.

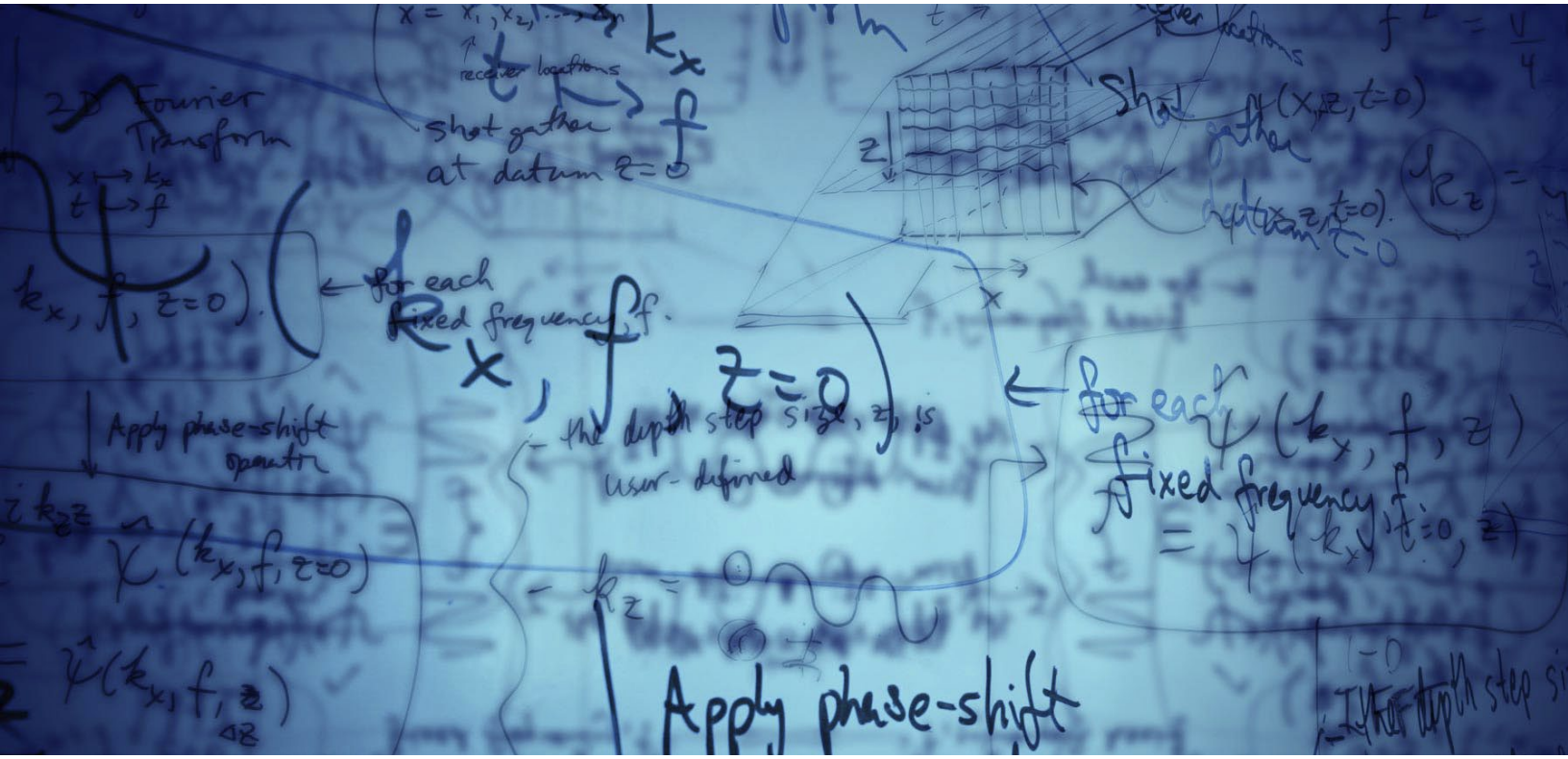
There are economic, environmental, and social consequences to every business decision we make. These decisions affect the resources that are available to those living today and to future generations– our children, our grand children, and generations far into the future. Economic policy-making, planning and tools must reflect this reality.

Earlier, we asked how we could operationalize sustainable concepts and integrate them into the way we deliver buildings, products and services. In this section, we will try to answer some of these questions.

Cost-Benefit Analysis and Life Cycle Assessment

Cost-Benefit Analysis (CBA) and Life Cycle Assessment (LCA) are two of the most useful tools we have to help us make investment decisions. The logic of seeking greater benefits than costs is indisputable. And, properly applied, LCAs transform open, throughput-oriented systems into closed-loop systems for products, services and buildings.

But, their use must be consistent with the economics of sustainability. We need to open the "Black Box" of CBA and LCA to examine their assumptions, and change the way we apply them to our decision-making process.



Multi Criteria Analysis

Many ecological economists criticize cost-benefit analysis because it relies on pricing of all factors involved in decision-making, including human lives, endangered species, and clean air and water. Multi Criteria Analysis is a decision-making framework for multi-disciplinary problems. This process includes the participation of many interested parties in decision making and in problem solving, and is focused on compromise or defining a coalition of views rather than dictation of judgment from a single stakeholder category.

Its greatest potential is in situations involving multiple value systems and objectives, which cannot be easily quantified (e.g. environmental issues) or translated in monetary terms due to their intangible nature e.g. social, cultural or psychological issues. This process involves stakeholders directly by presenting them with alternatives and allowing them to rank them. This brings a wide range of views and knowledge into decision-making.

Multi Criteria Analysis expands upon cost-benefit analysis, uses qualitative as well as quantitative measuring scales, is used to resolve problems with multiple values systems and objectives, and Involves stakeholders directly in decision-making.

Sustainable Indexes

It is essential for a government of a country or a state to be able to measure if it is doing a good job; moving in the right direction. The most commonly used indicator is the Gross Domestic Product (GDP). While GDP is a measure of economic activity (the amount of goods and services produced / consumed) which is sometimes used as a proxy for welfare. In theory, that means if GDP goes up, welfare will also go up, since people buying goods and services must mean that they value them higher than the price they pay, thereby generating additional welfare / satisfaction to them.

However, GDP does not include many components of welfare, including capital depreciation, goods and services purchased to counter externalities, household labor, volunteerism, and crime. Paradoxically, using cost benefit analysis, pollution can contribute to the calculation of economic welfare while the cost of prevention and amelioration can sometimes appear to reduce economic activity, and implicitly, public welfare.

A forest's ecosystem may contribute to economic and social well-being through provision of clean air, wildlife habitat, and recreation opportunities. But, GDP only includes the value of timber harvested from the forest and any "user fees" that may be leveraged from visitors.

There are measurement systems that reflect these factors and measure progress that includes both sustainability and well-being. Alternative indicators differentiate between the costs and benefits of growth and facilitate policies and institutional changes that promote activities where the needs of both the economy and environment can be met and create incentives for conservation and sustainable management of resources.

The Index of Sustainable Economic Welfare (ISEW) (Redefining Progress, 1995) recognizes that there are factors other than consumption that contribute to or detract from welfare. Some of the factors

are relatively easy to measure, such as capital formation, but others pose problems. For example, the depreciation of natural capital requires putting a value on it, which is highly debatable.

ISEW values durable goods based on service, not consumption. It subtracts the cost of air, water, and noise pollution, loss of wetlands and farmland, depletion of nonrenewable resources, and long-term environmental damage

The Genuine Progress Indicator (GPI) (Daly & Cobb 1989), which is very similar to ISEW, has recently come into favor. The Maryland Department of Natural Resources is using the Genuine Progress Indicator in accounting for their use of natural capital. This project originated out of concern for the economic impacts associated with water use on public lands. The State feels a responsibility to use this public water in a way that provides the most long-term benefit to Maryland's citizens, including social and environmental effects as well as impacts on economic performance.

The importance of indicators like ISEW and GPI is that using the Gross Domestic Product alone can lead to erroneous conclusions and counter productive policies. While both GDP and ISEW in the U.S. rose during 1960s, GDP continued to grow fivefold through the 1980's while the ISEW fell slightly in 1970s and sharply in 1980s – reflecting growing income inequality and exhaustion of resources.

"If an activity is sustainable, for all practical purposes it can continue forever. When people define an activity as sustainable, however, it is on the basis of what they know at the time. There can be no long-term guarantee of sustainability, because many factors remain unknown or unpredictable. The moral we draw from this is: be conservative in actions that could affect the environment, study the effects of such actions carefully, and learn from your mistakes quickly."

"'Sustainable growth'" is a contradiction in terms: nothing physical can grow indefinitely."

"'Sustainable use'" is applicable only to renewable resources: it means using them at rates within their capacity for renewal."

"'Sustainable development'" is used in this Strategy to mean: improving the quality of human life while living within the carrying capacity of supporting ecosystems."

International Union for Conservation of Nature and Natural Resources/ United Nations Environment Programme/World Wide Fund for Nature, 1991

Backcasting

How do we make sure that our policies are taking us where we want to go? If we are trying to create a sustainable world, it helps to look at the desired goal and develop strategies directly connected to that goal. This approach is known as 'Backcasting," which can best be defined in contrast to forecasting.

Forecasting is based on observation of past trends, which are then extrapolated to identify the most likely future developments. While forecasting seems like a logical way to reach a desired goal, it uses deterministic pathways and bases future actions on past practices that may actually have contributed to the problem at hand. This approach can be called "path-dependent."

Backcasting approaches the issue of path-dependency and desirability of long-term outcomes from the opposite perspective.

First, a desirable long-term sustainability target is defined. Then, a backcasting methodology is used to analyze the status quo to identify pathways leading to problem solving.

The backcasting process compares the desired target - such as diminishing the effects of global warming - and the status quo. In this case, establishing a goal of 350 parts per million of carbon dioxide in the atmosphere can lead to specific, necessary steps linking the present to the desired future. With this approach, well-meaning, but possibly ineffective policies can be avoided. Such an approach can determine whether reducing building energy cost budgets by 20 or 30 percent will be sufficient. Some estimates require an 80 percent decrease in world global warming pollution by 2050 to prevent the worst consequences of global warming.

In a multi-disciplinary organizational environment, backcasting will result in tangible milestones along a timeline, leading towards the long-term target. It provides a framework for establishing the policies and developing the tools that will ultimately operationalize sustainable development.

Unlike the random time periods associated with life cycle cost payback formulas, backcasting uses appropriate-length time spans to create methodological advantages. This approach is now increasingly applied in organizations, corporations, municipalities, agencies etc., to ensure reaching desirable strategic goals within a realistic and achievable time horizon.

"Apollo 17, Earth." Photo Credit: NASA

Existing Sustainability Tools

Existing Tools And Strategies

Several existing sustainability tools and strategies are in place that, if fully implemented, would significantly reduce the Government's impact on the natural environment and promote economic prosperity and social equity. There is no reason these policies cannot be fully implemented now in the acquisition of all goods and services that support Government operations.

With the exception of The National Oceanic and Atmospheric Administration's (NOAA) "Habitat Priority Planner," which begins to address these ideas, no readily available existing tools and strategies comprehensively address the principles of sustainability:

1. Sustainable Scale
2. Just Distribution, and,
3. Efficient Allocation.

Nor do they all provide for continued, balanced measurements and comparability with a level of scrutiny for all products, systems and buildings, both new and old, which will promote continuous improvement. Where economic principles are applied, they are base on traditional ideas of the open (rather than closed) world of perpetual growth.

The following is a first attempt to put existing tools and strategies into the truly sustainable context.

'Ready to Go' Tools

The Environmental Protection Agency, particularly the Office of Pollution Prevention, has programs to identify products and practices that reduce or eliminate waste and toxic substances in Government operations and promote recycling of materials. Agencies should work with EPA to eliminate use of non-compliant products and services. The EPA and the Department of Energy's Federal Energy Management Program (FEMP) also have programs that reduce energy consumption in products, services and buildings. ENERGY STAR qualified and FEMP designated products may be assumed to be life cycle cost-effective.

The benefits of these programs are easily demonstrated. And, depending upon the speed and breadth of their implementation, will reduce resource consumption and prevent pollution, and will move us towards sustainability.

Tools Needing Further Consideration

Some of the other tools used by the Government address more complex matters, and are themselves far more complex. While the elements that make up these tools are generally "transparent," they function as a sort of "Black Box," allowing their use without requiring detailed knowledge of their internal workings. These tools need further consideration:

- Office of Management and Budget OMB Circular A-11, "Preparation, Submission, And Execution of the Budget," which includes principles for capital asset acquisitions which address planning, costs and benefits, financing, and risk management requirements
- Various life cycle cost analysis (LCCA) guidelines, including:
- OMB Circular A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs,"
- FEMP life-cycle costing rules and procedures; NIST Handbook 135, "Life-Cycle Costing for the Federal Energy Management Program;" and
- Tri-Services Memorandum of Agreement on "Criteria/Standards for Economic Analyses/Life-Cycle Costing for MILCON Design"
- The National Institute of Standards and Technology's BEES® (Building for Environmental and Economic Sustainability) tool contains data on life cycle inventory results for a variety of building materials and building components
- Green Building Rating Systems, particularly the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system

How do we know whether these guidelines and tools result in sustainable choices, in the sense that they can be "carried on for a prolonged duration, or for the foreseeable future?"

Are these tools taking us where we want to go or are there unintended consequences? Some of them, like traditional lifecycle costing, have been the basis of economic decision-making for decades. But the state of the environment gives testament to the fact that these results are not sustainable.

Envisioning a Sustainable and Desirable America

Robert Costanza

World View

Humans as a part of nature
Steady state, ecological economy
Goal quality of life rather than consumption

Natural Capital

Protected as essential life support
Depletion heavily taxed

Built Capital

Runs on renewable energy and natural capital
Emphasis on quality rather than quantity
Small communities rule (both within and outside cities)

Human Capital

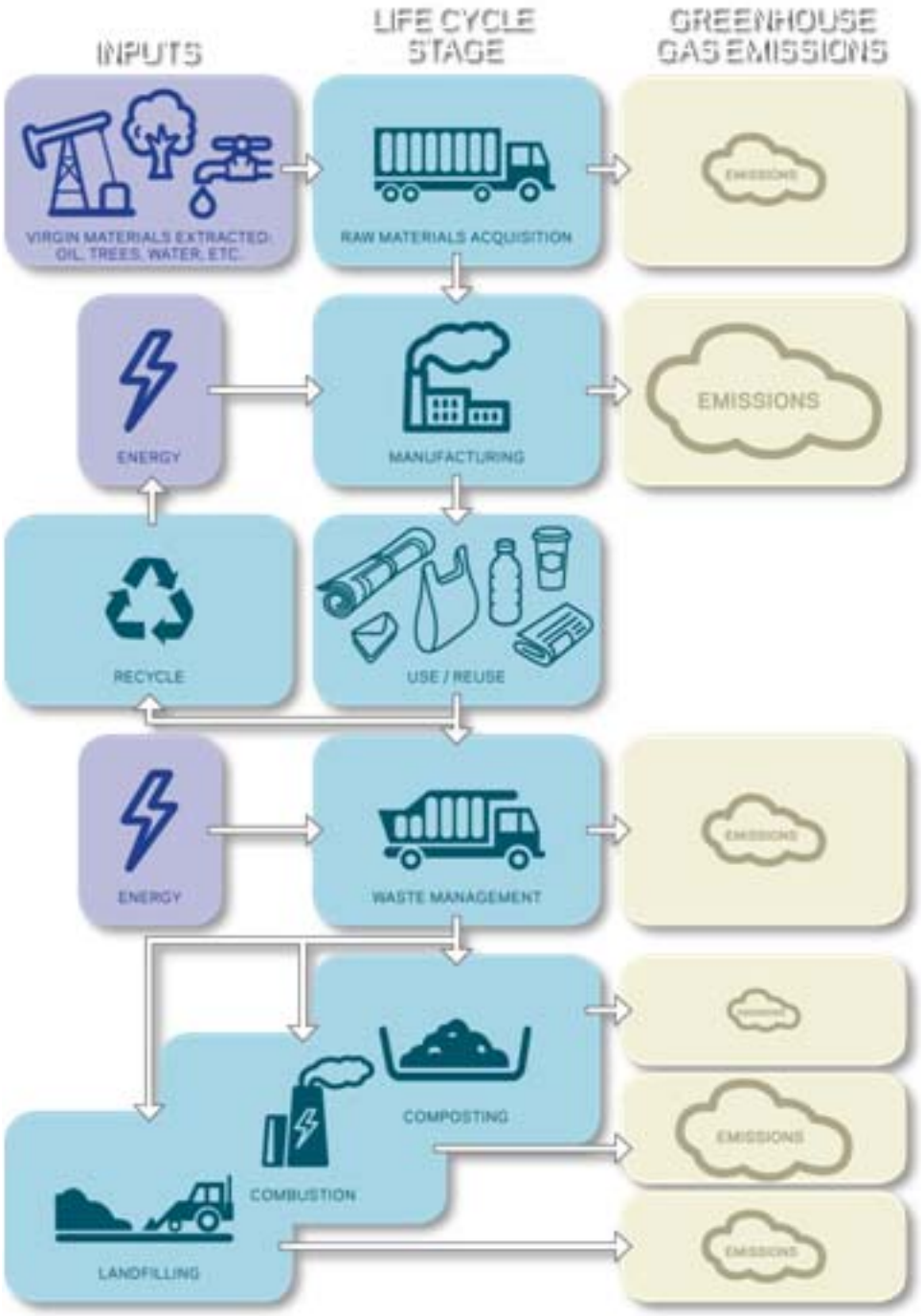
Balance of synthesis, analysis, and communication
Meaningful, creative work and leisure
Stable populations

Social Capital

A primary source of productivity and well-being
"Strong" democracy

see http://www.uvm.edu/giee/beyondenvironmentalism/costanza.htm

PHASES OF A PRODUCT'S LIFE-CYCLE



PRODUCT'S LIFE-CYCLE

Life-Cycle Assessments for Products

Building for Environmental and Economic Sustainability (BEES)

BEES measures environmental performance of building products using life-cycle assessments (LCA) specified in the ISO 14040 series of standards. BEES is for designers, builders, and product manufacturers and includes actual environmental and economic performance data for nearly 200 building products. Users do not need to know the intricacies of conducting LCA studies and little time is required to evaluate the material or product of interest. Environmental impacts are optionally combined into a single environmental performance score.

Limitations: it does not allow users to enter new products; rather, it's a tool for browsing pre-stored LCA and life-cycle costing (LCC) information on building components and materials. The subjectivity involved requires placing scores into the user's perspective and the BEES overall performance scores do not represent absolute performance. Instead, they represent relative performance among the alternatives.

Database Indicators: BEES 3.0 contains environmental and economic performance data for nearly 200 products across 23 building elements including beams, columns, roof sheathing, exterior wall finishes, wall insulation, framing, roof coverings, partitions, ceiling finishes, interior wall finishes, floor coverings, chairs, and parking lot paving.

BEES 4.0 was published in May 2007. The new release offers improved data. A total of 230 products are available for analysis and comparison (up from 198 in version 3.0), including 117 generic products and 163 brand-specific products, of which 23 are anonymous.*(http://www.buildinggreen.com/auth/article.cfm/2007/6/7/BEES-4-0-LCA-Software-Continues-Evolution/)*

Applicability to GSA operations: BEES can be used to compare the LCC and LCA of alternative building material choices. Congress provided fund to the USDA to support testing for biobased content using for products within the USDA that have been selected to designate for preferred procurement. As a result, manufacturers use NIST's BEES analytical tool to provide information on life-cycle costs and environmental and health benefits to federal agencies, when asked. USDA recommends that federal agencies affirmatively seek this information.

'Are our tools taking us where we want to go or are there unintended consequences? Some of them, like traditional lifecycle costing, have been the basis of economic decision-making for decades. But the state of the environment gives testament to the fact that the results are not sustainable.'

How does BEES compare against sustainability principles?

1. Sustainable Scale:

   a. *Does it address if the product returns to a reusable or biodegradable state?*
   BEES indirectly addresses recycling potential and whether or not commercial or industrial products are composed of biological products or renewable domestic agricultural materials. Such products are for the most part, recyclable or compostable and break down in landfills once the product wears out. BEES does not address incentives or processes for take-backs.

   b. *Does it address whether or not the company is going to lessen the environmental impact of the product?*
   Global Warming, Acidification, Eutrophication, Fossil Fuel Depletion, Indoor Air Quality, Habitat Alteration, Water Intake, Criteria Air Pollutants, Smog, Ecological Toxicity, Ozone Depletion, and Human Health are addressed.

   c. *Does it address whether or not environmental accountability is required of the suppliers?*
   Yes; to qualify for the new "USDA Certified Bio-based Product" label, products must first develop a BEES profile.

2. Toxics:

   a. Does it address toxics? Yes; ecological toxicity is an impact category.

3. Just Distribution:

   a. Does it address whether or not the product manufacturer put back into the community? No

4. Efficient Allocation:

   a. Does it address whether the product is the best solution to the problem?
   Subjectively by User – products are compared and scores are based upon the user's preferences. Continued, balanced measurements and comparability: Is the tool's data measurable? What is the unit of comparison? Does it maintain a level of scrutiny to all products, both new and old?
   Yes, but subjectively by user and weighted by the environmental impact categories. You must ensure a baseline weighting in order to accurately assess between multiple products.

McDonough Braungart Design Protocol (MBDC)™

MBDC uses the Cradle-to-Cradle Design Protocol, a scientifically based, peer-reviewed process to assess and optimize materials and their production processes. The Protocol,developed by Michael Braungart and his colleagues at Environmental Protection Encouragement Agency (EPEA) in Germany, places products into one of four categories based on human health and environmental relevance criteria. After all chemicals are assessed, the materials in a product application are optimized by positively selecting replacements for chemicals characterized as 'red'. These chemicals include all known or suspected carcinogens, endocrine disrupters, mutagens, reproductive toxins, and teratogens) and using 'green' chemicals as they are available.

Any product can be evaluated based upon its chemical hazard, recyclability and recycled content, energy and water use. Products that meet MBDC criteria may be certified as a Basic, Silver, Gold or Platinum product or as a Technical or Biological Nutrient, and can be labeled as Cradle-to-Cradle.

According to PHAROS, an LCA tool to evaluate specific building materials and systems: MBDC's basic and silver certifications are primarily based on doing inventories of energy and water flows, inventories of contents and making commitments to work with MBDC on eventual phase out of red list chemicals and improvement of water and energy flows. There can be no polyvinyl chloride (PVC) and background contamination of lead, mercury, cadmium and chrome are limited, but can be added for technical performance needs. For Silver, some of the product must be either recycled content or recyclable. Basic corporate policy statements on fair labor and other social ethics practices are required for Silver. Gold and platinum require increasing amounts of actual demonstrated changes in products and operations.

How does MBDC compare against sustainability principles?

1. Sustainable Scale:
    a. Does it address if the product returns to a reusable or biodegradable state? Yes
    b. Does it address whether or not the company is going to lessen the environmental impact of the product? Yes
    c. Does it address what happens when the product wears out? Or whether or not there is a process or incentive for take backs or recycling? Yes

d. Ecology: Does address whether or not environmental accountability is required of the suppliers (federal policy to mandate)? No

e. Does it address Toxics? Yes

2. Just Distribution:

   a. Does it address whether or not the product manufacturer put back into the community? Yes

3. Efficient Allocation:

   a. Economy: Does it address whether the product is the best solution to the problem? Yes

4. Toxics:

   a. Is there continued, balanced measurements and comparability? Is the tool's data measurable? What is the unit of comparison? Does it maintain a level of scrutiny to all products, both new and old? Yes

LCA within Green Building Standards and Third-Party Verification

Systems: Building standards and verification systems are good programs if the user understands their Green Building Standards and Third-Party Verification Systems.

LEED®

LEED is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across: energy savings, water efficiency, CO2 emissions reduction, improved indoor environmental quality, and stewardship of resources.

There is little argument over the level of influence that the USGBC's LEED rating system has had upon the built environment, manufacturing sector, and community conscience. Through its market transformation, LEED has created a new worldwide level of environmental awareness and sustainability.

For instance, we may know that water was saved and greenhouse gases avoided. But how do we know if LEED buildings are truly making the Earth sustainable? If sustainable development involves transforming the current "green" baseline beyond best practices, a design team should focus on issues such as waste elimination, renewable energy, closed loop flows, reduced transportation demand, energy efficiency and their ecological, social, and moral weightings.

How does LEED compare against sustainability principles?

LEED addresses multiple environmental and social attributes through various phases; however, there is no way to know whether LEED is sustainable since it is not placed in any type of context (e.g. through backcasting). Performance audits are not required post certification thereby creating an untested and limitless grade for all rating systems with the exception of 'Existing Buildings'.

1. Sustainable Scale:
    a. Does it address whether or not the user needs a new building? No. LEED it typically brought in after the decision to build has already been made.
    b. Does it provide a life-cycle plan from design through construction to operations and management? Life-Cycle Assessment is not a criterion to achieve LEED certification. LEED 2009 –Green Building Design and Construction has integrated aspects of LCA into its regional priority credits. LCA may also be used to achieve ID credits following strict performance criteria.
    c. Does it address the context of the project? Whether or not the company is going to lessen the environmental impact? Is it on a rural Greenfield or Urban infill? What region is the building in? Yes; extensively.
    d. Does it address whether or not the building minimizes the use of non-renewable resources?
    Yes; however, the use of renewable resources are greatly encouraged but not required.
2. Toxics:
    a. Does it address Toxics? Yes; however, the elimination of toxics is recommended but not required (e.g. toxic pest-control, volatile and toxic compounds within materials).
3. Just Distribution:
    a. Does it address whether or not the building makes people flourish? Yes
    b. Does it address if the building is aesthetically pleasing? No.
    c. Does it address if the building meets program needs and allow the users to be productive? Does it address if the users are happy with their space? To an extent. Owners may opt to implement an occupant survey but there is not process to verify that an owner responded to occupant discomfort levels, if any.
    d. Does it address if the building negatively affect the user's health? Yes. Quality of life and health are addressed within credits. It encourages owners to design in ways that allows occupants to be healthy, productive, and happy. Prerequisites ensure that basic comfort and environmental quality levels are met.
4. Efficient Allocation: Not directly addressed

GREENGUARD Environmental Institute

GREENGUARD Environmental Institute (GEI) is an industry-independent, non-profit organization that oversees the GREENGUARD Certification Program. GEI is an ANSI Authorized Standards Developer, and establishes acceptable indoor air standards for Indoor Air Quality, Schools, and Building & Construction.

Testing Procedures: The products are loaded into controlled environmental chambers which are then loaded with purified air streams that resemble airflow patterns of rooms and buildings into the chamber. GEI collects samples from the exhaust air. The environmental chamber testing provides a controlled and representative indoor environment that allows the product to produce the emissions in a realistic manner similar to the way the product would emit in a home or office.

Products are tested for formaldehyde, volatile organic chemicals (VOCs), particulates, ozone, carbon monoxide, nitrogen oxide, and carbon dioxide emissions. The environmental chamber testing emissions data can be mathematically modeled to determine exposure concentrations produced by the use of the product in many different indoor environments.

Limitations: GREENGUARD only provides a small snapshot of the product's make-up. It does not address the physical composition of a product (a typical test involves measurement of emissions over 168 hours with measurement points at 6, 24, 48, 72, 96, and 168 hours).

How does GreenGuard compare against sustainability principles?

1. Sustainable Scale:
    a. Does it address if the product returns to a reusable or biodegradable state? No; this program is only designed to evaluate VOCs, no other health and environmental attributes
    b. Does it address whether or not the company is going to lessen the environmental impact of the product? Yes; to the extent related to VOCs
    c. Ecology: Does it address what happens when the product wears out; or whether or not there is a process or incentive for take backs or recycling? No
    d. Ecology: Does it address whether or not environmental accountability is required of the suppliers? No
2. Efficient Allocation:
    a. Does it address whether the product is the best solution to the problem? No
3. Just Distribution:
    a. Does it address whether or not the product manufacturer put back into the community? No; this program is only designed to evaluate VOCs, no other health and environmental attributes
4. Toxics:
    a. Is there continued, balanced measurements and comparability? Is the tool's data measurable? What is the unit of comparison? Does it maintain a level of scrutiny to all products, both new and old? Yes but this program is designed to only evaluate VOCs; no other health and environmental attributes.

Green Seal

Green Seal is a voluntary labeling program to certify products for compliance with VOC and other chemical content criteria for indoor air quality and smog. It is a US-based ecolabeling organization that meets the United States Environmental Protection Agency's Criteria for Third Party Certifiers, the requirements of ISO 14020 and 14024, and the standards of the Global Ecolabelling Network.

Green Seal evaluates a product from the raw materials through the manufacturing process and ending with recycling or disposal. \The Green Seal means that the product has passed the tests; that it works as well as or better than others in its class.

Products covered include:

- Paints (including recycled content latex paint) (GS-11 and GS-43)
- Commercial Adhesives (GS-36)
- Windows & Doors & Window Films (GS-13)
- Electric Chillers (GS-31)
- Compact Fluorescent Lamps (GS-05)
- Occupancy Sensors (GS-12)
- Green Seal also covers a variety of paper, newsprint, cleaning and floor care products

Testing Procedures: Manufacturers arrange for product testing and submit product test data to Green Seal. Testing must be conducted by a facility meeting the requirements of the standard for test method, documentation, and reproducibility. Manufacturers with labs meeting the criteria are allowed to test their own products. Green Seal acts as the certifying agency, evaluating the testing results, and awarding the label.

According to PHAROS, an LCA tool to evaluate specific building materials and systems: "Green Seal's VOC restrictions are equal to SCAQMD, the South Coast Air Quality Management District, in some cases, less rigorous in others." SCAQMD develops, adopts and implements air standards established by national and state governmental legislation. "The one exception to that is Green Seal's restriction on point-of-sale added colorants (tints) to paints- an issue not addressed by SCAQMD, LEED or any other standard"; an important note as VOC levels often rise after colorants are added.

How does Green Seal compare against sustainable principles?

1. **Sustainable Scale:**
    a. Ecology: Does address whether or not environmental accountability is required of the suppliers? Yes
    b. Does it address what happens when the product wears out? Or whether or not there is a process or incentive for take backs or recycling? Yes
2. **Just Distribution:** not directly addressed

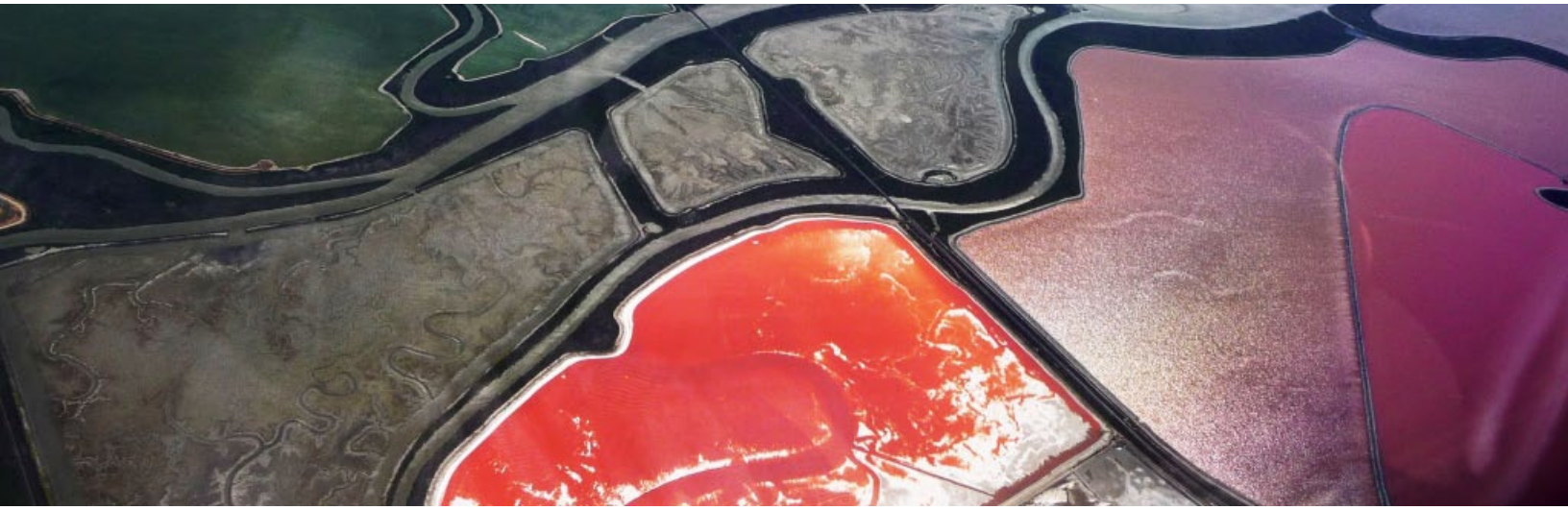
3. **Efficient Allocation:** not directly addressed
4. Toxics:
    a. Does it address toxics? Yes, Green Seal's standards addresses VOCs, performance, packaging, consumer education, and toxics.
    b. Is there continued, balanced measurements and comparability? Does it maintain a level of scrutiny to all products, both new and old? Yes

Energy Star

The ENERGY STAR Challenge intends to improve the energy efficiency of America's commercial and industrial buildings by 10 percent or more. There are many state and local efforts that refer to ENERGY STAR tools, such as Target Finder for new building or Portfolio Manager to track energy use, energy costs, and carbon emissions in existing buildings. For example, the District of Columbia programs include:

- the Green Building Act of 2006 which requires District-owned commercial buildings to be "Designed to achieve 75 points on the EPA national energy performance rating system as determined by the ENERGY STAR Target Finder tool" and benchmarked annually in EPA's Portfolio Manager; and
- the Clean and Affordable Energy Act of 2008 which requires that, beginning in 2010, eligible privately-owned commercial buildings be benchmarked using Portfolio Manager on an annual basis. Statements of energy performance will be published on a publicly available online database.

ENERGYSTAR itself is a joint program launched by the US DOE and US EPA. ENERGYSTAR indicates that devices carrying the Energy Star logo, such as computer products and peripherals, kitchen appliances, buildings and other products, save 20%-30% of energy use on average.



"South San Francisco Bay, California." Photo Credit: Jonathan Herz

The ENERGYSTAR program uses third-party validation and recognition as drivers for improving a building or product's energy management. This includes partnership programs, widely recognized performance standards, awards, and public reporting.

How does ENERGYSTAR Challenge compare against sustainability principles?

ENERGYSTAR has moved markets to greater efficiency. However, ENERGYSTAR only addresses one environmental and social attribute within one life cycle phase. And the Energy Star label process allows manufacturers to self-certify their products.

1. Sustainable Scale:
    a. Does it address if the product returns to a reusable or biodegradable state? No
    b. Does it address whether or not the company is going to lessen the environmental impact of the product?
    ENERGYSTAR is tightly focused on energy use, energy costs, and their reflective impact upon carbon emissions.
    c. Does it address what happens when the product wears out? Or whether or not there is a process or incentive for take backs or recycling? No
    d. Does it address whether or not environmental accountability is required of the suppliers? No
2. Toxics: Not addressed
3. Just Distribution:
    a. Does it address whether or not the product manufacturer put back into the community? No
4. Efficient Allocation:
    a. Does it address whether the product is the best solution to the problem? No

LCA for Whole Building Evaluation

ATHENA Version 4 (Dec 2008 release)

Athena 4 is an Environmental Impact Estimator (EIE) that evaluates whole buildings and assemblies based on LCA methodology. It allows users to compare the environmental implications of industrial, institutional, commercial and residential designs–both for new buildings and major renovations.

The Impact Estimator is a whole building environmental life cycle based decision support tool for use by designers, product specifiers, and policy analysts at the conceptual stage of a project, when key decisions are made about the shape and material make up of a building's structure and envelope.

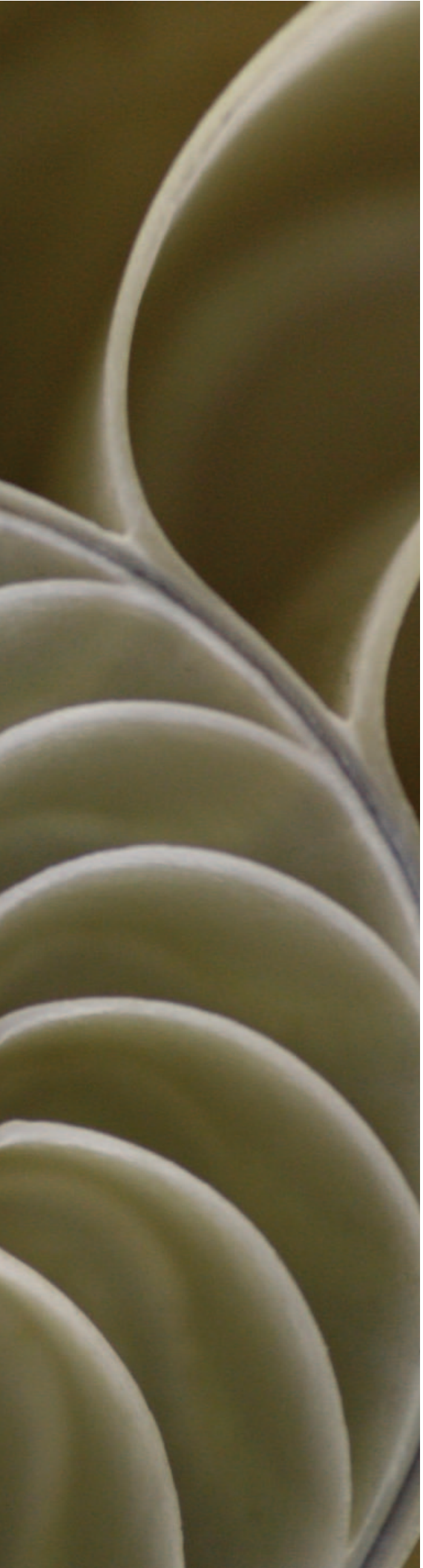
The impact Estimator is capable of simulating over 1,200 different assembly combinations and is applicable to about 95% of the building stock in North America. It has the ability to compare five different scenarios across a set of selected environmental impact measures and it tracts embodies primary energy use, global warming potential, solid waste emissions, air pollutants, water pollutants, weighted resource use.

The Estimator takes into account the environmental impacts of:

- Materials manufacturing, including resource extraction and recycled content
- Related transportation
- On-site construction
- Regional variation in energy use, transportation and other factors
- Building type and assumed lifespan
- Demolition and disposal
- Operating energy emissions and pre-combustion effects

Results are then provided in terms of cradle to grave for: embodied energy, acidification, global warming, human health respiratory effects, ozone depletion, smog, aquatic eutrophication, and weighted resource use.

"NOAA Center for Weather and Climate Prediction, Riverdale Park, Maryland." Courtesy of HOK



Database Management: Data is extracted from the US LCI Database Project and Canadian Database. Indicators include: Resource extraction, Manufacturing and on-site construction, recycled content, transportation, Maintenance, Demolition and land filling, and Operating energy effects.

How does ATHENA 4 compare against sustainable principles?

1. Sustainable Scale:
    a. Does it address if the user needs a new building? No
    b. Does it provide a life-cycle plan from design through construction to operations and management? Yes; extensively.
    c. Does it address the context of the project? Whether or not the company is going to lessen the environmental impact? Is it on a rural Greenfield or an Urban infill? What region is the building in? Yes; extensively.
    d. Does it address whether or not the building minimizes the use of non-renewable resources? Yes
2. Just Distribution
    a. Does it address whether or not the product manufacturer put back into the community? No
    b. Does it address whether or not the building makes people flourish? Yes
    c. Does it address if the building is aesthetically pleasing? No
    d. Does it address if the building meets program needs and allow the users to be productive? Does it address if the users are happy with their space? Yes
    e. Does it address if the building negatively affect the user's health? Yes. To an extent; ATHENA 4 heavily concentrates upon human health effects which can impact user productivity level.
3. Efficient Allocation
    a. Economy: Does it address whether the product is the best solution to the problem? No

4. Toxics:

    a. Is there continued, balanced measurements and comparability? Does it maintain a level of scrutiny to all products, both new and old? Yes; users are able to compare current and past analyses.

LCA for Specific Building Materials and Systems

EPA's EPP Program

EPA's Environmentally Preferable Purchasing Program (EPP) started in 1993 after the signing of Executive Order 12873, and continues under Executive Order 13423. EPA's Environmentally Preferable Purchasing (EPP) Program is helping agencies across the federal government comply with green purchasing requirements.

The intent of the project environmentally preferable means "products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose." This comparison applies to raw materials, manufacturing, packaging, distribution, use, reuse, operation, maintenance, and disposal.

Claimed Impact on Federal Purchasing:

- Improved ability to meet environmental goals
- Improved worker safety and health
- Reduced liabilities
- Reduced health and disposal costs
- Increased availability of environmentally preferable products in the marketplace

How does the EPP program compare against sustainability principles?

1. Sustainable Scale:

    a. Does it address if the product returns to a reusable or biodegradable state? Yes

    b. Does it address whether or not the company is going to lessen the environmental impact of the product? Yes

    c. Does it address what happens when the product wears out? Or whether or not there is a process or incentive for take backs or recycling? Yes

    d. Does address whether or not environmental accountability is required of the suppliers? Yes

    e. Does it address Toxics? Yes

2. Just Distribution:

    a. Ecology-Equity: Does it address whether or not the product manufacturer put back into the community? No

3. Efficient Allocation:

    a. Economy: Does it address whether the product is the best solution to the problem? Products are addressed on a comparable basis to one another, which may or may not provide the best solution.

Pharos

Pharos can be used to evaluate building materials against their impact upon health and pollution, environment and resources, and society and community. These include factors like embodied energy, indoor air quality, water usage, toxic materials, solid waste, global warming, and even corporate commitment to sustainability.

It has three elements: the Pharos Lens, the Pharos label, and Pharos Wiki. The Pharos lens is a graphically interactive tool for documenting the environmental and social performance of products in the marketplace. It is comprised of a series of wedges that are each assigned a different social or environmental issue. The number of wedges is currently not capped – meaning users can suggest and debate adding wedged priorities through Pharos Wiki, a virtual commons to share information about green building materials and the use of the other Pharos tools. The Pharos Project is still in development; Pharos v1 is currently being used to assess rating systems, verifiers, and products.

Pharos Lens

Courtesy of Pharos Project Wiki.

How does the Pharos Project compare against sustainability principles?

1. **Sustainable Scale:**
    a. Does it address if the material or system returns to a reusable or biodegradable state? Not specifically, Pharos addresses manufacturing and end-use waste.
    b. Does it address whether or not the company is going to lessen the environmental impact of the product? Yes
    c. Does it address what happens when the product wears out? Or whether or not there is a process or incentive for take backs or recycling? Unknown; it will address waste issues but it's currently unknown whether that data will be upstream or downstream.
    d. Does address whether or not environmental accountability is required of the suppliers? No
2. **Toxics:** Yes
3. **Just Distribution**
    a. Does it address whether or not the product manufacturer put back into the community? Yes
4. **Does it address whether the product is the best solution to the problem?** Yes

SimaPro

Contains detailed and transparent life cycle inventory data on thousands of life-cycle assessment processes as it pertains to the manufacturing, distribution and use of materials and products. It stands for "System for Integrated Environmental Assessment of Products" and contains life cycle impact assessment methods using input-output data sets to ISO standards. It's described as compact and simple, "usable by those who intend to spend less than 10 days on LCA."

Database Management: Within the inventory results, emissions can be specified into air, water, soil, solid waste, and waste streams. Emissions can also be defined using the sub compartments used by Eco-invent.

Parameters can be defined directly by the user and it is possible to link an amount field directly to an external data source. If a comparison is made, SimaPro will show the difference between two product systems, which gives the user the chance to see if the difference between product systems are indeed relevant, and for which impact category.

How does SimaPro compare against sustainability principles?

1. Sustainable Scale:
    a. Does it address if the material or system returns to a reusable or biodegradable state?

       Not specifically, SimaPro addresses manufacturing and end-use waste

    b. Does it address whether or not the company is going to lessen the environmental impact of the product? Yes

    c. Does it address what happens when the product wears out? Or whether or not there is a process or incentive for take backs or recycling? Yes

    d. Does address whether or not environmental accountability is required of the suppliers? No
2. Toxics:
    a. Does it address toxics? Yes
3. Just Distribution:
    a. Does it address whether or not the product manufacturer put back into the community? No
4. Efficient Allocation:
    a. Does it address whether the product is the best solution to the problem? Yes

GaBi 4.2

GaBi 4.2 is software for Life Cycle Assessment (LCA), Life Cycle Engineering (LCE), Greenhouse Gas Accounting, Benchmarking and Energy Efficiency of products and companies. It includes 650 sets of data compiled by IKP/PE International. The software allows users to model process chains for metals, organic and non-organic products, synthetics, minerals, provisions of energy (steam, thermal energy, electricity mixes and power stations), and end of life disposal processes.

How does GaBi 4.2 compare against sustainability principles?

1. Sustainable Scale:
    a. Does it address if the material or system returns to a reusable or biodegradable state? Yes
    b. Does it address whether or not the company is going to lessen the environmental impact of the product? Yes
    c. Ecology: Does it address what happens when the product wears out? Or whether or not there is a process or incentive for take backs or recycling? Yes
    d. Does address whether or not environmental accountability is required of the suppliers? Yes

2. Toxics:
    a. Does it address toxics? Yes
3. Just Distribution:
    a. Does it address whether or not the product manufacturer put back into the community? No
4. Efficient Allocation:
    a. Does it address whether the product is the best solution to the problem? No

Umberto

Umberto integrates both LCA and LCC in order to model material and energy flows throughout a product's entire life cycle. Umberto is most beneficial to companies with cost-intensive production that wish to optimize their processes and improve their competitiveness. This includes industries such as the chemical, semiconductor, waste management, and printing.

Within Umberto, a user creates projects defined by a list of products, raw materials, pollutants, and other forms of energy. These indicators are all referred to as materials and can be placed into a hierarchical listing based upon the user's priorities. The materials possess technical properties referred to as "caloric values". Technical properties can be ecological, such as the global warming potential or the toxicity of the material, to economic, the market value of the material. Outputs and comparisons are displayed as requested. The various fields of application include: energy supply, waste disposal, transport, provision of raw materials and basic materials such as plastics, metals, building material, fibers etc.

How does Umberto compare against sustainability principles?

1. Sustainable Scale:
    a. Does it address if the material or system returns to a reusable or biodegradable state? Not specifically; Umberto addresses waste disposal
    b. Does it address what happens when the product wears out? Or whether or not there is a process or incentive for take backs or recycling? Yes
    c. Does address whether or not environmental accountability is required of the suppliers? No
    d. Does it address whether or not the company is going to lessen the environmental impact of the product? Yes
2. Just Distribution:
    a. Does it address whether or not the product manufacturer put back into the community? No
3. Efficient Allocation:
    a. Does it address whether the product is the best solution to the problem? No

4. Toxics:

    a. Is there continued, balanced measurements and comparability? Does it maintain a level of scrutiny to all products, both new and old? Yes.

Life Cycle Costing (LCC) Tools: Buildings

EnergyPlus

This software models heating, cooling, lighting, ventilating, and other energy flows as well as water in buildings. EnergyPlus is originally based on the most popular features and capabilities of BLAST and DOE-2 and includes capabilities such as time steps of less than an hour, modular systems and plant integrated with heat balance-based zone simulation, multi-zone air flow, thermal comfort, water use, natural ventilation, and photovoltaic systems.

This is not a life cycle analysis tool. It produces results that can be fed into a LCC program.

How does EnergyPlus compare against sustainability principles?

1. Sustainable Scale:

    a. Does it address if the user needs a new building? No

    b. Does it provide a life-cycle costing plan from design through construction to operations and management?

        i. Design – Yes

        ii. Operations and maintenance – Yes

        iii. Re-use / recycle / deconstruct – No

        iv. Lifecycle cost management – Yes

    f. Does it address the context of the project? Whether or not the company is going to lessen the environmental impact? Is it on a rural Greenfield or an Urban infill? What region is the building in? No

    g. Does it address whether or not the building minimizes the use of non-renewable resources? EnergyPlus is useful for evaluating the costs and benefits of energy conservation and renewable energy projects.

"Northern New Mexico." Photo Credit: Jonathan Herz

2. **Toxics:** Not addressed
3. **Just Distribution:**
    a. Does it address whether or not the building makes people flourish? Does it address if the building is aesthetically pleasing? Does it address if the building meets program needs and allow the users to be productive? Does it address if the users are happy with their space? Does it address if the building negatively affect the user's health? To an extent; the software models heating, cooling, lighting, and ventilating which when adequately addressed, will allow users to be productive and happy within their space.
4. **Efficient Allocation:** Not addressed

Life-Cycle Costing Tools: Economic Analysis

All life cycle costing (LCC) tools must be used in conjunction with other strategies. Discount rates and other strategies can be problematic. For instance, in cost benefit analysis, "discounting" is used to estimate the present day value of benefits and costs that accrue over time. It makes sense in a purely financial decision, such as when we consider the present day value of interest that could be obtained by investing money over time, rather than spending it now. When applied to things that are not easy to price, such as ecosystem services, discounting can jeopardize sustainability goals by favoring actions in the present whose cost impacts are mainly in the future.

Furthermore, choosing discount rates beyond a single generation raises questions about equity, since it assumes that the same resource, or an identical substitute, will always be available and that future generations will be able to absorb the costs of our actions today.

Building Life-Cycle Cost (BLCC)

BLCC was developed by NIST. It conducts economic analyses by evaluating the relative cost effectiveness of alternative buildings and building-related systems or components. i.e. The LCC of two or more alternative designs are computed and compared to determine which has the lowest LCC and is therefore more economical in the long run.

It is especially useful for evaluating the costs and benefits of energy and water conservation and renewable energy projects. BLCC also calculates comparative economic measures for alternative designs, including Net Savings, Savings-to-Investment Ratio, Adjusted Internal Rate of Return, and Years to Payback.

This is not a life cycle analysis tool. The software can evaluate federal, state, and local government projects for both new and existing buildings.

Costs can be categorized as :

- initial investment costs,
- operation and maintenance costs,
- energy costs and water costs,
- capital replacement costs,
- residual values, and
- financing costs.

How does BLCC compare against sustainability principles?

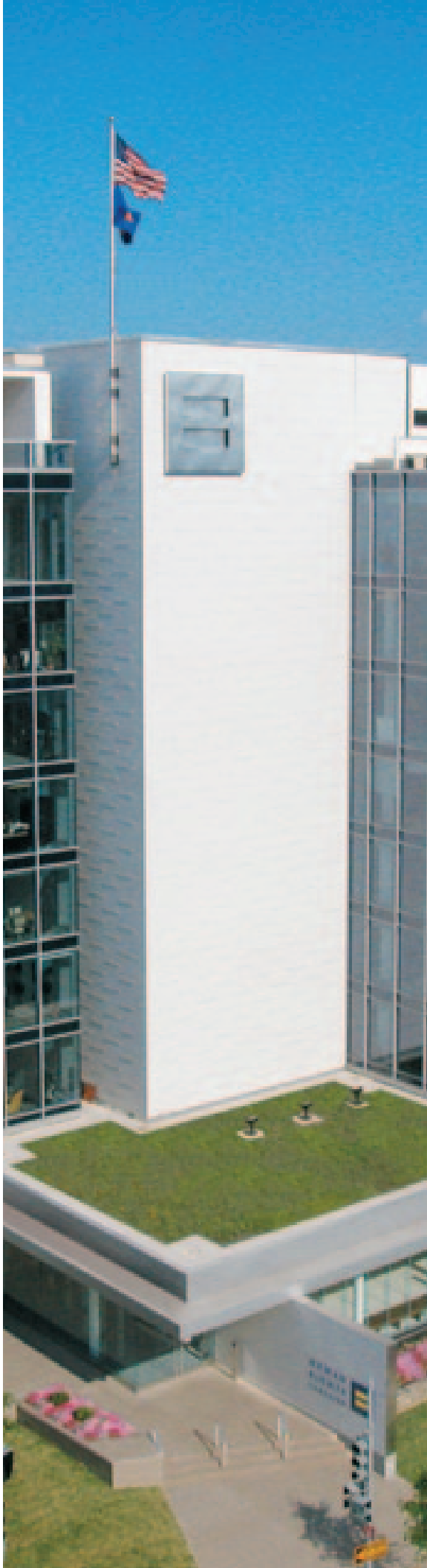
1. **Sustainable Scale:**
    a. Does it provide a life-cycle plan from design through construction to operations and management?
        i. Design – Yes
        ii. Operations and maintenance – Yes
        iii. Re-use / recycle / deconstruct – No
        iv. Lifecycle cost management - Yes BLCC only address LCC for initial investments and operations.
    b. Does it address the context of the project? Whether or not the company is going to lessen the environmental impact? Is it on a rural Greenfield or an Urban infill? What region is the building in? No
    c. Does it address whether or not the building minimizes the use of non-renewable resources? BLCC is useful for evaluating the costs and benefits of energy and water conservation and renewable energy projects.
2. **Toxics:** Not addressed
3. **Just Distribution:**
    a. Does it address if the building is aesthetically pleasing? Does it address if the building meets program needs and allow the users to be productive? Does it address if the users are happy with their space? Does it address if the building negatively affect the user's health? No; however, BLCC has the capability of estimating annual and lifecycle CO2, SO2, and NOX emissions in parallel with the energy use of the building or building system being evaluated.
4. **Efficient Allocation:** Not addressed

ECONPACK

ECONPACK incorporates economic analysis calculations, documentation and reporting capabilities. It is structured towards non-economists to prepare documented economic analysis (EA) in support of DOD funding requests. ECONPACK is geared towards standardized economic analysis for capital investments such as barracks, hospitals, family housing, information systems, utility plants, maintenance facilities, etc.

How does ECONPACK compare against sustainability principles?

1. **Sustainable Scale:**
    a. Does it address if the user needs a new building? No
    b. Does it provide a life-cycle plan from design through construction to operations and management?
        i. Design – Yes
        ii. Operations and maintenance – Yes
        iii. Re-use / recycle / deconstruct – No
        iv. Lifecycle cost management - Yes ECONPACK is a generic LCC for specific investment categories related to the DOD and government.
    c. Does it address the context of the project? Whether or not the company is going to lessen the environmental impact? Is it on a rural Greenfield or an Urban infill? What region is the building in? No
    d. Does it address whether or not the building minimizes the use of non-renewable resources? No
2. **Just Distribution:**
    a. Does it address whether or not the building makes people flourish? Does it address if the building is aesthetically pleasing? Does it address if the building meets program needs and allow the users to be productive? Does it address if the users are happy with their space? Does it address if the building negatively affect the user's health? No
3. **Efficient Allocation:** Yes



"Human Rights Campaign headquarters building, Washington, DC." Courtesy of HOK

Life-Cycle Costing Tools: Energy Use

Facility Energy Decision System (FEDS)

FEDS 6.0 was developed at Pacific Northwest National Laboratory (PNNL) with the support of the U.S. Army Installation Management Agency Southeast Region, U.S. Coast Guard, Tennessee Army National Guard, and the Canadian government.

It identifies minimum life cycle cost retrofits, determining payback, and enabling users to prioritize options for meeting energy efficiency goals. FEDS contains a built-in database of building survey data and is able infer a number of building parameters based on the small set of required (minimum set) inputs by the user.

For example, information such as building type, location, floor area, and vintage can be used to model buildings without having intimate knowledge of the detailed engineering parameters. Hourly weather data, energy simulation and financial engines determine energy consumption, electric demand, and calculate the cost effectiveness of potential retrofits. Additionally, FEDS determines the impact of retrofit projects on emissions of CO, CO2, NOx, SO2, hydrocarbons, and particulates.

How does FEDS compare against sustainability principles?

FEDS strictly focuses on energy use. It does not address sustainable scale, toxics, just distribution, and efficient allocation.

ENERGY-10

ENERGY-10 is a design tool that analyzes—and illustrates—the energy and cost savings that can be achieved through more than a dozen sustainable design strategies. It is a whole-building design tool that enables designers to test energy use and costs of their design. Hourly energy simulations helps the user quantify, assess, and clearly depict the benefits of technologies such as daylighting, passive solar heating, natural ventilation, well-insulated envelopes, better windows, lighting systems, mechanical equipment, and more.

The simulation software is suitable for examining small commercial and residential buildings that are characterized by one, or two thermal zones (generally less than 10,000 ft2.)

ENERGY-10 is the key tool in SBIC's Small Commercial Buildings program. It covers 16 energy-efficiency strategies that software users need to understand in order to use it effectively:

- Daylighting
- Glazing
- Shading
- Energy-efficient lighting
- Lighting controls
- Insulation
- Air leakage control
- Thermal mass

How does Energy-10 compare against sustainability principles?

Energy-10 strictly focuses on energy use. It does not address sustainable scale, toxics, just distribution, and efficient allocation.

Multi-Criteria Analysis

NOAA's Habitat Priority Planner

NOAA's Coastal Services Center provides a tool to review alternatives for coastal development that quantifies economic, environmental, and social impacts. The "Habitat Priority Planner" looks beyond smart growth and towards a perfect balance between the natural and built environment by preparing and analyzing hypothetical development scenarios.

For example, in coastal Georgia, NOAA worked to integrate life cycle concepts, consensus-based standards, and performance measurement and verification methods into three hypothetical designs: conventional, new urbanism, and conservation scenarios. The approach used local partners and science based skills and technologies to evaluate each. From there, the team began with a list of potential economic, environmental, and social indicators to measure hypothetical impacts from the various scenarios on the surrounding environment. Factors such as whether or not the site location was within a region or watershed were important. As the project moved forward, the team discussed and refined its indicators - life cycle analysis, local consensus, performance measurements and verification methods all influenced the achievement of a sustainable development.

Rather than jumping to an assumed "less bad" approach, this process focused on a coalition of views and indicators in order to omit dictation of judgment from a single stakeholder category. This structure assesses multiple value systems and objectives, not easily quantified, to develop a scenario that works best for the community and its surrounding environment.

You can view these project results on NOAA's Web site at: (http://www.csc.noaa.gov/digitalcoast/tools/hpp/). The Web site is structured to allow users to walk through the project processes and results. It is a valuable educational tool that provides information and promotes dialog with local government officials, planners, developers, and citizens in the communities they serve.

How does NOAA Habitat Priority Planner compare against sustainability principles?

1. Sustainable Scale:
    a. Does it address if the user needs a new building? No
    b. Does it provide a life-cycle plan from design through construction to operations and management? Yes
    c. Does it address whether or not the company is going to lessen the environmental impact? Yes
    d. Does it address if the project is on a rural Greenfield or an Urban infill? Yes
    e. Does it address region? Yes
    f. Ecology: Does it address whether or not the building minimizes the use of non-renewable resources? Yes
    g. Ecology: Does it address whether or not toxics are used? Possibly. Measured indicators are determined by individual teams.
2. Just Distribution:
    a. Does it address whether or not it makes people flourish? Yes
    b. Does it function to meet program needs and allow the users to be productive? Yes

The Tools Matrix

Moving towards a sustainable world requires an understanding of sustainability and natural systems. Sustainable operations are those that, to the greatest extent practicable, use only goods and services that:

- consume non-renewable resources at a rate below that at which they can be replaced by renewable substitutes, if any,
- prevent pollution or generate waste at rates below the ecosphere's assimilative capacity,
- eliminate virgin material requirements and 'close the loop' by using recycled and/or recyclable materials, and
- maintain critical ecosystems that provide essential life support.

The following are matrices and graphics that consolidate and organize the tools reviewed above. The intent is - to identify closed-loop transformative practices, far from the typical baseline, and its relevant tool that may enables us to achieve that practice, if any. These matrices can help users make informed choices between competing tools and strategies to encourage better solutions.

The tools reflect the following transformative criteria:

- give priority to human and ecosystem health, safety and welfare,
- restore and protect public goods and services such as clean air and water,
- prevent, rather than remedying the harmful results of economic activities through pollution prevention and toxics elimination, and
- integrate economics with the physical and life sciences so that decisions respect the interrelations among economic, environmental and social sustainability.

These matrices are a first step towards identifying sustainability tools. It is not meant to be comprehensive. Other tools are available and should be evaluated with the same goals in mind.

www.noaa.gov

SITE

Sustainable Goal	Transformative Practice	Applicable Tool
Maintain, protect, and enhance the surrounding environment.	Living systems and local climate are reflected within the building design, the surrounding landscape, and operations of a building. The site's character should be very much rooted in the existing plant material and topography.	Biomimicry: discipline that studies nature's best ideas and then imitates these designs and processes to solve human problems.
Minimize development on Greenfields and maximize development on land that will have the least environmental impact.	Minimize footprint, bring development towards urban centers, and use existing buildings and local/ natural materials.	NOAA's Habitat Priority Planner: an approach to quantify the economic, environmental, and social impacts of a development. LEED: an internationally recognized green building certification system. Athena: an Environmental Impact Estimator (EIE) that evaluates whole buildings and assemblies based on LCA methodology.
Take into account climate change.	Take advantage of local experts to integrate resilient development. Divergence from coastlines, wetlands and sensitive zones to manage flood risks. Minimize urban heat island affect with reflective or vegetative surfaces.	NOAA's Habitat Priority Planner: an approach to quantify the economic, environmental, and social impacts of a development.
Reduce GHGs: promote sustainable and efficient transportation.	Incentives for electric hybrid vehicle use and multiple mass transit options. Providing a site with access to public transportation will help to curb vehicle emissions that contribute to smog and harmful air quality as well as the continued use of oil extraction. Mass transit eases traffic congestion and the harmful demands it causes upon the environment. Encourage healthy lifestyles through the promotion of pathways that create a safe and healthy workplace by supporting staff who want to achieve and/or maintain active lifestyles. Use smart Conference Rooms that minimize travel.	NOAA's Habitat Priority Planner: an approach to quantify the economic, environmental, and social impacts of a development. LEED: an internationally recognized green building certification system.
Reduce impact upon municipal stormwater systems; minimize environmental impact.	Design stormwater management approaches that emphasize conservation, minimization techniques, pollution prevention measures and runoff. Areas with occurrences of combined sewer overflows (CSOs) require zero stormwater impact through strategies such as pervious pavement, green roofs, or rainwater capture and re-use.	NOAA's Habitat Priority Planner: an approach to quantify the economic, environmental, and social impacts of a development. LEED: an internationally recognized green building certification system.
Restricted use of potable water for landscaping needs (greywater recycling and rainwater harvesting).	Overcome environmental, health, and technical barriers towards widespread water recycling and increased rainwater harvesting.	Unknown
Community Connectivity: supporting wellness at work and within the community.	Promote access to decent, appropriate and affordable housing. Encourage healthy lifestyles through the promotion of pathways that create a safe and healthy workplace by supporting staff who want to achieve and/or maintain active lifestyles.	NOAA's Habitat Priority Planner: an approach to quantify the economic, environmental, and social impacts of a development.

HABITAT

BASELINE → TRANSFORMATIVE

TRANSPORTATION

BASELINE → TRANSFORMATIVE

COMMUNITY

BASELINE → TRANSFORMATIVE

WATER

BASELINE → TRANSFORMATIVE

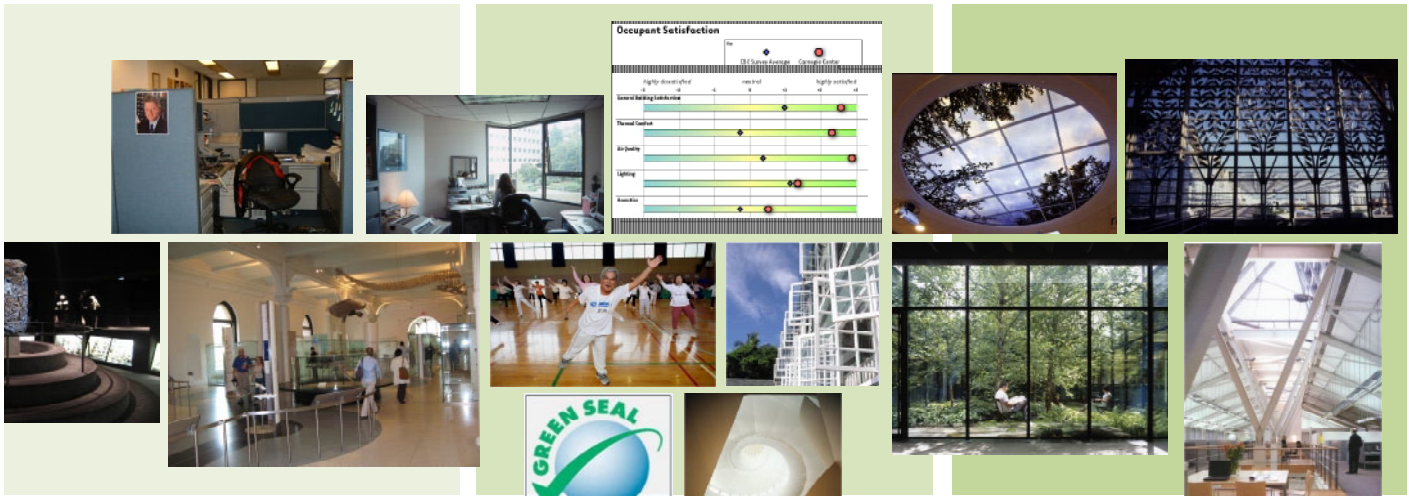
WATER

Sustainable Goal	Transformative Practice	Applicable Tool
Minimize impacts on the consumption of energy, water and other resources due to waste growth.	Required 40% water-use reduction from current baseline standards for water sensitive areas (e.g. Phoenix, Texas, Florida, and California) through waterless urinals, greywater re-use, etc., as well as stronger backing for innovative natural wastewater technologies. Other improvements should include new Building Regulations which require water efficient measures to be incorporated especially within affordable housing.	Unknown
Closed Loop water supply: sustainably provide potable water by naturally treating wastewater on-site. It can then be recycled for flushing or irrigation needs. Treating wastewater on-site reduces demand upon local treatment facilities and water transportation requirements.	Use of multi-criteria analysis to operate sustainable mechanisms for water treatment. Maximized use of technologies such as: solar desalination, natural treatment systems, water conservation (e.g. waterfree urinals, low-flow aerators and composting toilets).	Unknown

HUMAN HEALTH

Sustainable Goal	Transformative Practice	Applicable Tool
Improve surrounding air quality by minimizing development on Greenfields and maximizing development on land that will have the least environmental impact.	Minimize footprint, bring development towards urban centers, and use existing buildings and local/natural materials. Encouraging development near or within urban areas will help to increase the use of public transportation and curb vehicle emissions that contribute to smog and harmful air quality as well as the continued use of oil extraction. Mass transit eases traffic congestion and the harmful demands it causes upon the environment.	LEED: an internationally recognized green building certification system. NOAA's Habitat Priority Planner: an approach to quantify the economic, environmental, and social impacts of a development.
Construction Practices: Create a construction environment absent of toxins and other harmful health compounds through high quality and natural materials and use of sustainable construction methods.	Implement technologies to promote occupant health, comfort, and productivity through the elimination of toxins and harmful substances.	GaBi 4.2: software for Life Cycle Assessment (LCA), Life Cycle Engineering (LCE), Greenhouse Gas Accounting, Benchmarking and Energy Efficiency of products and companies. The Pharos Project: used to evaluate building materials against their impact upon health and pollution, environment and resources, and social and community. McDonough Braungart Design Protocol (MBDC): a Cradle to Cradle Design Protocol to evaluate a product based upon its chemical hazard, recyclability and recycled content, energy and water use and some social responsibility. Umberto: models material and energy flows throughout a building material's entire life cycle.
Indoor Air Quality: Create an indoor environment absent of toxins and other harmful health compounds through high quality and natural products.	Use low-emitting materials to preserve healthy indoor air by reducing the level harmful emissions and toxins permitted in the building. Many new building products outgas Volatile Organic Compounds (VOCs) and formaldehyde, among other toxic chemicals. Educate facilities' staff to support the goals, technologies, and sustainable operations of the building.	McDonough Braungart Design Protocol (MBDC): a Cradle to Cradle Design Protocol to evaluate a product based upon its chemical hazard, recyclability and recycled content, energy and water use and some social responsibility. GREENGUARD: establishes acceptable indoor air standards for Indoor Air Quality, Schools, and Building & Construction. EPA's Environmentally Preferable Purchasing Program (EPP): a program that helps government agencies comply with green purchasing requirements.

PEOPLE/INDOOR ENVIRONMENT



BASELINE → TRANSFORMATIVE

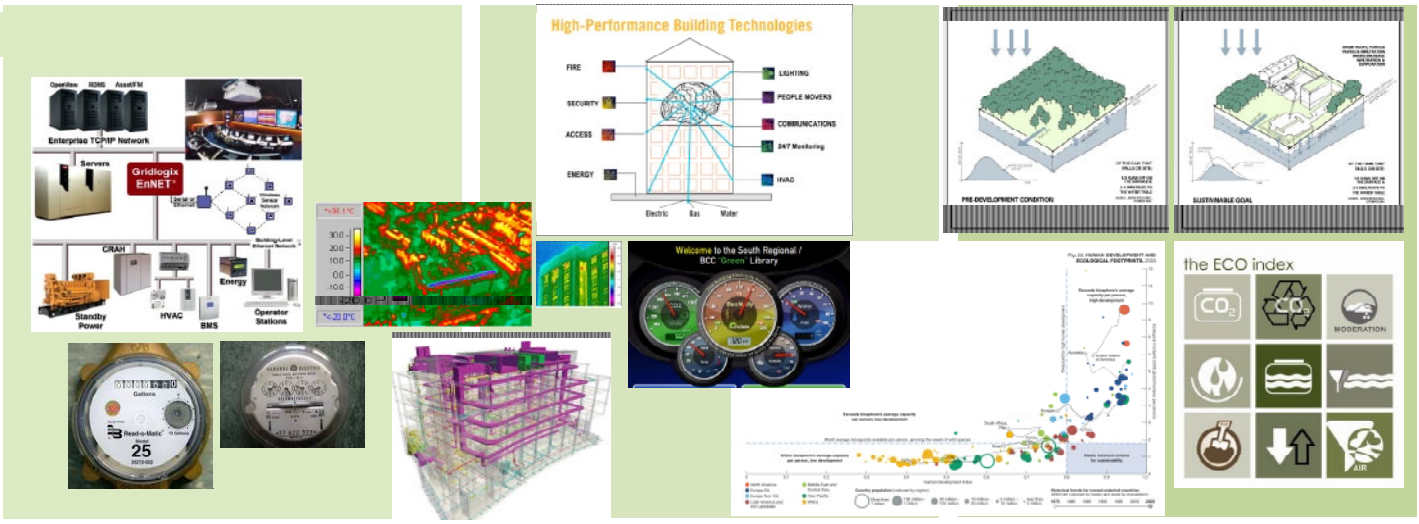
CONSTRUCTION PRACTICE AND WASTE ELIMINATION

Sustainable Goal	Transformative Practice	Applicable Tool
Closed Loop Practices. No cumulative impact identified, and potential is mitigated by development control policies.	Implement processes and protocols that minimize resource utilization, waste, and life cycle environmental impacts from building construction, renovation, and demolition: 1. Deconstruction first, demolition second 2. Streamline construction processes that re-use furniture, building materials, recycled construction materials	Green Recycling Network (GRN): full deconstruction services of commercial buildings using a disassembly process with the objective to recover materials for re-use. GRN landfill diversion rates regularly exceed 90% of materials such as such as carpeting, drywall, metal, ceiling tile, stained/painted wood, glass, etc. while following EPA's comprehensive guidelines for the construction, renovation. (http://greenrecyclingnetwork.com/2009/) The Construction Waste Management Database contains information on companies that haul, collect and process recyclable debris from construction projects. Created in 2002 by GSA's Environmental Strategies and Safety Division to promote responsible waste disposal, the Database is a free online service for those seeking companies that recycle construction debris in their area. (http://www.wbdg.org/tools/cwm.php?u=5)

BUILDING MATERIALS AND PRODUCTS

Sustainable Goal	Transformative Practice	Applicable Tool
Use only those goods and services that, in their production use and distribution, conserve, recover and continuously recycle natural resources and restore ecosystem services in a closed-loop manner.	Conduct life-cycle assessments for building products, materials, and services. Take into account toxicity and volatile compounds.	Building Materials: GaBi 4.2: software for Life Cycle Assessment (LCA), Life Cycle Engineering (LCE), Greenhouse Gas Accounting, Benchmarking and Energy Efficiency of products and companies. The Pharos Project: used to evaluate building materials against their impact upon health and pollution, environment and resources, and social and community. McDonough Braungart Design Protocol (MBDC): a Cradle to Cradle Design Protocol to evaluate a product based upon its chemical hazard, recyclability and recycled content, energy and water use and some social responsibility. Umberto: models material and energy flows throughout a building material's entire life cycle. Products: McDonough Braungart Design Protocol (MBDC): a Cradle to Cradle Design Protocol to evaluate a product based upon its chemical hazard, recyclability and recycled content, energy and water use and some social responsibility. GREENGUARD: establishes acceptable indoor air standards for Indoor Air Quality, Schools, and Building & Construction. EPA's Environmentally Preferable Purchasing Program (EPP): a program that helps government agencies comply with green purchasing requirements.

MEASUREMENT



BASELINE → TRANSFORMATIVE

ENERGY AND TECHNOLOGY

Sustainable Goal	Transformative Practice	Applicable Tool
Net-zero energy, sustainable high-performance buildings	Create a high quality design through use of sustainable construction methods, ultra energy efficient electronics and building systems.	ENERGY-10: a design tool that analyzes—and illustrates—the energy and cost savings that can be achieved through more than a dozen sustainable design strategies. EnergyPlus: This software models heating, cooling, lighting, ventilating, and other energy flows as well as water in buildings. FEDS 6.0: facilitates the assessment and analysis of energy efficiency opportunities in buildings. It identifies minimum life cycle cost retrofits, determining payback, and enabling users to prioritize options for meeting energy efficiency goals.

glossary

Abiotic Resource
A nonliving resource that cannot reproduce: fossil fuels, minerals, water, land, and solar energy.

Acid Rain
The result of sulfur dioxide (SO2) and nitrogen oxides (NOx) reacting in the atmosphere with water and returning to earth as rain, fog, or snow. Broadly used to include both wet and dry deposition. (US EPA)

Adaptation
Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Allocation
The process of apportioning resources to the production of different goods and services. Neoclassical economics focuses on the market as the mechanism of allocation. Ecological economics recognizes that the market is only one possible mechanism for allocation.

Backcasting
A method in which the future desired conditions are envisioned and steps are then defined to attain those conditions, rather than taking steps that are merely a continuation of present methods extrapolated into the future.

Biocapacity
The capacity of a given biologically productive area to generate an on-going supply of renewable resources and to absorb its spillover wastes. If an ecological footprint exceeds its biocapacity, it is not sustainable.

Biotic Resource
A living resource, such as trees, fish, and cattle (elements of ecosystem structure), as well any of the services they provide, such as climate regulation, water regulation, and waste-absorption capacity (ecosystem functions, or ecosystem services).

Cadmium
Cadmium was once used as pigment and for corrosion resistant plating on steel and to stabilize plastic. With the exception of its use in nickel-cadmium batteries, the use of cadmium is generally decreasing in all other applications due to the high toxicity and carcinogenicity.

Carbon Dioxide (CO_2)
A naturally occurring gas made of carbon and oxygen. Sources of carbon dioxide in the atmosphere include animals, which exhale carbon dioxide, and the burning of fossil fuels and biomass.

Carrying Capacity
Originally the maximum population of cattle that can be sustained on a given area of rangeland. By extension the population of humans that can be sustained by a given ecosystem at a given level of consumption, with a given technology.

Clean Air Act
The law that defines the US EPA's responsibilities for protecting and improving the nation's air quality and the stratospheric ozone layer. The last major change in the law, the Clean Air Act Amendments of 1990, was enacted by Congress in 1990.

Climate
Usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands of years. The classical period is 3 decades, as defined by the World Meteorological Organization (WMO). These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

Climate Change
Any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from:

- natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun;
- natural processes within the climate system (e.g. changes in ocean circulation);
- human activities that change the atmosphere's composition (e.g. through burning fossil fuels) and the land surface (e.g. deforestation, reforestation, urbanization, desertification, etc.).

Closed System
A system that imports and exports energy only, matter circulates within the system but does not flow through it. The Earth closely approximates a closed system.

Corporate Social Responsibility (CSR)
A form of corporate self-regulation integrated into a business model.

Cost Benefit Analysis (CBA)
A type of economic evaluation in which both the costs and consequences of different interventions are expressed in monetary units.

Deforestation
Those practices or processes that result in the conversion of forested lands for non-forest uses. This is often cited as one of the major causes of the enhanced greenhouse effect for two reasons: 1) the burning or decomposition of the wood releases carbon dioxide; and 2) trees that once removed carbon dioxide from the atmosphere in the process of photosynthesis are no longer present.

Desertification
Land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities. The United Nations Convention to Combat Desertification defines land degradation as a reduction or loss, in arid, semi-arid, and dry sub-humid areas, of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest, and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: (i) soil erosion caused by wind and/or water; (ii) deterioration of the physical, chemical and biological or economic properties of soil; and (iii) long-term loss of natural vegetation. Conversion of forest to non-forest.

Development
The improvement in quality of goods and services, as defined by their ability to increase human well-being, provided by a given throughput.

Dioxins (PCDDs, PCDFs)
A group of chlorinated organic chemicals with similar chemical structures that act as pollutants. According to the most recent US EPA data, the major sources of dioxins are:

- Coal fired utilities
- Municipal waste incinerators[1]
- Metal smelting
- Diesel trucks
- Land application of sewage sludge
- Burning treated wood
- Trash burn barrels

These sources together account for nearly 80% of dioxin emissions. Dioxins are also generated in reactions that do not involve burning — such as bleaching fibers for paper or textiles, and in the manufacture of chlorinated phenols, particularly when reaction temperature is not well controlled.

Discounting or discount rate
In economic decision making, the rate at which the present is valued over the future, as a result of uncertainty, or of productivity, or of pure time preference for the present.

Ecological Footprint
The ecological footprint is a measure of human demand on the Earth's ecosystems. It compares human demand with planet Earth's ecological capacity to regenerate. It represents the amount of biologically productive land and sea area needed to regenerate, representing the amount of biologically productive land and sea area needed to regenerate the resources a human population consumes and to absorb and render harmless the corresponding waste. Using this assessment, it is possible to estimate how much of the Earth (or how many planet Earths) it would take to support humanity if everybody lived a given lifestyle.

Ecosystem
All living things and non-livings things in an area, as well as the interactions between them. (US EPA)

Efficient Allocation
The basis of traditional economics, which maximizes the utility of resources through a properly functioning marketplace.

Entropy (see Thermodynamics)

Environmental Economics
The branch of neoclassical economics that addresses environmental problems such as pollution, negative externalities, and valuation of nonmarket environmental services. In general, environmental economics focuses almost exclusively on efficient allocation, and accepts the pre-analytic vision of neoclassical economics that the economic system is the whole, and not a subsystem of the containing and sustaining global ecosystem.

Environmental Management System (EMS)
A set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency.

Externalities
An unintended and uncompensated loss or gain in the welfare of one party resulting from an activity by another party.

Fossil Fuels
Petroleum, coal, natural gas. Fuels formed over geologic ages from biotic materials, but now treated as nonrenewable abiotic resources.

Fuel Cells
A fuel cell is an electrochemical conversion device. It produces electricity from fuel (on the anode side) and an oxidant (on the cathode side), which react in the presence of an electrolyte. The reactants flow into the cell, and the reaction products flow out of it, while the electrolyte remains within it.

Free Rider
In economics, one who enjoys the benefit of public good without paying a share of the cost of its provision and maintenance.

Globalization
The economic integration of the globe by free trade, free capital mobility, and to a lesser extent by easy migration. It is the effective erasure of national boundaries for economic purposes.

Global Warming
An average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities.

Greenhouse Gases
Gases that occur naturally in the Earth's atmosphere and trap heat to keep the planet warm. Some examples are carbon dioxide, water vapor, halogenated fluorocarbons, methane, hydrofluorocarbons, nitrous oxide, perfluoronated carbons, and ozone. Some human actions, like the burning of fossil fuels, also produce greenhouse gases. (US EPA)

Habitat
The place where an animal or plant lives and grows such as a forest, lake, or stream.

"U.S. EPA Environmental Research Center, Research Triangle Park, North Carolina." Courtesy of HOK

Heat Pollution
A term used to describe the release of heat into the environment by human activities. Developed environments like concrete and black roads absorb and store heat. The urban heat island effect is the trapping of heat in thermal mass and is ultimately emitted back into the urban air especially at night. Urban heat island effect has been known to have human livability implications, ranging from the aggravation of health problems such as hyperthermia, increasing the intensity of urban air pollution, and contributing to extreme heat waves. Higher temperatures also result in higher cooling demands increasing energy use and potentially resulting in brownouts and higher greenhouse gas emissions. Heat from vehicles, manufacturing plants, and thermal power stations also contribute to excess heat in urban areas.

Human Needs Assessment
A multidimensional concept of welfare that goes beyond income and wealth to include capabilities, capacities, and other existential categories used to measure the extent to which human needs are satisfied. These indicators go beyond the strictly economical GNP approach of basing human welfare upon a country's market value of goods and services purchased by households, government, and foreigners within the current year.

Hydrochlorofluorocarbons (HCFCs)
Compounds containing hydrogen, fluorine, chlorine, and carbon atoms. Although ozone depleting substances, they are less potent at destroying stratospheric ozone than chlorofluorocarbons (CFCs). They have been introduced as temporary replacements for CFCs and are also greenhouse gases. See ozone depleting substance. HFCs were introduced as alternatives to ozone depleting substances in serving many industrial, commercial, and personal needs. HFCs are emitted as by-products of industrial processes and are also used in manufacturing. They do not significantly deplete the stratospheric ozone layer, but they are powerful greenhouse gases with global warming potentials ranging from 140 (HFC-152a) to 11,700 (HFC-23).

Hydrological Power
Energy that is generated by dams, which use water to turn turbines and generate electricity.

Just Distribution
Allocation of the Earth's finite resources so that all can live with respect.

Life Cycle Assessment (LCA)
Process of comparing the environmental performance of products. A life-cycle assessment must consider all steps from cradle to grave: raw material production, processing, use and disposal, and transportation.

Life Cycle Cost Analysis (LCCA)
A method for assessing the total cost of facility ownership. It takes into account all costs of acquiring, owning, and disposing of a building or building system. LCCA is especially useful when project alternatives that fulfill the same performance requirements, but differ with respect to initial costs and operating costs, have to be compared in order to select the one that maximizes net savings. For example, LCCA will help determine whether the incorporation of a high-performance HVAC or glazing system, which may increase initial cost but result in dramatically reduced operating and maintenance costs, is cost-effective or not. LCCA is not useful for budget allocation. (Whole Building Design Guide)

Life Cycle Costing
Life-cycle cost (LCC) is the most straightforward measure of economic evaluation. Some other commonly used measures are Net Savings (or Net Benefits), Savings-to-Investment Ratio (or Savings Benefit-to-Cost Ratio), Internal Rate of Return, and Payback Period. They are consistent with the Lowest LCC measure of evaluation if they use the same parameters and length of study period. Building economists, certified value specialists, cost engineers, architects, quantity surveyors, operations researchers, and others might use any or several of these techniques to evaluate a project. The approach must be carefully applied when making cost-effective choices for building-related projects whether it is called cost estimating, value engineering, or economic analysis. (Whole Building Design Guide)

Multi Criteria Analysis
A multi-disciplinary method that uses qualitative as well as quantitative measuring scales to resolve problems with multiple value systems and objectives, which cannot be easily quantified (e.g. environmental issues) or translated in monetary terms due to their intangible nature (e.g. social, cultural or psychological issues). Unlike cost benefit analysis, MCA does not require all factors to be priced in order to be considered.

Municipal Solid Waste (MSW)
Residential solid waste and some non-hazardous commercial, institutional, and industrial wastes. This material is generally sent to municipal landfills for disposal.

Naphthalene
Naphthalene is commonly used in mothballs. Short-term exposure of humans to naphthalene by inhalation, ingestion, and dermal contact is associated with hemolytic anemia, damage to the liver, and neurological damage. EPA has classified naphthalene, possible human carcinogen.

Natural Resources
All the parts of the Earth that are not human-made and which people use, like fish, trees, minerals, lakes, or rivers.

Neoclassical Economics
The currently dominant school of economics, characterized by its marginal utility theory of value, its devotion to the general equilibrium model stated mathematically, its individualism and reliance on the free markets and the invisible hand as the best means of allocating resources, with a consequent downplaying of the role of government.

Nitrogen Oxides (NOx)
A group of gases made up of nitrogen and oxygen that generate acid rain and other environmental problems, such as smog and eutrophication of coastal waters. Burning fossil fuels, such as coal and gasoline, releases NOx into the atmosphere. Various programs are reducing NOx emissions, including the Acid Rain Program and NOx cap and trade programs. (US EPA)

Nuclear Power
Energy that comes from breaking apart the center (nucleus) of an atom. (US EPA)

Nonrenewable Resource
Low entropy matter-energy useful to humans and present in fixed stocks whose quantity declines over time. This includes mineral resources, fossil fuels, and fossil aquifers. As fresh water is naturally recycles through the hydrological process, we do not classify it as a nonrenewable resource.

Open System
An open system takes in and gives out both matter and energy. The economy is such a system.

Opportunity Cost
The best alternative given up when a choice is made, i.e., if a farmer cuts down a forest to expand his cropland, and if the consequent loss of timber, firewood, and water purification is the opportunity cost of the expanded cropland.

Optimal Scale of the Macroeconomy
Occurs when the increasing marginal social and environmental costs of further expansion are equal to the declining marginal benefits of the extra production. Beyond the optimal scale growth becomes uneconomic, even if we conventionally refer to the expansion of the economy as “economic growth.”

Particulate Matter
Tiny solid particles or liquid droplets suspended in the air.

Perfluorocarbons (PFCs)
A group of human-made chemicals composed of carbon and fluorine only. These chemicals (predominantly CF4 and C2F6) were introduced as alternatives, along with hydrofluorocarbons, to the ozone depleting substances. In addition, PFCs are emitted as by-products of industrial processes and are also used in manufacturing. PFCs do not harm the stratospheric ozone layer, but they are powerful greenhouse gases.

Persistent Bioaccumulative Toxic (PBT)
PBT pollutants are chemicals that are toxic, persist in the environment and bioaccumulate in food chains and, thus, pose risks to human health and ecosystems. The biggest concerns about PBTs are that they transfer rather easily among air, water, and land, and span boundaries of programs, geography, and generations.

Pollutants
Chemicals or other substances that are harmful to or unwanted in the environment. Some examples of pollutants are sulfur dioxide (SO2), nitrogen oxides (NOx), ozone, and particulate matter. (US EPA)

Polychlorinated Biphenyls (PCBs)
PCBs belong to a broad family of man-made organic chemicals known as chlorinated hydrocarbons. PCBs were domestically manufactured from 1929 until their manufacture was banned in 1979. They have a range of toxicity and vary in consistency from thin, light-colored liquids to yellow or black waxy solids. Due to their non-flammability, chemical stability, high boiling point, and electrical insulating properties, PCBs were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other industrial applications.

Public Good
Without financial incentives, the marketplace does not supply essential goods and services such as clean air and water, and ecosystem services. These goods and services are called "public," rather than "private," because everyone can use them and often, government action is necessary for their creation or protection.

Renewable Resource
A living resource that is capable of regeneration and growth in perpetuity if exploited in a sustainable manner and that provides raw materials for the economic process.

Scale
The physical size of the economic subsystem relative to the ecosystem that contains and sustains it. It could be measured in its stock dimension of population and inventory or artifacts, or in its flow dimension of throughput required to maintain the stocks.

Sink
The part of the environment that receives the waste flow of the throughput and may, if not overwhelmed, be able to regenerate the waste through biogeochemical cycles back to usable sources.

Social Discount Rate
A rate of conversion of future value to present value that reflects society's collective ethical judgment, as opposed to an individualistic judgment such as the market rate of interest.

Solar Energy
Radiant energy flowing from the sun, our basic long-run source of low entropy that sustains life and wealth.

Subsidy
A bonus or payment for doing something, the opposite of a tax.

Sulfur Dioxide (SO2)
A naturally occurring gas made of sulfur and oxygen that contributes to acid rain. Burning fossil fuels, such as coal, releases SO2 into the atmosphere. Various EPA programs are reducing SO2 emissions, including the Acid Rain Program. (US EPA)

Sulfuric Acid
An acid that can be produced in the atmosphere from sulfur dioxide, a pollutant that results from the burning of fossil fuels. (US EPA)

Sustainable Scale
Defined by the Earth's finite limits, in which efficient allocation and just distribution must be maintained, if a stable, steady-state economy is to be attained.

Thermodynamics
First Law of Thermodynamics
Matter's quantity is finite and constant. Its quality is not. Matter changes both in nature, and as it moves through the economic system (this is the 1st Law of Thermodynamics). This means that any interaction we have with the World and the ecosystems that support life, such as waste disposal, must be accounted for, sooner or later.

Second Law of Thermodynamics (Entropy)
As matter moves through nature and the economic system, its intrinsic properties change and it becomes less useful and usable (this is the 2nd Law of Thermodynamics), requiring more and more resources to make them useful, once again. Very useful (low-entropy) goods, such as mineral ore or fuels, eventually produce less useful (high-entropy) matter, such as scrap metals and greenhouse gas, as they move through the economic system**.**

Throughput
The flow of raw materials and energy from the global ecosystem's sources of low entropy (mines, wells, fisheries, croplands), through the economy, and back to the global ecosystem's sinks for high entropy wastes (atmosphere, oceans, dumps).

Toxic
Toxic is any substance that is capable of harming a person if ingested, inhaled, or absorbed through any body surface. Toxic substances vary widely in the types of harm they cause and the conditions under which they become harmful.

Toxin
A toxicant produced by a living organism.

Urbanization
The growth of urban areas from rural areas as a result of population immigration to an existing urban area.

Volatile Organic Compound (VOCs)
Any organic (carbon-containing) compound that evaporates readily to the atmosphere at room temperature. VOCs contribute significantly to smog production and certain health problems. VOCs often have odors, examples include gasoline, alcohol, and the solvents used in paints.

Waste Absorption Capacity
The capacity of an ecosystem to absorb and reconstitute wastes into usable forms through biogeochemical cycles powered by the sun. This capacity is a renewable resource that can be overwhelmed and destroyed, or used within sustainable limits.

Wastewater
Used water that contains dissolved or suspended waste materials.

Wind Power
Energy that is generated when the wind turns the sails of a windmill, which are attached to turbines that generate electricity. (US EPA)

interviews

Christopher Payne
Lawrence Berkeley National Laboratory

Matthew Gray
Office of Energy Efficiency + Renewable Energy, DOE.

Ernest Fossum and Chris Ischay
Idaho National Laboratory

Melanie Berkemeyer
Department of State, Overseas Buildings

christopher payne

Lawrence Berkeley National Laboratory (LBNL)

March 27, 2009 via telephone

What are some of the daily challenges you face in operationalizing sustainability into your workplace? In other words, where does the "system" break down?

One of the primary challenges the Washington, DC office of LBNL faces is making physical changes to the workplace, like installing blinds, repainting walls, and moving partitions. As a tenant in a commercial office space that is sub-leased, the lease agreement precludes these types of modifications. Our office is currently a sub-lease tenant that occupies 1/3 of 1 floor in 10 floor building, so our clout with the building management to request these modifications is minimal.

Another challenge that LBNL faces is in the procurement process. Procurement is typically initiated and filtered through the local office manager. For items that have a relatively high dollar value or inventory value, procurement is then moved to a central purchasing process. Big ticket items require an official procurement requisition. Smaller items can typically be ordered through a more informal process (email).

The procurement dilemma is two-fold. Contracting authorities need more training in appropriate purchasing practices. An additional challenge is there is no effective feedback mechanism. As the procurement official is not typically the person that purchases the good. Typically, the best way to return items is by "grumbling". The best way to ensure that the right item is ordered is to contact the purchasing person via telephone before it is ordered. It is often very difficult to actually speak to the person, so this method is typically not effective.

Another failure is that in some cases, the policy follows the practice. Christopher shared a great anecdote about implementation of green building practices at a federal facility. At the facility, there has been continuous effort to make office alterations more "green". The facility managers implemented a requirement of green wall board. After the policy was implemented; the facility managers discovered that all of the contractors were already using green wall board. Since other government agencies had already mandated this, the contractors had started using green wall board on all of their federal work. Christopher mentioned that kind of "spillover" is powerful and happens regularly.

There is an Energy Efficiency Program in place but it is not robust. LBNL, like other federal facilities, operates under multiple energy mandates like the Energy Policy Act of 2005, the Energy Independence and Security Act of 2007, and Executive Order 13423. Despite these mandates, there are few feedback mechanisms to ensure such guidelines are met.

Where does the system work?

Some environmental policies are successful. For example, the Defense Logistics Agency instituted a process several years ago of automatic substitution. If someone tries to order paper that doesn't meet the required recycled content, there is automatic substitution of their order for the product that does not meet the requirement. The paper with the required recycled content arrives with a note in the box

explaining why the substitution occurred and what to order in the future. This is very effective with paper, but it tends to be more difficult with items other than paper - cost, design features, and other variances make automatic substitutions problematic.

LBNL, like many federal government agencies, has leveraged their buying power in computers. Laptop computers typically incorporate technology that allows very low energy use by using power management functions. Desktop models had previously not been outfitted with this technology. Executive Order 13221 required that desktop computers be outfitted with the same low-energy technology that laptops are, thus dramatically reducing energy requirements and cost. It was relatively easy for manufacturers to comply. While the success in not easily quantifiable, impact does occur. Similarly, some of the success of the Energy Star Label for buildings can be attributed to the federal sector because of the federal requirement for agencies to lease high-performance buildings.

Were You Familiar with the concepts of Ecological Economics?
The theoretical concepts are straightforward and sensible. Ecological Economics is a refinement and complicating theory of neo-classical economics where first cost often receives most of the attention, and Ecological Economics offers a more holistic vision.

Tools of neo-classical economics, such as LCCA, are necessary but often not sufficient. Ecological Economics breaks through theoretical barriers into a logical process for decision makers.

Chris is optimistic for long-term prospects and cited the history of social change. We are recognizing the need to move to transformative economy that values clean energy. However, at this stage we are in a race against time. Are we going to figure it out in time?

What organizations are you a part of that have helped you become more informed? (Partnerships that have been helpful thus far.)
Lawrence Berkeley's relationship with federal interagency working groups has been beneficial as has their relationship with the Office of the Federal Environmental Executive. In broad terms, entities that are concerned about the environment and the Federal Government and are doing what they can to move forward are beneficial relationships. These are the groups that are making changes happen and thinking about sustainability broadly. There are other entities that could be obvious partners such as The Associations of Public Procurement Officials. Thus far, there have been mixed responses coming out of the vendor community.

"If someone orders paper that doesn't meet the required recycled content, there is automatic substitution of their order for the product that does meet the requirement."

Have you implemented any policies to ensure "green behavior"? (contracts, procurement)
Successful amendments to the FAR encouraging green behavior have been important. Also, instituting automatic substitutions has been successful, and should be rolled out further.

Closing thoughts

Christopher believes that continuing the discussion on the "3 legs of the stool" economic, environmental, and social is important. People are starting to see the link between economic and environmental, but are having a tougher time with the social aspect and linking environmental and social is difficult. The new Sustainable Development Guide is trying to strengthen this link. Christopher recommended reading Blessed Unrest by Paul Hawken. Christopher also suggested making implementation a focus of the Sustainable Development Guide, as it is one of the greatest problems for green programs. Specifically, a communication section aimed at people who "try to make it easy".

Understanding the existing process is the key to change. The people, who want to do the right thing, will figure out how to do it. While there are typically work-arounds, the majority of people will go with the flow and do what is easy. Make the right thing: the easy thing to do.

“Understanding the existing process is the key to change. The people, who want to do the right thing, will figure out how to do it.”

matthew gray

Office of Energy Efficiency and Renewable Energy, DOE

April 9, 2009 via telephone

What are some of the daily challenges you face in operationalizing sustainability into your workplace? In other words, where does the "system" break down?

One of the primary challenges that DOE and many other agencies face is properly accounting for all environmental and social considerations in Life Cycle Cost Analysis. Another recent challenge has been getting to DOE sites the level of training on sustainable practices that's requested.

Where does the system work?

DOE is pretty successful at leveraging the work of sustainability champions at a number of DOE sites. These champions proactively started their work years ago before there were any sustainability requirements largely because it was just the right thing to do. One of these requirements at DOE is requiring LEED Gold certification for all new construction projects over $5 million. Implementing a sustainability requirement for existing buildings has been more difficult partly because the tools are still in development.

Do you have a green program for the workplace, procurement, or services?

DOE has implemented an electronic stewardship program for 95% of their sites.

Yes, the Department has established green procurement goals and requirements. DOE's Preferred Procurement program requires the purchase of products with the most environmental attributes possible, especially those attributes designated by Congress for purchase—biobased, energy and water efficient, recycled, alternative fuels and vehicles, and non-ozone depleting. The Department also integrates sustainable purchasing into operations through its chemical safety, electronics stewardship and sustainable design programs.

The Department sets policies and requirements at the Headquarters level, but procurement of products is typically controlled at the site level. The Department collects data from each site on an annual basis to track site compliance with its sustainable procurement requirements, and reports annually to OMB and the Federal Environmental Executive.

"DOE requires LEED Gold certification for all new construction projects."

The Preferred Procurement Program holds a quarterly teleconference to promote sharing of best practices and lessons learned, and to keep purchasers informed of new products and emerging issues.

What organizations are you a part of that have helped you become more informed? (Partnerships that have been helpful thus far.)
There's many great organizations to go to for more information on sustainability. A couple examples include:

- Key contributors to the Whole Building Design Guide, including the National Institute of Building Sciences and numerous federal agencies.
- Laboratories for the 21st Century (Labs 21) has been a very successful partnership between government and the private sector.

Have you leveraged technology to support either green behavior or green operations? (building automation systems, automatic light shut-off, conferencing technology)

DOE buildings are increasingly using the latest green technologies available, but there's still much work to be done. Automation of systems is also increasingly used, which is necessary to complement any behavioral changes.

Does your agency measure success on the sustainability front? (carbon footprint, specific improvements)

DOE has been measuring energy usage for over twenty years. Carbon measurement and Greenhouse gases are starting to come to the forefront especially on the campus or site level. Water use is being tracked and water reduction goals have been set. Other key indicators we track include green procurement, the number and quality of LEED certified buildings, and the number of buildings that have been assessed against the High Performance and Sustainable Building Guiding Principles.

What are other agencies or companies out there that would be interesting to include in this Guide?

There are many great organizations out there, but here's just a few:

- The Rocky Mountain Institute
- American Institute of Architects
- US Green Building Council
- Sustainable Buildings Industry Council
- IFMA is helpful especially for training of facility managers

Do you have a "green" training program? How is this rolled out and how often do you offer "refresher" training sessions for existing or new employees?

We certainly have training programs on many topics related to sustainability, but they probably still don't suffice to meet the demand. This is an area we continuously work to improve, as it is vital for folks in the field to get the training they need. Webinars are used to the extent possible to eliminate travel. Some "Train the Trainer" sessions have also been successful.

ernest fossum + chris ischay

Idaho National Laboratory (INL)

May 20, 2009 via email

What are some of the daily challenges you face in operationalizing sustainability into your workplace? In other words, where does the "system" break down?
We have deeply entrenched project policies to maximize the square footage of new facilities with the available funding. This has an unfortunate side affect of loosing many of the more innovative and sustainable opportunities due to value engineering. Energy efficiency and sustainability are still viewed as "extras" that do not contribute to a cost effective project. Although several on the engineering staff have embraced sustainability, it is still viewed as a burden to most.

This viewpoint is slowly changing. We have two recent projects where LEED certification has been desired and specified.

Where does the system work?
We have a functioning "Affirmative Procurement Program", which considers the energy and environmental factors of purchases. We also have a basic recycling program with individuals that are proactively engaged in expanding the program.

Do you have a green program for the workplace, procurement, or services?
Only the "Affirmative Procurement" and recycling programs.

What organizations are you a part of that have helped you become more informed? (Partnerships that have been helpful thus far.)
We actively participate in the EFCOG Energy Efficiency Working Group, which has provided networking and lessons learned on activities from DOE national labs across the complex. This working group has recently been modified to the Energy and Infrastructure Working Group with an Energy and Sustainability Subgroup.

Have you implemented any policies to ensure "green behavior"? (contracts, procurement)
The "Affirmative Procurement" program which includes a checklist that requesters must complete prior to submittal, and recycling programs (office, industrial, and chemical). The INL Green Building Strategy is used as a reference document when applying the engineering management system.

Have you leveraged technology to support either green behavior or green operations? (building automation systems, automatic light shut-off, conferencing technology)
Yes, we have building automation controls on eight of our significant in-town office and laboratory facilities. We have lighting controls and programmable thermostats on many other facilities. We are beginning a large project to install $33M of upgrades to one of our desert site locations including lighting upgrades, building control systems, boiler replacements, air compressor replacements, and two solar walls.

We are regularly streamlining our transportation systems. We currently operate a fleet of over 1,600 vehicles, 112 of which are over the road motor coaches for bus transportation. We are developing park and ride opportunities, express bus routes, and reducing low usage routes and shuttle service. We are obtaining new leased buses with increased fuel economy and the ability to run on biodiesel, of which we are testing the use throughout the year, even when our temperatures dip well below zero.

Our fleet contains many flex fuel vehicles and we are updating our fueling infrastructure to accommodate E-85 at as many locations as possible. Our fleet also contains numerous GNG vehicles, seven LNG buses, and three brand new hybrids.

Over 10 years ago, our Industrial Complexes (50 miles west of Idaho Falls) moved to a four day a week, ten hour day schedule to decrease transportation and infrastructure costs. The Idaho Falls Research and Engineering Campus moved to an eighty hours in nine days schedule to decrease infrastructure costs.

Does your agency measure success on the sustainability front? (carbon footprint, specific improvements)
We do keep track and report energy usage, which includes GHG estimates from the reporting packages. We do not currently report our carbon footprint, but we are planning to delve into our carbon footprint in the next several months.

What are some of the more creative or unexpected solutions that came out of the process of greening your workplace? (alternative work, transportation policies)
We still struggling with obtaining updated bike racks to accommodate increased bicycle usage, so we are a little short on the unexpected solutions. We are getting there though.

What are other agencies or companies out there that would be interesting to include in this Guide?
You should include information on the Federal Super ESPC program as well as information on utility UESC programs. These partnerships can be especially useful for agencies that have very little or no liquid financing to pay for upgrades up front.

Do you have a "green" training program? How is this rolled out and how often do you offer "refresher" training sessions for existing or new employees?
We do not currently have green training program. We do provide employee awareness information on a quarterly basis to all employees that can be used to assist programs at work as well as at home.

"Our fleet contains many flex fuel vehicles and we are updating our fueling infrastructure to accommodate E-85 at as many locations as possible. Our fleet also contains numerous GNG vehicles, seven LNG buses, and three brand new hybrids."

melanie berkemeyer

Department of State, Overseas Buildings Operations

May 19th, 2009 via email.

What are some of the daily challenges you face in operationalizing sustainability into your workplace? In other words, where does the "system" break down?
The Green Team at OBO has done a great job of executing sustainability processes into our buildings overseas. However, to be truly successful in this endeavor it's incumbent upon every employee to understand the impact of their actions and what steps they can do in this effort. We're trying to spread the word that every little day-to-day activity such as recycling all cardboard, paper and glass products, using energy only when it's needed, and making carpooling or public transportation a more popular commuting method can make a huge difference. The Green Team can provide the sustainability expertise, but the challenge is to have everyone use that expertise to change their every day behaviors.

Where does the system work?
The Green Team has the most influence with outreach through publications that chronicle our activities. Green Team members write articles for State Magazine and other publications to help provide information about what we do and share best practices. In addition, we published the Green Guide for Embassy and Consulate Operations which is used at posts overseas and are launching a new webpage on the Bureau's website. All of this is done with the primary goal of better informing the Department of the work we do in the field of sustainability.

Do you have a green program for the workplace, procurement, or services?
The Department, under the direction of Secretary of State Hillary Rodham Clinton, is in the process of establishing a Greening Council as part of a large Greening Diplomacy Initiative. This initiative will work to institute Green policies of this type Department-wide, and will address sustainable issues both overseas and domestically.

What organizations are you a part of that have helped you become more informed? (Partnerships that have been helpful thus far.)
The US Green Building Council, Construction Industry Institute, American Institute of Architects, and the Federal Interagency Sustainability Working Group are a few of the organizations that have been a great resource for sharing ideas and implementation strategies.

Have you implemented any policies to ensure "green behavior"? (contracts, procurement)
The Green Team has created a Green Guide for Embassy and Consulate Operations which provides suggestions for employees such as Fleet Management and establishing priority parking for ride-share participates. OBO emphasizes green behavior but uses technology to supplement the lack of personal behavior by placing occupancy sensors in the restroom, automatic shut-off faucets, and other energy and water conservation tools.

Have you leveraged technology to support either green behavior or green operations? (building automation systems, automatic light shut-off, conferencing technology)
OBO routinely installs waterless urinals, dual-flush toilets, low-e glazing, sun shading devices coupled with light shelves, occupancy sensors for lighting and ventilation, high-efficiency HVAC systems and other state of the art technologies. The Green Team is constantly looking for new technology to support green behavior and green operations. For example, in April of this year OBO installed a magnetic levitation (maglev) chiller in Geneva, Switzerland, the first of its kind in Europe. Tokyo, Japan was a recipient of the maglev technology two years ago.

Does your agency measure success on the sustainability front? (carbon footprint, specific improvements)
OBO is very proud of the steps we have taken to track our buildings' cost and utility consumption in order to benchmark our success in compliance with Executive Order 13423. The ultimate goal is to measure the Department of States' overall carbon footprint throughout the entire world.

What are some of the more creative or unexpected solutions that came out of the process of greening your workplace? (alternative work, transportation policies)
The Green Guide for Embassy and Consulate Operations was the catalyst for embassies overseas to begin to implement green solutions. Since each location around the world has different challenges, State Department employees found creative ways to implement these suggestions. These creative ideas spurred other offshoots which had a multiplier effect on new ways to reduce our carbon foot print. The Green Team has become a repository for these new and innovative ideas which are constantly being fed to Washington and sent back out to the field and shared as best practices. For example, at one embassy an innovative employee wrote a computer program that shut down all desk-top computers at night and started them again an hour before the work day commenced, saving hundreds of thousands of dollars in saved electricity costs.

What are other agencies or companies out there that would be interesting to include in this Guide?
The US Postal Service appears to be very green in some of their policies, and manages the nation's largest civilian fleet—they might have some lessons to share.

Do you have a "green" training program? How is this rolled out and how often do you offer "refresher" training sessions for existing or new employees?
OBO typically enlists outside consultants to provide LEED training for accreditation. Additionally, the Department provides training tailored to various Foreign Service Officers, so that they may understand the issues, context, urgency, and application specific to the buildings they work in, operate, and manage.

"The Green Team can provide the sustainability expertise, but the challenge is to have everyone use that expertise to change their every day behaviors."

section 2

economic decision–making

Ecological and Traditional Economics

Economic Literature Review

Additional Readings in Economics

ecological + traditional economics

Traditional Economic Theory: An Overview

Ecological Economics: History & Theory

Translating Theory Into Practice: Tools & Applications

traditional economic theory: an overview

Traditional or general economics studies the allocation of limited resources among competing ends. Its main concern is efficiency.[1] Although many economic disciplines have emerged throughout history, here the Neoclassical School of thought is described, as it is currently the dominant approach and much of ecological economics literature is written in opposition to its principles. Although ecological economics exists in part to address failures with neoclassical economic theory, most tenants of micro and macro economic theory are useful to all economists as they accurately describe the relationships among various factors that produce certain economic outcomes. This overview should allow readers unfamiliar with economic theory to understand the principles of ecological economics discussed in the GSA publication, "The New Sustainable Frontier."

Microeconomics

Microeconomics studies resource allocation and decision-making at the level of the individual consumer, household or firm. It is concerned with how and why these entities make decisions about what to purchase, how much to produce, and what price to charge.

Supply and Demand

Decisions regarding how much of a commodity to produce, what price should be charged, or how much of it should be purchased can be made using a supply and demand model.[2] With price on the y axis and quantity on the x axis, demand is represented by a line with a negative slope (demand curve), reflecting

Right: "Chapada Diamantina National Park, Salvador, Brazil." Photo Credit: Jonathan Herz

the fact that, for most goods and services, consumer demand for a commodity falls as the price rises.

Supply is typically represented line with a positive slope (supply curve), showing that the firm's willingness to supply a commodity increases as the price rises. This is often called the partial equilibrium model, which assumes that other markets do not influence it. The equilibrium price and quantity at which decisions of consumers and producers are consistent with each other is found at the intersection of the supply and demand curves.[3]

A general equilibrium model, shown in Figure 1, is one in which all markets of an economy are represented.[4]

Utility

The economic choices of consumers are assumed to be a rational process of utility maximization, where utility is a function of individual preferences.[5] Utility cannot be precisely quantified and instead is measured ordinally (in relation to other preferences) rather than in absolute terms.[6] The price that a consumer is willing to pay for a commodity is determined by the utility gained from purchasing it rather than other commodities.[7]

In economics, it is assumed that consumers are never satiated. They always prefer greater quantities of a given commodity, and regardless of the level of utility they gain from a commodity they will

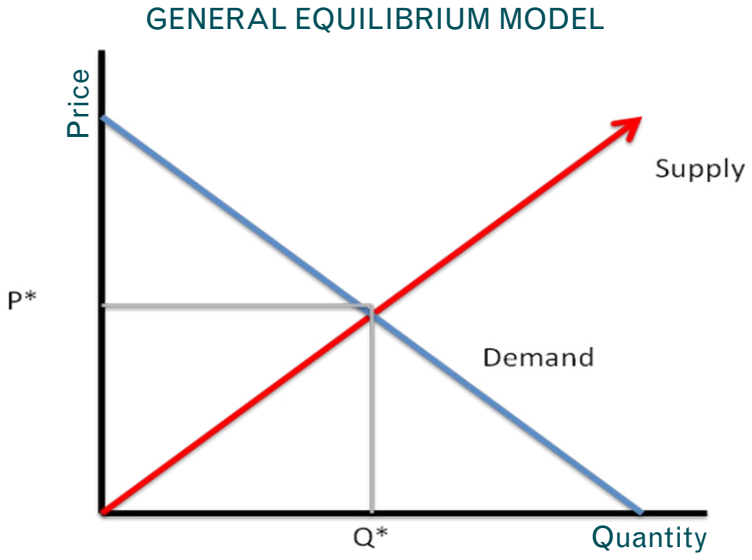


Fig. 1: The General Equilibrium Model shows how supply and demand functions determine the price and quantity of a commodity in the market.

Achieving sustainability will require addressing three areas of human need: Social, Environmental, and Economic.

prefer having some of it having to none of it. However, each additional unit of a commodity is assumed to result in smaller contributions to utility, or, in technical terms, "diminishing marginal utility". Still, the non-satiation assumption posits that a consumer will always prefer to have some amount of a commodity to having none at all.

Opportunity Cost

The economic cost of a commodity is determined by what is given up in order to get it.[8] For example, if a factory is capable of producing either shirts or socks, the cost of producing socks is the foregone opportunity to produce shirts. The opportunity cost of depleting a renewable resource, such as a fishery, is the foregone opportunity to harvest fish in the future. The cost of depleting a non-renewable resource is the missed opportunity of future generations to use those resources. Typically, renewable resources are depleted because of time preference or expectation of future substitutes. Time preference is the choice to have something now rather than in the future, independent of other factors.

Resource depletion also occurs as a result of the expectation that future generations may not need the resource, in anticipation that technological innovation will produce a substitute. For example, nineteenth century whalers were unconcerned with the depletion of the whale stock, despite their reliance on whale oil for light, because they anticipated that other options would become available. This calculation failed to take into account the harm they were doing to the ecosystem or the existence value (value for their own sake rather than as a resource) of the whales.

Macroeconomics

Macroeconomics studies the performance of the economy as a whole. Various indicators, such as employment rates, growth rates, savings and investment, and inflation are used to determine the overall state of the economy. Interaction among various parts of the economy and the effects of policy decisions on the economy is also part of macroeconomics.

Right: "Geothermal Power Plant, São Miguel Island, Azores, Portugal." Photo credit: Jonathan Herz

Public Policy

Macroeconomics also studies the use of policy instruments to affect economic performance.[9] Government spending, interest rates, and the money supply all influence indicators of economic performance.

Growth

Founded in the non-satiation assumption, an increase in economic output (economic growth) is often equated with rising utility levels among consumers. For the macroeconomy, output is measured by Gross National Product (GNP) or Gross Domestic Product (GDP), which capture the market value of all marketable goods and services in a given year by the nationals of a country (GNP) irrespective of their location, or domestically (GDP). A key assumption of neoclassical macroeconomics posits that GDP and GNP are suitable economic indicators of improvements in the conditions for consumers.[10]

For example, in their influential text on economic growth Barro and Sala-i-Martin[11] observe that real per capita GDP in the United States grew by a factor of 8.1 from 1870 to 1990. They then conclude, "Even small differences in… [annual GDP] growth rates, when cumulated over a generation or more, have much greater consequences for standards of living than… short-term business fluctuations…".

Ecological economists dispute the claim that quantitative increase in the *size* of the economy and *qualitative improvement* are linked. Ecological economists posit that the dis-utility generated by the environmental destruction caused by economic growth may be greater than the utility gleaned from that growth. This means that, while the economy may be growing, the quality of life can actually be decreasing, particularly when environmental safeguards are ignored. Macroeconomic theory also assumes unlimited economic growth,[12] whereas ecological economics recognizes that the limits of the natural world constrain the size of the economy.

"Lake Mendota, Madison, Wisconsin." Photo credit: Jonathan Herz

Assumptions and Market Failures

In order for goods to be efficiently allocated in an unregulated market economy, certain conditions must apply. Among these are the conditions are that:

- markets are perfectly competitive
- all decision makers have perfect information
- all households maximize their utility, and
- all firms maximize their profits.

In these circumstances, businesses do not overproduce, waste resources, or create undesirable by-products; and consumers do not over consume and create waste. When these conditions are not met, the unregulated economy fails to create socially optimal conditions and a market failure occurs.[13] Many economists see this as justification for corrective action by government.[14]

Rivalness and Excludability

A good must be rival and excludable in order to achieve socially optimal allocation in an unregulated market. If a good is rival, consumption by one individual reduces availability for all. Rival goods have finite quantities—if person A uses some, it depletes the stock that person B may use. Pizza is rival, as is a bicycle. With a non-rival resource, consumption by one individual does not reduce availability for all. Examples are: light from a street lamp or use of the ozone layer to protect against ultraviolet light (UV).

Excludability is the legal concept that allows an owner to keep others from using his asset. The owner can use it while denying others the right to use it at the same time (e.g., pizza, bicycles, etc.). Non-Excludable goods, also called public goods are those whose use by others cannot be prevented (e.g., climate stability, atmospheric gas regulation, etc).[15]

Public Goods

In an unregulated market, goods that are non-rival and/or non-excludable will not be produced at a socially optimal level because of free-riding: firms have little or no incentive to produce non-excludable goods when they cannot ensure that people will pay to use them, and consumers will have little incentive to buy non-rival goods because to do so would be to accept a personal cost for a public benefit.[16] Therefore, goods that are both non-rival and non-excludable are referred to as public goods because, in order to be produced at a socially optimal level, the public sector must intervene in the market.

Free-Riding

Free-riding occurs when a public good is produced and not all users contribute. Say, for example, a neighborhood wanted to turn an abandoned lot into a public park. People could collect donations from their neighbors to fund the park, but not everyone would contribute. Each individual in the neighborhood has the incentive to not contribute, but enjoy the park. However, if everyone in the neighborhood chose this path of rational self-interest, the park would not be built.

Tragedy of the Commons

It is also worth noting that publicly available goods can be subject to overexploitation. The classic example of this phenomenon is a public pasture on which people graze their cattle[17]. The pasture can sustain a finite number of cattle while still replenishing its grasses. Yet each herder, pursuing personal gain, seeks to maximize the size of his cattle herd. They add cattle until the capacity of the pasture is overwhelmed, resulting in environmental ruin. The tragedy is that the ruined pasture can sustain no cattle because the pursuit of individual gain led to overexploitation.

Externalities

An externality is an unintended consequence of economic activity, which affects individuals other than the decision maker.[18] Externalities can be positive or negative. For example, a positive externality occurs when a building owner plants a green roof: this improves local air quality, provides habitat, reduces the burden on municipal storm water infrastructure, and mitigates the impact on the local waterways. A negative externality occurs when office buildings are sited far from workers' homes, necessitating transportation expenditures by workers and local government and increasing air pollution from cars. Although providing incentives for private actors to internalize the full costs of their actions was long thought to be the theoretical solution to the externality problem, government activity in the environmental realm has been the most effective means of dealing with the greatest externality: pollution.

An externality occurs when one party's actions impose uncompensated benefits or costs on another. Environmental problems are a classic case of externality. Another example is the case of common property resources that may become congested or overused, such as fisheries or the broadcast spectrum. A third example is a "public good," such as defense or basic scientific research, which is distinguished by the fact that it is inefficient, or impossible, to exclude individuals from its benefits.[19]

Addressing externalities that occur across wide geographic distances, or especially across time, is particularly difficult. "When externalities affect future generations, we must accept that transaction costs between generations are infinite, and that the market will not solve the "externality" problem unaided."[20] Distance through time and space makes communication between the party responsible for the externality and the affected party complicated, if not impossible.

Environmental Economics and Resource Economics

Externalities and market failures involving the natural world are addressed by two branches of neoclassical economics: environmental economics and resource economics. These disciplines attempt to respond to problems not adequately addressed by Neoclassical Economics, but they do not depart from its basic worldview. Environmental and resource allocation problems are resolved through these disciplines by attempting to fit these problems within the neoclassical economic model, by methods such as setting prices for environmental goods. By contrast, ecological economics seeks to alter the foundations of our economic models to reconcile them with the realities of the natural world. As prominent ecological economist Joshua Farley said, "Free-market economics works great, for a certain narrow class of goods and services, but there's a huge, broad class of goods and services that are incredibly important to our well-being where it doesn't work at all."[21]

Figure 2 - The Traditional Economic Paradigm

Environmental Economics

Environmental economics is a sub-discipline of neoclassical economics that deals with the allocation of environmental resources. It seeks to correct market failures related to environmental goods, such as ecosystem services, and negatives, such as pollution, to ensure that the economy provides them at a socially optimal level. Topics typical to this field include pricing environmental resources and using policy instruments such as taxation, subsidies and other incentives, and property rights for environmental goods to correct environmental externalities and improve the allocation of environmental resources.[22]

Environmental economics is not a synonym for ecological economics.[23] The key difference between ecological economics and environmental economics is that ecological economics sees the economy as a subset of the ecosystem and is therefore concerned with finding the appropriate economic scale, (figure 2) while environmental economics considers the environment as an aspect of the economy. Environmental economics treats the performance of ecosystems as but one aspect of the function of the economy, whereas ecological economics sees a healthy ecosystem as a necessary precondition of economic activity.[24] The next portion of this review explains ecological economics' position that the human economy exists within the natural world, not as a separate abstract entity to which environmental problems are external.

Natural Resource Economics

Resource economics is a branch of neoclassical economics that studies efficient allocation of natural resources, including the optimal extraction rate of nonrenewable resources.[25] A basic assumption is that a nonrenewable resource can be extracted only once. Therefore, optimal prices of a unit of a resource must reflect not only its cost of extraction but also account for the opportunity costs associated with depleting the resource endowment by that unit.

Traditional economic models employ positive discount rates[26] to reflect the possibility that technological improvement can give rise to increasing economic wealth, and that even though future generations will inherit smaller physical resource endowments, an enlarged stock of human-made resources may compensate for the reduction in the physical resource base. Optimal use of renewable resources is also studied by examining economic factors that influence their depletion and renewal.[27] Sustainable use of resources is studied as it pertains to maximizing utility gained from exploiting these resources, whereas ecological economics is concerned with the benefits bestowed upon humanity from leaving resources intact.

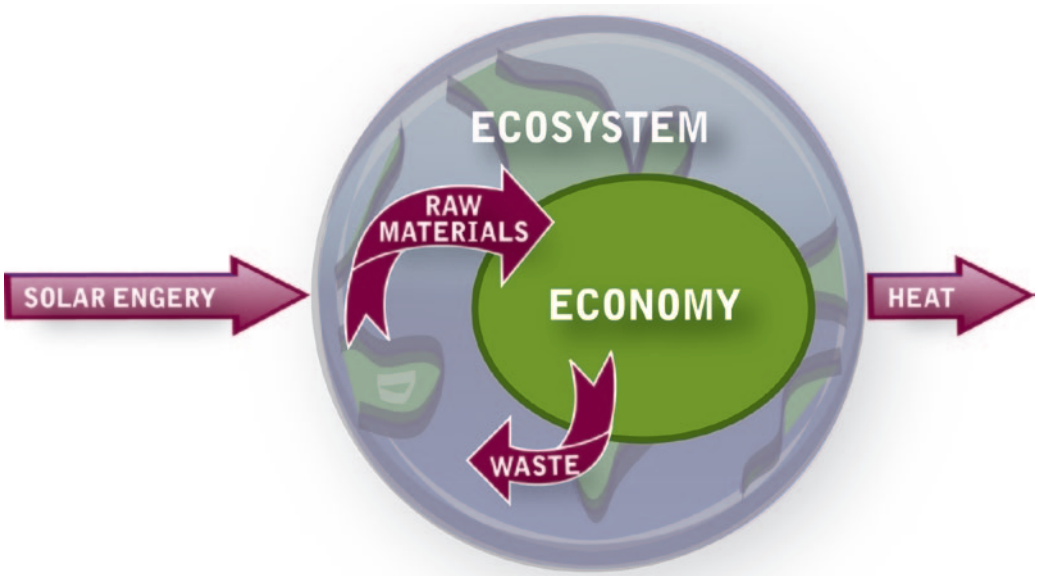


Figure 3 - Ecological economics views the economy as a subset of the larger ecological environment, where low-entropy raw materials flow through the economy and exit as high-entropy waste.

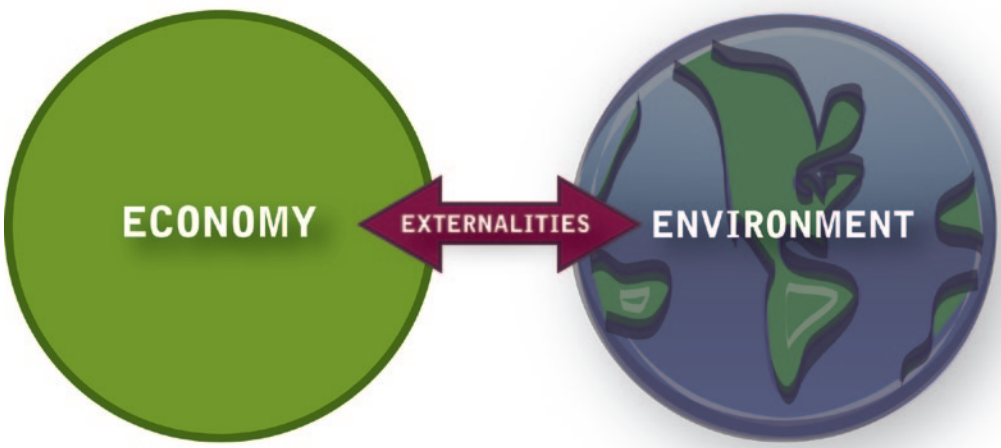


Figure 4 - Neoclassical economics, including environmental economics and resource economics, sees the economy as an abstract entity separate from the natural world. When the economy and environment interact, it is an externality that can be corrected with market-based tools, such as pricing environmental goods.

ecological economics: history and theory

For ecological economists, the economy is a subsystem of a finite, non-growing, materially closed ecosystem. As Figure 3 illustrates, the economy is firmly ensconced within the environment. To neoclassical economists, the ecosystem and the economy are separate entities that, the interaction of which usually creates market failures (See Figure 4). According to ecological economics' model of the world, the economy extracts raw materials from the environment and then sends waste back into it. Economic growth can only occur within the constraints imposed by the finite limits of the natural world. No such limitations apply to an abstracted model of the economy, independent of the physical world, which is employed by neoclassical economics.

As modern economic thought emerged around the 18th century, the idea emerged that economic value is determined by scarcity. In that time human-made capital, such as factories and plows, was relatively scarce, as was labor. Seeming so abundant over this period that it hardly rated a mention in economic theory was 'natural capital' – the natural resources such as fertile soils, supplies of timber, water, minerals and fossil fuels, and the capacity of the earth and its atmosphere to absorb wastes. So, the tools that emerged in the practice of modern economics were based on the assumption that the natural world is infinite, at least in relation to labor and human-made capital.

As a result, human technical ingenuity has focused on better and better machines, and has improved the productivity of labor using those machines on an extraordinary scale. The work of two hundred workers in 1770 could be done by a single spinner in 1812.[28] One can scarcely guess by what order of magnitude modern technology has improved labor productivity since 1812. In addition, the human population has grown astronomically during that time. We now live in a full world, in which natural capital is scarce in relation to human beings and man-made capital. For example, the productivity of our fisheries is no longer determined by the amount of fishermen and boats, but by the amount of fish in the water. Today, mainstream economic theory continues to focus on the allocation of labor and capital, to the exclusion of the natural world.

Ecological economics addresses the failures of the neoclassical economic paradigm by treating goods and services from the natural world are vital components of the human economy. Ecosystem processes provide energy and regulate wastes, and natural resources are used for a variety of goods and services including food, medicine and recreation.[29] Ecological economics is an interdisciplinary field that studies the allocation of these natural resources, with emphasis on the view of the human economy as a subset of the ecological world. Drawing upon expertise from the natural and social sciences, ecological economists seek to include natural resources in the traditional economic view as a capital stock, of sorts, that can be used by the economy.

A central tenet of ecological economics lies in the recognition of biophysical limitations on economic growth and instead favors sustainable development. The field builds on traditional ideas of sustainability

to include responsible use of resources that does not preclude future generations from enjoying standards of living comparable to those of citizens today. The literature review documents the work that defined ecological economics as a discipline, and highlights the key tenets of the field as a philosophical and theoretical foundation from which to build an understanding of how to include concepts of sustainability in business and policy making.

Economy as a subset of the environment

Traditional economics views our economy as separate from the surrounding environment with potential for infinite expansion. From an ecological standpoint, the economy is actually a subset of the larger natural world, limited in its expansion by the laws of thermodynamics (Fig 3). The first law of thermodynamics states that matter and energy can neither be created nor destroyed, so the economy must use resources provided by the natural world. The second law of thermodynamics states that all things tend towards entropy; they become less useful. Economic production begins with low-entropy materials, such as natural resources, and ends with high-entropy wastes. Ecological economics is concerned with the rate at which the economy uses natural resources and ecosystem services. As resources flow through the economy (a process known as throughput) natural goods are transformed and ultimately released as wastes.

Ecosystem services are natural functions that have value to humans. These services include natural processes like oysters filtering the toxins out of water in a bay, or trees sequestering carbon dioxide from the air. The environment also provides capital in the form of food and raw materials for human-made goods. Ecologists, who study ecosystems, cannot identify every aspect of the systems or their functioning. It is impossible to measure the precise value of these services, although various accounting measures have been developed to provide approximate monetary values. The ecological footprint and life cycle assessment (LCA), for example, has been applied to assign value to the environment based on the revenue generated by associated economic markets.[30]

Because the world is a closed system, there is a finite base of natural resources with which to create goods, and this base is depleted by economic growth. Many of these resources are nonrenewable and even renewable resources are frequently consumed more quickly than they can be replaced. Technological

innovation can facilitate more efficient resource use, but technology itself – however rapidly changing – cannot function without a minimum of materials and energy.

As economic growth continues to occur, the environment shifts from an 'empty world' (i.e. many natural resources available) to a 'full world' (i.e. most natural resources have been appropriated and even depleted by the economy).[31] During this transition, there is a point of economic growth beyond which human welfare is in fact reduced rather than increased.[32]

Improving Welfare: Growth vs. Development

Gross Domestic Product (GDP) and Gross National Product (GNP) are standard measures of economic growth. Growth is often linked to increasing welfare despite the fact that unfettered growth may actually reduce welfare in the long run. Empirical evidence exists[33], for example, that ever larger portions of GDP are diverted to address undesirable consequences of growth, thus raising GDP even further. In contrast, development refers to qualitative improvement in quality of life. Developing economically focuses on the ability to make improvements in the designs of existing commodities and institutions that improve the scale, allocation, and distribution of resources.

> *"Gross National Product, as well as other related measures of national economic performance have come to be extremely important as policy objectives, political issues and benchmarks of the general welfare. Yet GNP as presently defined ignores the contribution of nature to production, often leading to peculiar results."* [34]

Ecological Economics and Public Policy

Economic policy should be directed towards achieving three policy goals: optimal scale, efficient allocation, and just distribution. This document focuses on scale, as it is the policy area most relevant to the General Services Administration's sustainability initiatives. Also, many ecological economists would argue that conventional economic thought already addresses efficient allocation and it is necessary for scale to be addressed before distribution can be addressed in a meaningful way. Together, these three policy areas represent a three-pronged model of sustainability in which environment, society, and economy are interdependent.

Optimal scale

In economic terms, scale refers to the volume of matter and energy used to provide goods and services in the economy. Many ecological economists posit that our current scale of natural resource use is unsustainable, and that the human economy is approaching the full world scenario in which growth is uneconomic.[35] This is in part due to negative externalities (e.g. pollution) resulting from growth and from failure of the market to capture scarcity of resources without monetary value.

Command-and-control regulations have historically been the primary mechanisms for setting limits on resource consumption. These policies set strict limits on pollution, extraction or harvest levels and fine firms for violation. However, there has been a recent shift in the discourse about the effectiveness of such policies in favor of more flexible solutions that provide incentives to reduce scale beyond one set cap in a more cost-effective manner (e.g. Pigouvian taxes, tradeable permits). Economists from all disciplines continue to debate the merits of market-based environmental policies versus the traditional command-and-control approach.

Efficient allocation

While accepting of the basic laws of supply and demand as useful tools of market analysis, ecological economics draws attention to the insufficiency of the market to allocate many types of natural resources. Open-access regimes such as fisheries, for example, are nonexcludable (i.e. traditionally lack property rights) and individuals may overexploit these resources because any costs incurred are shared among many other individuals also using the resource. Public goods (e.g. fresh water, clean air, scenic beauty) are subject to similar effects because they can be used for free and thus scarcity will not be adequately reflected in the market price.

Environmental economics suggests that some of these problems can be solved by assigning prices to natural resources and taxing polluters. Public policy mechanisms can make effective use of price estimates for ecosystem services. In Costa Rica, landowners are paid to preserve their land based on estimated values of biodiversity, carbon sequestration and scenic beauty.[36]

Ecological economics, while generally not averse to this solution, sees clear limitations and emphasizes the intrinsic and moral value of ecosystems and their role in supporting the human endeavor that is fundamentally different from the contributions that come from ordinary goods and services.[37] Policy mechanisms and business practices can be developed to reflect the fact that natural goods and services do have some value without attempting to calculate a dollar value for each. The Endangered Species Act is a classic piece of legislation in the United States that reflects this ideal through policy. Wildlife classified as threatened or endangered is given implicit value in its protection by the law, without attempt to monetize the value of a given species or biodiversity as a whole.

Business and industrial practices can also be developed to reflect the fact that natural goods and services do have value without attempting to assign specific dollar values. For example, production methods that minimize waste generation can limit throughput and environmental impact. Efficiency in production is highest when complemented by attention to input volume, since costs associated with the rate of resource consumption can outweigh the benefits from reduced waste generation.[38]

Just distribution

Ecological economics places importance on the distribution of wealth and income for sustainability and responsible use of resources. Income distribution can undermine sustainability because poor communities may not be able to afford dealing with environmental impacts, while the very rich consume vast amounts of limited resources and may be better able to adapt to growing resource constraints or decreasing environmental quality. Policies designed to remedy this situation include progressive income and wealth taxes, mandated minimum wages, unemployment insurance and welfare programs.

Defining sustainability

Ecological economics charges the present generation to carefully examine the relationship between the economy and the ecosystem that encompasses it. The scale of the economy should be constrained to the point where the present generation does not compromise future generations' ability to use natural resources and services. Defining sustainability in a precise way is tricky as it involves normative judgments about the present generation's obligations to future generations and assumptions regarding

technological progress.[39] A sustainable economy requires a long-term view of income. Ecological economics defines income as the amount that can be consumed without depleting the ability to consume the same amount in the future.

Consumption of capital (including natural capital) does not count as income because it makes the community (or the ecosystem) less able to produce goods in the future. So, depleting a fishery at a greater rate than it can replenish itself does not create income, it is consumption of natural capital that depletes future wealth. Spending capital, including natural capital, can create short-term economic growth, but should not be confused with income. The distinction is that income is a return on capital whereas capital depletion destroys the ability to earn income.

Increasingly, the discussion of sustainability has evolved into analyses involving multiple stakeholders from the sciences and from business that focus on systems-level management strategies and holistic approaches to production. A holistic viewpoint of complex interactions maintains that a single part within a network can be best understood not in isolation, but rather in the context of its relationship to other parts and its function within the larger whole.

The field of industrial ecology studies the intricate relationship between the environment, economy, and technology that exists within industrial systems. An industrial system is a network of production and consumption built of several steps of varying complexity from raw materials to marketable products to their use and return to the environment or other parts of the economy. This network exists within, and is dependent upon, the larger ecosystem that provides a stock of natural capital for the creation of products and assimilation of wastes. The ways in which industrial processes are designed and end products are used determine the degree of impact on the environment, and in turn the condition of resources available for production. The socioeconomic environment also factors into decision-making regarding scale of resource use, design of products and industry structure, as well as impact on the biophysical environment.

As with other complex networks, a perturbation in any part of the broad industrial-ecological system can cause adjustments in other parts of the network. Because unintended consequences become ever more likely as the size of the operation (a production process or the economy) increases, implementation of solutions to problems must be done with care to avoid adverse repercussions. Emphasis of a comprehensive view over narrow partial analyses has become an approach to defining and working toward sustainability in practice.[40] Several tools have emerged to make ecological economic theory applicable in business, and these will be discussed in depth in the next piece of this literature review.

translating theory into practice: tools and applications

A major challenge to achieving sustainable development as is the practical application of theory. This section reviews some of the major tools for incorporating the theories of ecological economics into policy, business and industrial practices including extension of traditional decision-making and cost-benefit analysis, life cycle analysis and industrial ecology. The section also presents general criteria indicators for inclusion of sustainability into the micro and macroeconomic views of welfare, and backcasting theory as a method to integrate sustainable development in microeconomic business strategy.

Decision-making toward sustainability

Cost-benefit analysis (CBA) is a common tool used to choose between potential projects or courses of action. The costs and benefits of the impacts of a proposed activity are evaluated with the goal to determine all of the parties affected by the activity, and to place a monetary value of the effect an activity has on economic welfare. Choices are made by seeking out activities with the lowest cost-benefit ratio. Ecological economists take issue with the traditional practice of CBA as a decision-making tool because it does not account for potential costs/benefits of actions that do not have monetary values and because it limits the criteria for decision making, often avoiding valuable perspectives and interests of broader stakeholder groups. Empirical analyses comparing the realized costs and benefits of projects to previously estimated values have revealed frequent inaccuracies.[41] For example, it is impossible to accurately price natural resources, ecosystem services, social institutions, and human lives.

Multi-criteria analysis (MCA) is a technique that facilitates the use of both qualitative and quantitative measurement scales, which makes it possible to address multidisciplinary problems involving consequences on the environment and/or public health issues.[42] This process includes the participation of many interested parties in decision making and in problem solving, and is focused on compromise or defining a coalition of views rather than dictation of judgment from a single stakeholder category. Its potential stands is greatest in situations involving multiple value systems and objectives, which cannot be easily quantified (e.g. environmental issues) or translated in monetary terms due to their intangible nature (e.g. social, cultural or psychological issues).[43]

An MCA usually begins by identifying all the potential impacts of each decision, and a set of criteria that all stakeholders find important for choosing among alternatives. The potential options are then ranked using methods that range from simple hierarchical systems to more complex algorithms.[44] The ranking of alternatives is then used as a template to guide the final decision and to understand the implications of choosing one option over another, rather than identifying a single 'best' option.[45]

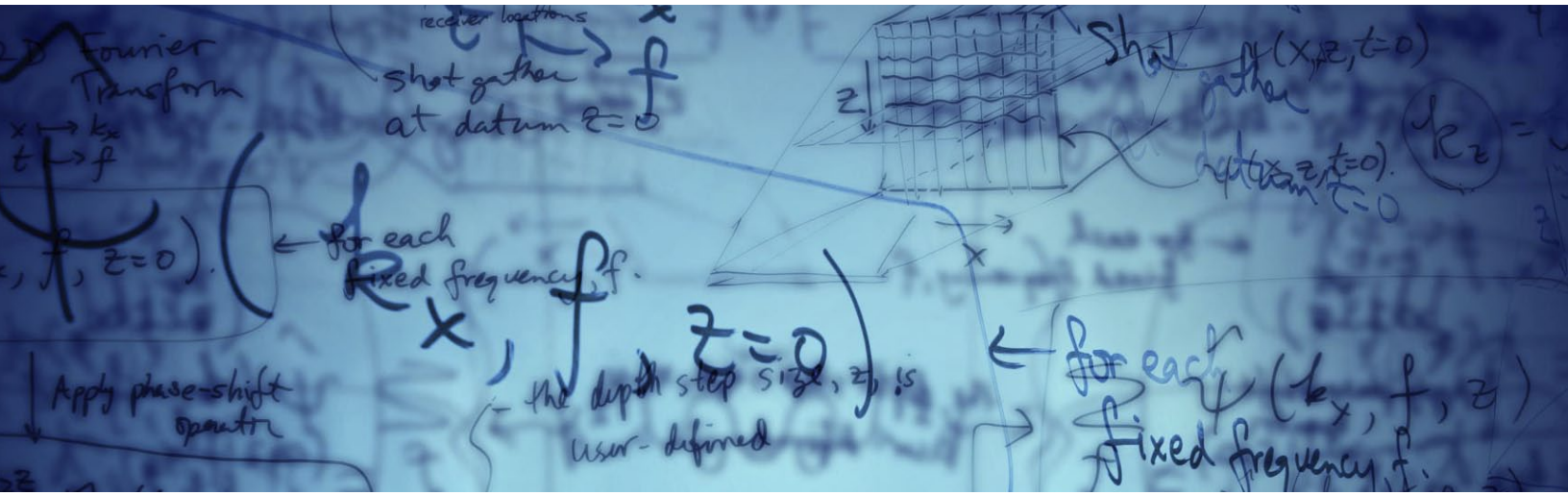
Multidisciplinary stakeholder involvement is an important aspect of understanding alternatives to a problem and identifying the most desirable solutions. To gain a comprehensive picture of the social, economic, and environmental impacts of a decision requires input from individuals with a wide range of views and knowledge, including decision-makers, scientists and engineers, and the general public. Reliance solely on expert opinion, or on the perspective of a single stakeholder, when conducting MCA provides solutions that may satisfy only narrow interests or may have undesirable consequences for another group.[46]

Sustainability in industry

There has been increasing attention to the greening of industrial practices as a component of sustainable development. Industrial ecology is the study of the interaction between industrial and environmental systems, emphasizing design of manufacturing processes that minimizes waste and reduces environmental impacts. Uniquely viewing human industry as part of a dynamic, linked network that includes the environment and the economy, industrial ecology seeks approaches to sustainable use of resources that work well from a holistic perspective.

Experts from a range of backgrounds including the natural and physical sciences, public policy and law have joined a discourse that has expanded from questions regarding efficiency of material and energetic flows in industrial processes to include concerns about biodiversity, sustainable development and public health. Specifically, research topics include determination of material inputs to production, improvements of environmental impacts through technological change, institutional and managerial responsibility for product design, development of eco-efficient industries and industrial parks, and policy incentives for environmentally friendly practices.

Increasingly, firms implementing responsible production techniques have broadened their approaches to material use from a “cradle to grave” to a “cradle to cradle” perspective, continually reusing and recycling waste rather than creating products that are ultimately discarded wholesale.[47] This perspective takes into account not just relations among processes but also the broader infrastructures and social systems that constrain these processes and influence their development. InterfaceFLOR’s carpeting systems, for example, are designed so that only worn tiles of carpet are replaced over time, rather than discarding an entire flooring system when only few areas are damaged. Old tiles are recycled and used as inputs to new production cycles, along with other renewable materials. This production cycle limits the extraction of raw materials needed to provide the flooring service, and minimizes net waste products.



Life cycle assessments

Part of the challenge of transitioning from a linear, through-put oriented system (in which raw materials are input and wastes are output) to a closed-loop production system (in which materials are recycled and wastes are eliminated) is accounting for energy balances and resource flow from a product, starting with a raw material and ending at the point at which the product is no longer usable. Life Cycle Assessments are production budgeting tools used to inventory all transfers of energy and materials to the environment, to characterize impacts of each release, and to identify areas for efficiency improvements to reduce impacts. One such area is the design of products for maximum reuse of its constituent parts. A systems perspective is particularly important in these analyses to ensure that potential improvements aren't canceled out by costs in another part of the network.

Because they tend to be focused on single products or processes, Life Cycle Assessments are often interpreted in tandem with impact assessments of different foci. Environmental Impact Assessments, for example, evaluate and model waste emissions from entire plants or firms. Cost evaluation techniques (e.g. cost-benefit analysis) can then be used to compare potential methods to reduce impacts. Combining impact assessments from the perspectives of technical, ecological and socio-economic systems provides a comprehensive, higher-order picture of the industrial network for experts to use when considering efficiency improvements.

Life Cycle Cost Analyses are similar tools that can be used to choose among production options by examining costs and benefits over the entire life cycle of a product. The truly cost-effective option is not necessarily that with the lowest procurement costs, but the lowest cost:benefit ratio over a product's economic life. These analyses may include not only material inputs, but also more complex facets of a product. In building design, for example, one may want to consider operating and maintenance costs, productivity of workers in the environment, and savings values from efficiency measures (e.g. windows to make use of daylight versus more electric lighting).[48]

Technological innovation

Technological innovation often plays a key role in moving from open to closed loop systems by increasing efficiency of industrial processes or aiding in the recycling of waste products. In any given

industry, manufacturing equipment has different efficiency and production capacity over its lifetime. For example, a machine that produces aluminum cans might have a typical lifespan of 35 years, over which time it becomes less efficient at using energy to manufacture the cans in the absence of investment and improvements. This production capacity of manufacturing equipment over lifetime, known as capital vintage structure, to a certain extent 'locks in' production methods and efficiency because upgrades and improvements to industrial capital can be very time-consuming and expensive.

There is a burgeoning area of study within industrial ecology dedicated to the economics of such innovation, emphasizing the timing of change and improvements based on the technological inertia in the industry. Systems modeling is typically used to set potential schedules representing the most cost- and energy-efficient time scales for implementing innovative technological change. For example, the energy-intensive pulp and paper industry is a recent target for CO2 emissions reductions. Researchers in Europe and the United States have used dynamic modeling to investigate the impacts of various policy options on emissions given the capital vintage structure (i.e. the lifetime capacity and age structure) of pulp and paper plants.

Industrial ecology emphasizes the design of new products that anticipates environmental impacts from the start, ideally saving manufacturers costs of cleanup or improvements in the future. The "design for environment" (DFE) approach joins the capital vintage approaches described above with comprehensive environmental assessments toward a forward-thinking view of design. Typically product-oriented, this approach focuses on reduction of toxic material use, potential for recycling and manufacturer responsibility as a feature of product development rather than an afterthought. The movement toward green cars (e.g. hybrid and electric vehicles) from 'end-of-pipe' mechanisms to reduce emissions (e.g. catalytic converters) represents an ongoing application of DFE. Installation of green roofs and vegetation in cities can reduce air temperatures, leading to less energy use for air conditioning and water use for cooling in industrial buildings.

"South San Francisco Bay, California." Photo Credit: Jonathan Herz

Networking sustainability

One archetypical example of sustainable production in practice is an integrated industrial network in Kalundborg, Denmark. Borrowing the adaptive strategy of mutualism (co-beneficial relationships) from nature, this and other eco-industrial parks share materials and energy among participating firms in an effort to achieve greater returns to production than can be achieved when each firm operates independently. These cost savings are incentives for firms to participate in business practices that often result in efficiency improvements and reduced waste emission. Six firms including an oil refinery, a plasterboard firm and a pharmaceutical company trade waste for reuse and recycling, recover solvents for manufacturing processes, and share transportation and security services. Over the past 30 years since the park was founded, evolution of the symbiosis has amounted to substantial annual energy savings; for example, resource exchange between the refinery Statoil and the power station Asnes saves the firms 1.2 million cubic meters of water and 30,000 tons of fossil fuel per year, respectively.[49]

Businesses around the world are beginning to apply industrial ecological approaches from the eco-industrial park model to smaller-scale partnerships. Texas Industries, for example, enjoyed an increase in cement production and decrease in energy consumption following a 1999 agreement to re-use waste products from neighboring Chaparral Steel. Similar symbiotic developments have emerged throughout the United States and abroad in Japan, Canada and Puerto Rico, among others.

Backcasting

Backcasting is a methodology that aims to provide decision-makers in organizations with an idea about the underlying systemic dimensions of the challenges they deal with. Backcasting can best be defined in contrast to forecasting. Forecasting, as a strategy tool in business and policy, is based on observation of past trends, which are then extrapolated to describe the most likely future developments. The problem inherent in a forecasting approach is a strategic lock-in to undesirable developments, such as ever-growing energy demand. This approach can be called "path-dependent."

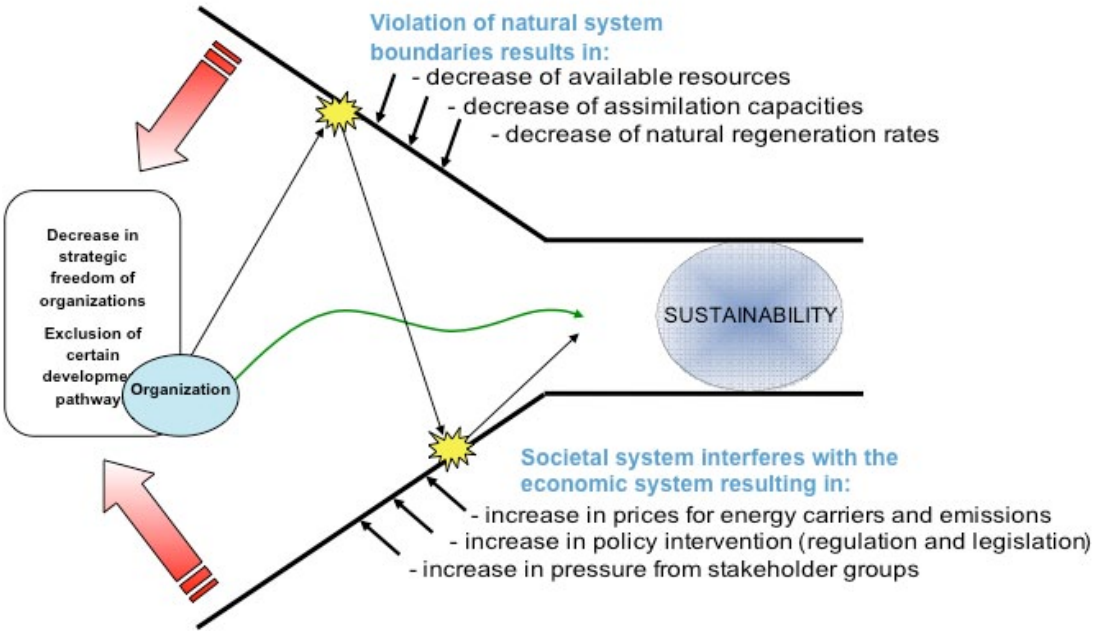


Figure 5: Figure based on Holmberg 1998, p. 35 and Nattras & Altomare 2006, p. 20.

Extrapolation of past developments and practices as a basis for realizing a more sustainable future does not usually take into consideration overall system limitations (i.e. acknowledge the problem of scale). Backcasting, as an alternative method in future studies, approaches the issue of path-dependency and desirability of long-term outcomes from the opposite perspective. First of all, a desirable long-term sustainability target is defined. After the target is clarified, a backcasting methodology is used to analyze the status quo in a detached manner that opens the horizon of decision makers for problem solving (See Figure 5). The actual backcasting process is a comparison of the pre-set target and the status quo, such as establishing a goal of 350 parts per million carbon dioxide in the atmosphere to diminish the effects of global warming.

This comparison highlights necessary steps that link the present to a desirable future. In an organizational environment, backcasting will ideally yield tangible milestones all along a time line towards the long-term target and thus help to operationalize sustainable development. Decisions under strategic backcasting are therefore always evaluated against the target scenario, they are ranked according to their capability to realize sustainable development rather than short-term profitability. Backcasting consequently requires long time spans to unfold its methodological advantages; time spans of 20 to 100 years are manageable with the method that was developed for policy scenarios but is now increasingly applied in organizations (corporations, municipalities, agencies etc.) to ensure a desirable strategic development within a long time horizon.

Discounting

Discounting is the process of systematically devaluing future costs and benefits. This is done in order to compare present costs and benefits with those occurring in the future, by calculating a net present value. There are a number of reasons for discounting the future: uncertainty about future technological or economic conditions, expectations of economic growth or future productivity, or pure time preference for the present. The discount rate is the rate at which future assets are devalued in present accounting. So, choosing an appropriate discount rate is crucial if we are to reserve and appropriate amount of resources for future use. The Office of Management and Budget uses a discount rate of seven percent in

most calculations to reflect expected returns on private sector investment.[50] At that rate, an investment that yields $100 50 years from now but requires an investment of 4 cents today will not be carried out. As a result of high discounting, many projects that could address climate change, for example, are not carried out, because investments today may be large and benefits may not be seen until a distant future.[51]

Ecological economics approaches discounting differently. When future returns are discounted due to an assumption of increased productivity or economic growth, it must be realized that this implies an increase in the size of the economy relative to the ecosystem and therefore environmental destruction. Discounting is problematic when it assumes future economic growth because growth cannot be sustained indefinitely.[52]

The appropriate use of discounting is crucial to improving the sustainability of the federal government's operations. Many sustainability initiatives necessitate start-up expenditures with expected future benefits. Retrofitting buildings to make them more energy efficient, for example, requires spending money in the present to attain future financial and ecological benefits in the form of energy savings. Because discounting devalues future financial benefits, an inappropriately high discount rate may discourage decision-makers from undertaking these retrofits. Discounting devalues the future, which precludes policymakers from engaging in the kind of long-term planning necessary for sustainability.[53]

Indicators

One of the prevailing themes of ecological economics has been the critique of existing measures of welfare, especially the GDP and related indicators. While these were never intended to represent the well-being of a society,[54] they are being used that way both by economists and policymakers.[5]

The GDP does, however, include many activities that actually reduce welfare, such as the destruction of the environment. It further counts expenditures that are defensive, compensating for the effects of

growth without giving additional benefits themselves. Costs of commuting or for the protection against UV radiation are just some of the examples. On the other side, the GDP fails to integrate activities that clearly do contribute to well-being, especially household labor, and only partially counts public activities like education. As an additional shortcoming, GDP does not take social inequality into account, even though it clearly affects welfare. Finally, standard national accounting does not consider sustainability, it does not assess if current growth is occurring at the cost of future generations.[56]

To compensate for the inadequacy of GDP as an indicator for the progress of a society, various alternatives have been designed. These range from happiness indicators relying on survey data[57] through aggregate social indicators like the UN Human Development Index to indicators that make certain corrections to standard national accounting. The Index of Sustainable Economic Welfare (ISEW)[58] and the Genuine Progress Indicator (GPI)[59] have been applied in many settings, using personal consumption as a basis, but making corrections for environmental degradation, inequality, defensive expenditures, household labor and more, with dozens of corrective steps.

While some weaknesses to these alternative indicators have been shown,[60] such as a tendency to continue to monetize elements, they clearly provide a better approximation of progress than GDP can. Almost all calculations for industrialized countries have shown that sustainable economic welfare has already peaked, and further economic growth might well lead to a lower level of welfare.[61] This can be explained by economies surpassing their optimal scale, eliminating growth in GDP as a valid policy goal; growth in welfare must be achieved.

"Downtown Atlanta, Georgia." Courtesy of NASA/Goddard Space Flight Center Scientific Visualization Studio

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economic literature review

GSA and The New Sustainable Frontier

A New Approach to Environmental Analysis:
Multi-Criteria Integrated Resource Assessment (MIRA)

Pricing the Priceless:
Cost-Benefit Analysis of Environmental Protection.

Ecological Economics: The Concept of Scale and its Relation to Allocation, Distribution, and Uneconomic Growth

Literature Referenced in Ecological Economics: Theory and History

Examples of Literature Assessed and Synthesized in Translating Theory Into Practice: Tools and Applications

Additional Readings

gsa and the new sustainable frontier

This literature review is intended to aid the understanding of the principles of sustainable development by presenting a background of economic theory in general to provide context for the principles of ecological economics, history of the seminal works and principal themes of ecological economics as a discipline, and providing examples of applications of these themes in business and industrial enterprises. The review includes an overview of mainstream economic theory to familiarize readers with the terminology of economics and provide context for ecological economics, a synthesis of the principles of ecological economics, and a description of tools used in the practice of ecological economics.

The following brief overviews of pertinent literature served as preparation for the GSA and the New Sustainable Frontier workshop that took place on March 6th, 2009. For more in-depth reading, please use the links to find the literature in its entirety.

1. A New Approach to Environmental Decision Analysis: Multi-Criteria Integrated Resource Assessment (MIRA)
2. Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection.
3. Ecological Economics: The Concept of Scale and its relation to allocation, Distribution, and Uneconomic Growth.

A New Approach to Environmental Analysis: Multi-Criteria Integrated Resource Assessment (MIRA)

Authors: Cynthia H. Stahl, US EPA Region III and University of Delaware; Alan J. Cimorelli and Alice H. Chow, US EPA Region III.

http://ceep.udel.edu/publications/sustainabledevelopment/publications/2002_sd_new_approach_mira.pdf

The authors present Multi-Criteria Integrated Resource Assessment (MIRA) as a new approach to environmental analysis. MIRA allows for stakeholders to analyze separate identities of data and social judgments to arrive at a conclusion made on mutual stakeholder intelligence. MIRA's key features include: indexing, criteria weighting, learning, and the increased opportunity for consensus building.

The authors identify occurring conflict within a neoclassical system; complex social, economic, and political issues cannot be resolved by the typical singular route it employs. They argue that policymakers need a multi-criteria decision analysis framework in order to adhere to the social and ecological factors affecting the given situation. Through the MIRA process, single optimal answers are avoided. MIRA offers policymakers the choice of rethinking options at each stage in the analysis process towards an end goal of obtaining sustainable environmental policy.

9 Steps of the MIRA Process

1. Define the decision question; decide on decision criteria based on that question
2. Select the 'problem set' which is the set of elements (the decision options or pollutant sources) that are to be ranked using MIRA
3. Gather the data needed for each criterion
4. Index the set of elements
5. Weigh the criteria
6. Create an initial 'decision set' (a problem set whose elements are ranked based on the data and criteria weighting)
7. Create different decision sets for the initial problem set and modifying that problem set if Appropriate as learning occurs and additional options are discovered;
8. Discuss these with stakeholders
9. Make the final decision

MIRA Methodology

1. Determine criteria (stakeholder participation) and define with a metric (data input)
2. Index criteria (expert)
3. Initialize with values (preference schemes)
4. Obtain ranked list of options Iterate

Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection.

Authors: Lisa Heinzerling and Frank Ackerman. Georgetown Environmental Law and Policy Institute, Georgetown University Law Center.

Date: 2002

http://www.ase.tufts.edu/gdae/publications/C-B%20pamphlet%20final.pdf.

In recent years the use of "cost-benefit" analysis to inform environmental standards and policy has attracted a large and high-profile group of supporters. Cost-benefit analysis tries to mimic a basic function of capital markets by setting an economic standard for measuring the success of government's projects and programs. Cost-benefit analysis adds up the benefits of a public policy and compares them to the cost.

There are 2 typical arguments in favor of cost-benefit analysis. First is that cost-benefit analysis furthers efficiency by ensuring that regulations are only adopted when benefits exceed costs and by helping direct attention to those problems for which regulatory intervention will yield the greatest net benefits.

Second, CBA is believed to produce great transparency and great objectivity, thus being more accountable to the public.

Pricing the Priceless argues that cost-benefit analysis is a deeply flawed method that repeatedly leads to biased and misleading results. In comparison to other economic approaches Cost-Benefit Analysis offers no clear advantages in making regulatory policy decisions and often produces inferior results, in terms of both environmental protection and overall social welfare.

The primary flaw is that cost-benefit analysis seeks to monetizing benefits such as the value of life and a healthy environment, for which there are no natural prices. Cost-benefit analysis therefore requires the creation of artificial ones. This process of reducing life, health, and the natural world to monetary values is inherently flawed.

Another flaw is that cost-benefit analysis uses discounting to systematically and improperly downgrade the importance of environmental regulation. While discounting makes sense in comparing financial investments; it should not be applied when choosing noneconomic harms to present generations and preventing similar harms to future generations. Additionally discounting tends to trivialize long-term environmental risks, minimizing the very real threat our society faces from potential catastrophes and irreversible environmental harms, such as those posed by global warming.

Additionally, cost-benefit analysis ignores the question of who suffers as a result of environmental problems and therefore, threatens to reinforce existing patterns of economic and social inequality. Cost benefit analysis would justify imposing greater environmental burdens on them than on their wealthier counterparts.

Finally cost-benefit analysis lacks transparency because it rests on a series of assumptions and value judgments that cannot remotely be described as objective. These make it extremely difficult for the public to understand and participate in the process.

The article does fail to offer a conclusive recommendation on what alternatives are out there. A comprehensive compare and contrast against the listed methodologies would be useful.

Ecological Economics: The Concept of Scale and its relation to allocation, Distribution, and Uneconomic Growth

Authors: Herman E. Daly. School of Public Affairs. University of Maryland

Date: October 2003.

http://www.publicpolicy.umd.edu/faculty/daly/Scale%20paper%20rev%20final%20copy.pdf.

Ecological Economics is an interdisciplinary field, with conceptual roots in thermodynamics, ecology, and economics. Ecological Economics seeks to understand how human behavior is constrained by, and integrated with, the natural world and its physical laws.

In reviewing these concepts, Daly breaks this overview into 5 parts. First, he looks at Ecological Economics from the outside-summarizing views of scholars from various disciplines interested in ecological economics, their comparisons to neoclassical. Second, he looks at the main features and issues of ecological economics. Third, he looks at the meaning of economic growth in the scale of the physical economy. Fourth, he offers policy implications related to ecological economics and fifth, the author considers alternative formulations on why optimal allocation presupposes a given scale.

Selected quotes from scholars on Ecological Economics:

a. "[Ecological Economics] is problem focused rather than concerned with abstract modeling, and in contrast to conventional neoclassicism, ecological economics shifts the focus from micro to macro and relevant time frames from the very short term to deep time…"

b. "What the ecological economists have to say about the inherent flaws of neoclassical economic theory from an ecological perspective is, as we shall see, quite devastating, and many of their proposed economic solutions to environmental problems are carefully reasoned, beautifully conceived, and utterly appropriate. But if this is the case, why is there virtually no dialogue between the ecological economists and the mainstream economists who sit at the right hand of global planners?"

Daly summarizes ecological economics as having three priorities: allocation of resources, distribution of income, and scale of the economy relative to the ecosystem.

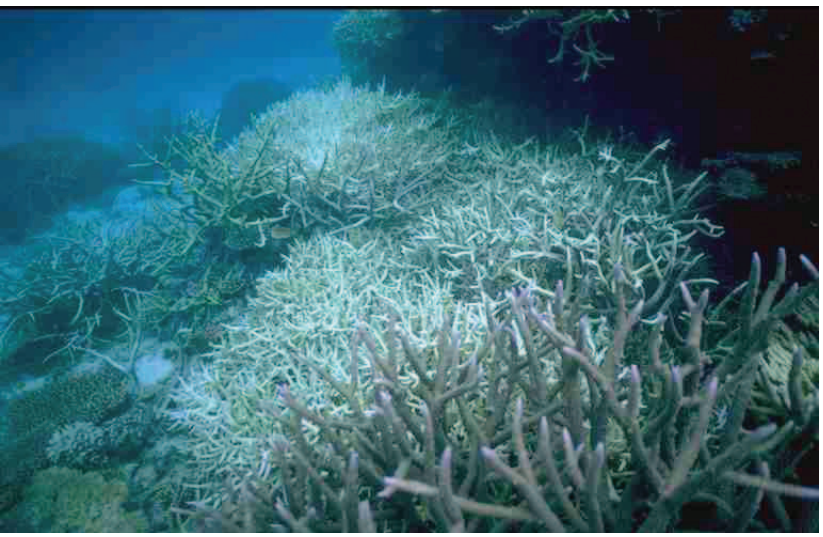
A good allocation of resources is efficient; a good distribution of wealth is just. The defining difference between ecological and neoclassical economists is the emphasis upon distributive "fairness." For ecological economists, fairness is much more pressing. They view the economy as a growth that encroaches upon the existing, finite ecosystem. Therefore, scale determines what is scarce and what is free.

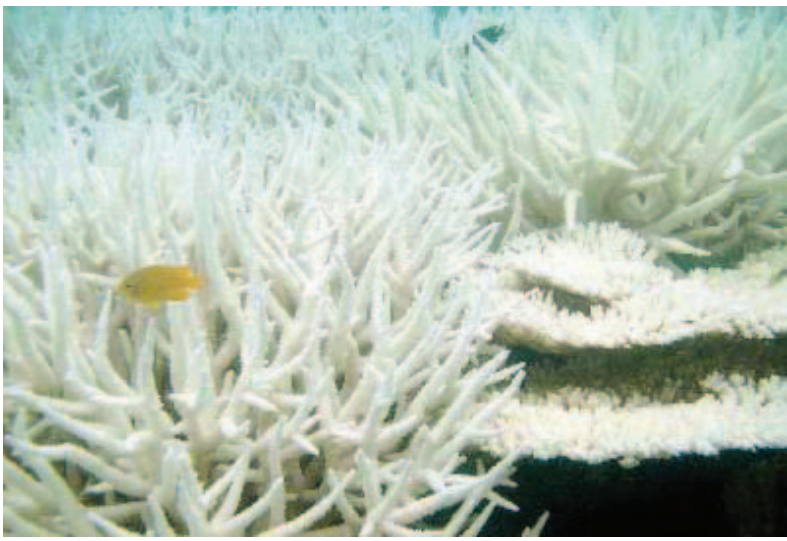
Neoclassical economists do not consider scale an issue, and are unconcerned with throughput. Rather, they focus singularly on efficient allocation.

Ecological economists base their analysis upon the idea that the economy is connected to, and sustained by, a flow of energy, materials, and ecosystem services; i.e. a connection of depletion to pollution by the concept of throughput. Primarily, the impacts upon the entire ecosystem by economic activities that cause depletion, pollution and entropic degradation.

Daly writes that the Earth has a finite amount of matter and energy. Although they are constant in quantity they change in quality, both naturally and as they move through the economic system. Because of this, ecological economists are advocates of metrics that measure the health and stability of the ecosystems beyond an atypical price and exchange value.

"Bleached Coral Reefs." Photo Credits: NOAA





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Cobb, C.W., & Cobb, J.B. (1994). ***The green national product: a proposed index of sustainable economic welfare***. Lanham: University Press of America.

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Martiniez-Alier, J. & Schlupmann, K. (1999). ***Ecological economics. International Encyclopedia of the Social and Behavioral Sciences***, 4.9, 9.

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Flyvbjerg, B., Skamris Holm, M.K., & Buhl, S.L. (2002). Underestimating costs in public works projects: error or lie? ***Journal of the American Planning Association***, 68, 3, 279-295.

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additional readings

Allocation, Distribution, and Scale

Cost-Benefit Analysis

Development

Discounting

Ecological Economic Theory

Economic Growth

Economic Indicators

Ethics

History of Ecological Economics

Industry

Life Cycle Assessments

Methodology

Multi Criteria Analysis

Technology

Thermodynamics

Throughput

Valuing Environmental Goods and Services

additional readings in economics

This appendix provides a brief listing of pertinent literature that will serve for more in-depth reading of the concepts that are addressed within the main text and its appendices.

Allocation, Distribution, and Scale

Ackerman, F. (2002). ***Still Dead After All These Years: Interpreting the Failure of General Equilibrium Theory.*** Global Development and Environment Institute Working Paper 00-01.
This article discusses the failure of general equilibrium theory. Cited by 37.

Barry, B. (1983). Intergenerational Justice in Energy Policy. In D. MacLean & P.G. Brown, (Eds.). ***Energy and the Future*** (pp. 15-30). Totowa, NJ: Rowman and Littlefield.
Compensation of future generations by the present generation for exhausting natural resources is proposed. Cited by 31.

Beltratti, A., Chichilnisky, G., & Heal, G. (1995). Sustainable Growth and the Green Golden Rule. In I. Goldwin & L.A. Winters (Eds.). ***The Economics of Sustainable Development.*** Cambridge, England: Cambridge University Press.
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Boulding, K.E. (1966). The Economics of the Coming Spaceship Earth. In H. Jarrett (Ed.). ***Environmental Quality in a Growing Economy*** (pp. 3-14). Baltimore: Johns Hopkins Press.
The planet's finite space and resources, and its implications for economics, is explored. Cited by 760.

Burness, S., Cummings, R., Morris, G., & Paik, I. (1980). Thermodynamic and Economic Concepts as Related to Resource-Use Policies. ***Land Economics,*** 56, 1-9.
Market-based solutions to resource scarcity are discussed. Cited by 21.

Common, M. & Perrings, C. (1992). Toward an Ecological Economics of Sustainability. ***Ecological Economics,*** 6, 7-34.
A model is developed which includes both economic and ecological concepts of sustainability. Cited by 234.

Costanza, R. (1991). ***Ecological Economics: The Science and Management of Sustainability***. New York: Columbia University Press.
This book explains the theory and methods of ecological economics. Cited by 557.

Costanza, R. & Daly, H.E. (1987) Toward an Ecological Economics. ***Ecological Modeling,*** 38, 1-7.
This article argues that humanity's increasing impact on the environment requires a convergence of the disciplines of ecology and economics. Cited by 50.

Daly, H.E. (1987). The Economic Growth Debate: What Some Economists Have Learned but Many Have Not. ***Journal of Environmental Economics and Management,*** 14, 323-336.
The distinction between growth and development is examined, as well as the perils of a growth-oriented economy. Cited by 101.

Daly, H.E. (1992). Allocation, Distribution, and Scale: Towards an Economics That Is Efficient, Just, and Sustainable. ***Ecological Economics,*** 6, 185-193.
This article discusses the goals of an economic system and ways to achieve them. Cited by 231.

Daly, H.E. (1993). Introduction to the Steady-State Economy. In H.E. Daly & K. Townsend (Eds.). ***Valuing the Earth: Economics Ecology, Ethics (***pp. 1-31***).*** Cambridge, MA and London: MIT Press.
This article explains the paradigm shift presented by ecological economics. Cited by 24.

Daly, H.E. (2003). ***Ecological Economics: The Concept of Scale and its Relationship to Allocation, Distribution, and Uneconomic Growth***. For CANSEE, Oct. 16-19 2003.
This article summarizes the main points of ecological economics and explores the limits to economic growth. Cited by 6.

Daly, H.E. & Farley, J. (2003). ***Ecological Economics: Principles and Applications.*** Washington, D.C. and Covelo, CA: Island Press.
This book explains the theory and policy goals of ecological economics. Cited by 167.

Daly, H.E. (2005). Economics in a Full World. ***Scientific American,*** 293, 3.
This article explains the economy's relationship to the ecosystem and why limitless economic growth is impossible. Cited by 32.

Dixon, J.A. and Fallon, L.A. (1989). The Concept of Sustainability: Origins, Extensions, and Usefulness for Policy. ***Society and Natural Resources,*** 2, 73-84.
This article provides some definitions of sustainable development terminology in an effort to alleviate some ambiguity in the field. Cited by 78.

Engel, J.R. (1990). Introduction: The Ethics of Sustainable Development. In J.R. Engel & J.G. Engel (Eds.). ***Ethics of Environment and Development: Global Challenge, International Response*** (pp. 1-23). London: Belhaven Press.
This article explores the implications of holding sustainable development as a global ethic. Cited by 35.

Foy, G. & Daly, H.E. (1989). ***Allocation, Distribution, and Scale as Determinants of Environmenal Degradation: Case Studies of Haiti, El Salvador, and Costa Rica***. World Bank Environment Department Working Paper No. 19.
Case studies show three causes of environmental problems in Haiti. Cited by 42.

Georgescu-Roegen, N. (1975). Selections from "Energy and Economic Myths." ***Southern Economic Journal,*** 41.
This article outlines some economic principles that are inconsistent with the laws of physics. Cited by 14.

Goodland, R., Daly, H.E., & El Serafy, S., (Eds.). (1992). ***Population, Technology, and Lifestyle.*** Washington, D.C. and Covelo, California: Island Press.
This book explores the implications of creating a sustainable world. Cited by 51.

Gowdy, J.M. (2000). Terms and Concepts in Ecological Economics***. Wildlife Society Bulletin ,*** 26-33.
Sustainability is defined in the context of ecological economics. Cited by 25.

Gowdy, J.M. & Erickson, J.D. (2004). ***Ecological Economics at a Crossroads.*** Rensselaer Working Papers in Economics: Troy, NY.
This paper looks at the points where ecological economics conflicts with neoclassical economics. Cited by 17.

Gowdy, J.M. & Erickson, J.D. (2005). ***The Approach of Ecological Economics.*** Rensselaer Working Papers in Economics: Troy, NY.
This paper explores the major tenets of ecological economics. Cited by 23.

Guha, R. (1989). Radical American Environmentalism and Wilderness Preservation: A Third World Critique. ***Environmental Ethics,*** 11, 71-83.
The deep ecology movement is criticized as a uniquely American phenomenon that doesn't account for the needs of people worldwide. Cited by 210.

Hannon, B. (1977). Energy, Labor, and the Conserver Society. ***Technology Review,*** March/April 1977, 47-53.
The United States' energy options are explored. Cited by 4.

Harris, J.M. (1991). Global Institutions and Ecological Crisis. ***World Development,*** 19, 111-122.
This article examines the capacity of global institutions to handle ecological degradation. Cited by 10.

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section 3

the state of the world

Where are we Now?

Climate Change

IPCC Climate Change 2007 Synthesis Report

Fossil Fuel Use

Toxification

the state of the world

Where are we Now?

As a nation, our environment today is visibly cleaner than it was forty years ago. Water, air, land, and chemical pollution are being monitored and steps taken for their reduction and control. But the major problems that remain suggest that existing practices are not sustainable for the long-run. Our policies and tools, while ameliorating the situation, still require considerable improvement. In 1998, biologist Paul R. Ehrlich wrote:

> *"The last decade has also seen an accelerating loss of populations and species of other organisms that are involved in supplying crucial natural services to society, as natural areas are more and more displaced by human activities. Thus tropical forest destruction continues throughout most of the developing world. Destruction of oceanic fisheries has come to wide public attention in the same period, as stock after stock is overfished, and often the physical/biological infrastructure that supports the fisheries is destroyed. There are also growing signs that the toxification of the planet is causing serious effects on wildlife and human health through the release of hormone-mimicking synthetic organic chemicals, although demonstrating the causal links is difficult. And ecosystem services that are essential for maintaining agricultural production, such as pollination, are faltering in many areas."*[2]

And in 2008, James P. Leape, Director-General, WWF International, noted the lack of progress:

> *"… over the past 35 years alone the Earth's wildlife populations have declined by a third.*
>
> *"Yet our demands continue to escalate, driven by the relentless growth in human population and in individual consumption. Our global footprint now exceeds the world's capacity to regenerate by about 30 per cent. If our demands on the planet continue at the same rate, by the mid-2030s we will need the equivalent of two planets to maintain our lifestyles."*[2]

Climate Change

> *"The Industrial Revolution had profound impacts on the economy, society, and the global ecosystems. For the first time, human society became largely dependent on fossil fuels and other nonrenewable resources (particularly in response to the depletion of forests as fuel). Fossil fuels freed us from dependence on the fixed flow of energy from the sun, but it also allowed the replacement of both human and animal labor by chemical energy…New technologies and vast amounts of fossil energy allowed unprecedented production of consumer goods…The market economy evolved as an extremely efficient way of allocating such goods, and stimulating the production of even more.*[3]
>
> *"Used fuel does not disappear; it must return to the ecosystem as waste. Acid rain, global warming, carbon monoxide, heat pollution, and oil spills are unavoidably associated with the use of fossil fuels. On a small scale; some of these wastes could be readily processed by natural systems, but on the current scale. They pose serious threats. Indeed, the growing accumulation of waste products from fossil fuel use and the negative impacts these have on planetary ecosystems is probably a far more imminent threat to human welfare than depletion; the sink will be full before the source is empty."*[4]
>
> *Joshua Farley, Herman E. Daly*

According to the Intergovernmental Panel on Climate Change (IPCC), the global average temperature is expected to increase by about 0.2°C per decade over the next two decades.[5] Continuing greenhouse gas emissions at or above current rates would cause a further increase in global temperatures and many other climatic changes during the 21st century. We are seeing this through observations such as increasing air and ocean temperatures, widespread melting of snow and ice, rising sea levels, as well as more intense and frequent extreme weather events such as heat waves, floods and ice storms.

The IPCC points out that those who will be most affected are the poor people who are least responsible for increasing levels of greenhouse gas emissions in the atmosphere. Global warming is predicted to decrease agricultural yields in the low-latitudes and increase agricultural yields in the high latitudes, but yields will then decrease with higher global temperatures. Water availability in the moist tropics and in the high latitudes will increase, but will drop in the semi-arid low latitudes. And, a 2°C rise from today's temperatures will cause the extinction of 30% of species, and additional warming will lead to widespread coral deaths.

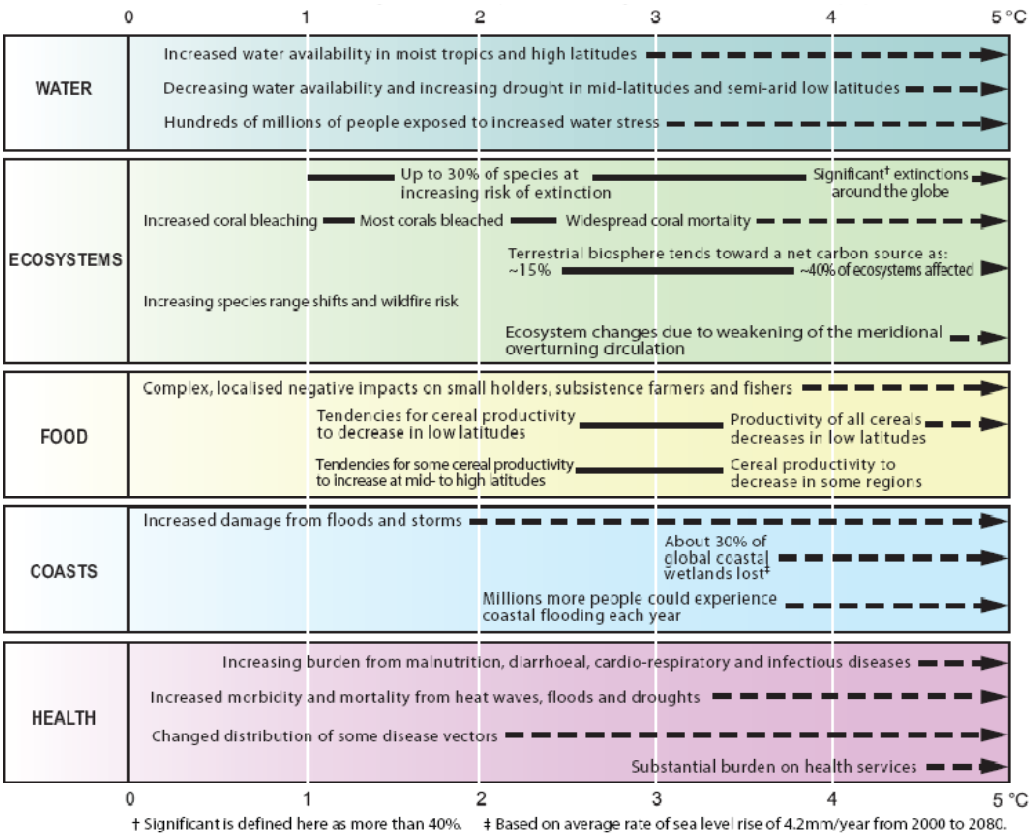
IPCC Climate Change 2007 Synthesis Report[6]

Global greenhouse gas (GHG) emissions due to human activities have increased markedly because of human activities since 1750. Global atmospheric concentrations of carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), as determined from ice cores spanning many thousands of years, now far exceed pre-industrial values.

- Global GHG emissions due to human activities increased by 70% between and 2004
- CO2 (the most important anthropogenic GHG) emissions increased 80% between 1970 and 2004
- The long-term trend of declining CO2 emissions reversed after 2000
- Atmospheric concentrations of CO2 (379 ppm) and CH4 (1774 ppb) in 2005 exceed by far the natural range over the last 650,000 years

Global increases in CO2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution. It is very likely that the observed increase in CH4 concentration is predominantly due to agriculture and fossil fuel use. CH4 growth rates have declined since the early 1990s, consistent with total emissions (sum of anthropogenic and natural sources) being nearly constant during this period. The increase in N2O concentration is primarily due to agriculture.

GLOBAL AVERAGE ANNUAL TEMPERATURE CHANGE RELATIVE TO 1980-1999 (°C)[7]



† Significant is defined here as more than 40%. ‡ Based on average rate of sea level rise of 4.2mm/year from 2000 to 2080.

Fossil Fuel Use

Reducing use of carbon-based fossil fuel directly reduces greenhouse gas emissions, but more is needed than just reducing their use in transportation, heating and electrical power.

Many of the things we take for granted today are based on fossil fuel consuming processes. Most commercial food production pesticides are oil- based, and all commercial fertilizers are ammonia-based - made from natural gas. Oil powers machinery, food storage and transport systems. As oil production went up, so did food production. As food production went up, so did the population - from 1 billion at the middle of the 19th century to 6.3 billion at the turn of the 21st. As the population went up, the demand for food went up, which increased the demand for oil.

> *"After cars, the food system uses more fossil fuel than any other sector of the economy — 19 percent. And while the experts disagree about the exact amount, the way we feed ourselves contributes more greenhouse gases to the atmosphere than anything else we do — as much as 37 percent, according to one study. Whenever farmers clear land for crops and till the soil, large quantities of carbon are released into the air. But the 20th-century industrialization of agriculture has increased the amount*

of greenhouse gases emitted by the food system by an order of magnitude; chemical fertilizers (made from natural gas), pesticides (made from petroleum), farm machinery, modern food processing and packaging and transportation have together transformed a system that in 1940 produced 2.3 calories of food energy for every calorie of fossil-fuel energy it used into one that now takes 10 calories of fossil-fuel energy to produce a single calorie of modern supermarket food. Put another way, when we eat from the industrial-food system, we are eating oil and spewing greenhouse gases."[8]

Michael Pollan
University of California, Berkeley,

Oil is also largely responsible for the advances in medicine that have been made in the last 150 years, including the mass production of pharmaceuticals; and development of health care infrastructure, such as hospitals, ambulances, and roads.

There is little debate that the world is warming. According to the IPCC, the global average temperature is expected to increase around 0.2°C per decade over the next two decades. Despite these continued warming trends, there is little consensus into whom and how the climate issue should be addressed. While most governments are realizing that something must be done to protect the environment and its global communities, action is typically short-term and constrained within the typical economic approaches that have locked countries into the current climate quandary at present.

If countries continue to manufacture greenhouse gas emissions at or above the current rates, they will cause further increase in global temperatures and other climatic changes. The IPCC has highlighted overwhelming evidence of repercussions from rising temperatures through observations such as increasing air and ocean temperatures, widespread melting of snow and ice, and rising sea levels. Arctic sea ice cover continues to shrink and thin while death and disease rise through increased natural disasters, such as heat waves, floods and droughts. It is expected that those who will be most affected by the impact of climate change are the poor and developing nations, predominantly within tropical/subtropical countries, who are the least responsible for the current levels of greenhouse gas emissions in the atmosphere.

Toxification

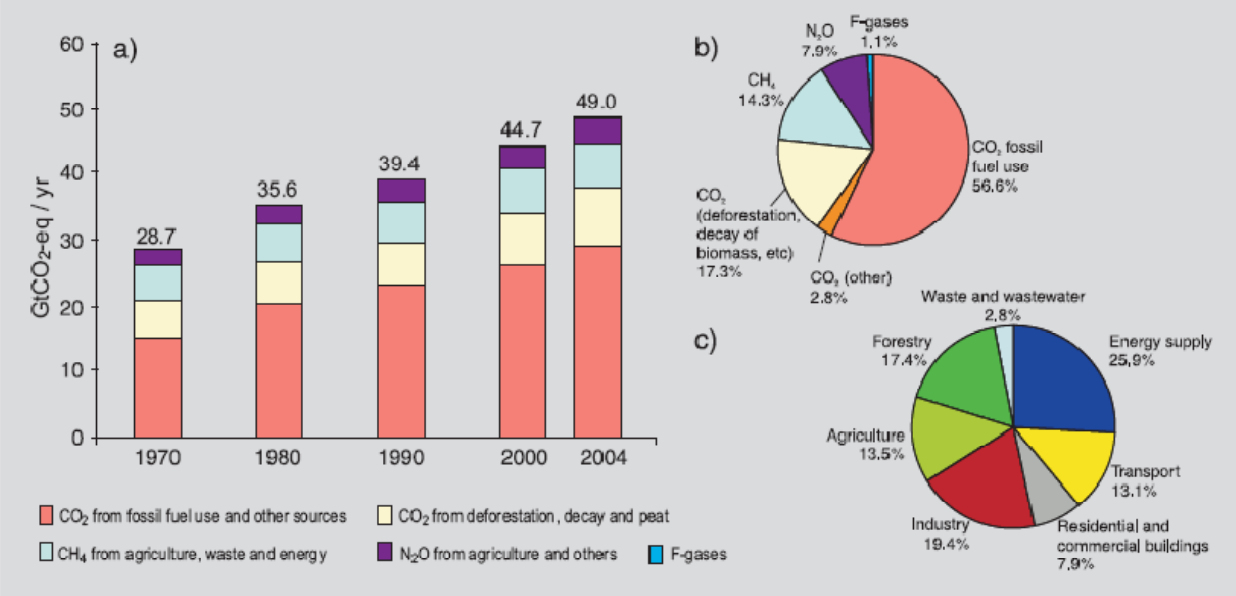
Preventing exposure to persistent, dangerous substances is at the core of sustainability. The reason is simple: toxics can cause severe illness, poisoning, birth defects, disease, or death.

> *"… so much of what comes into our factories, into our homes, into our offices, is replete with materials that never, ever should have been taken from the earth's crust. It took nature 3.8 billion years to put some of it there. In its presence, we never would have evolved into Homo sapiens, but now we're bringing that very stuff right into our living rooms, so to speak. It's very much suicidal."*[9]
>
> *Ray Anderson, Interface*

Human-made chemicals are in the air we breathe, the food we eat and the water we drink. Each one of us carries at least 250 chemical contaminants. Many artificial chemicals evade metabolic degradation and accumulate in our tissues, particularly body fat.[10] Polychlorinated biphenyls (PCBs), mercury and dioxins are in the blood and breast milk of Inuit mothers in the Canadian north. In the 1940s American farmers used about 22 thousand metric tonnes of insecticides. Now more than 450 thousand metric tonnes are used each year.[11]

As much as 80% of the pollution load in coastal waters and the deep oceans originates from land-based activities. This includes municipal, industrial and agricultural wastes and run-off, as well as the atmospheric deposition of pollutants from power generation, heavy industry, automobiles, etc.

GLOBAL ANTHROPOGENIC GHG EMISSIONS



(a) Global annual emissions of anthropogenic GHGs from 1970 to 2004. (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of carbon dioxide equivalents. (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of carbon dioxide equivalents.

The pollutants include heavy metals and Persistent Organic Pollutants (POPs), litter, nuclear waste, hydrocarbons and chemicals. These contaminants, as well as changes to naturally occurring loads of nutrients and sediments affect the most productive areas of the marine environment, including estuaries and near-shore coastal waters.[12] The oceans contain more than 200 "dead" zones -- the largest, in the Gulf of Mexico, is the size of New Jersey -- caused by fertilizers and other pollutants being washed out to sea by rivers.

Toxic chemicals are widely used in manufacturing, suggesting that we must avoid strategies that simply shift hazardous materials from one place to another, rather than eliminating them. The choices we make in specifying products and services that generate toxics at any point in their lifecycle have equity consequences.

In the past 25 years, childhood cancers have increased another 25 per cent. There has also been a 400 percent increase in child asthma, behavioral problems and other childhood diseases. In North America, more than 100,000 chemicals are in use with 1,000 new synthetic compounds introduced each year, about 700 biologically active compounds are used to make some 50,000 pesticide products. Lester Brown of the Earth Policy Institute, believes that we are in a new world. He writes:

> *"Nature has many thresholds that we discover only when it is too late. In our fast-forward world, we learn that we have crossed them only after the fact, leaving little time to adjust. For example, when we exceed the sustainable catch of a fishery, the stocks begin to shrink. Once this threshold is crossed, we have a limited time in which to back off and lighten the catch. If we fail to meet this deadline, breeding populations shrink to where the fishery is no longer viable, and it collapses… the world is in what ecologists call an "overshoot-and-collapse" mode. Demand has exceeded the sustainable yield of natural systems at the local level countless times in the past. Now, for the first time, it is doing so at the global level."*[13]

And sustaining a healthy quality of life is vital, as well. Everyone should be safe making and using products the products we specify at every stage of their life-cycle. Wherever possible, less environmentally harmful substitutes and processes should be used. And, to the extent that no reasonable substitutes can be found, toxics should be subject to strict, plant-wide monitoring under closed-loop control, including sensor fault detection, loop performance monitoring and disturbance detection.

"… so much of what comes into our factories, into our homes, into our offices, is replete with materials that never, ever should have been taken from the earth's crust. It took nature 3.8 billion years to put some of it there. In its presence, we never would have evolved into homo sapiens, but now we're bringing that very stuff right into our living rooms, so to speak. It's very much suicidal."

Ray Anderson, Interface

U.S. EPA TOXICS RELEASE INVENTORY 2007 REPORT (TRI materials released or disposed of)

- 32% (1.31 billion pounds) as air emissions
- 23% (947 million pounds) in underground injection wells and landfills
- 19% (771 million pounds) in surface impoundments
- 15% (622 million pounds) as waste piles, spills or leaks, and
- 6% (246 million pounds) as surface water discharges

The largest sources are mining operations, followed by hazardous waste management facilities; primary metals facilities, chemical manufacturers, and electric utilities. Federal facilities accounted for 2.32% (95 million pounds) of disposal or other releases and 257 million pounds of total production-related waste managed.

Persistent Bioaccumulative Toxic (PBT) Chemicals and Carcinogens

PBT chemicals remain in the environment for long periods, are not readily destroyed (they persist), and accumulate in body tissues (they are bioaccumulative). In 2007, 506 million pounds of PBT chemicals were disposed of or otherwise released, including lead and lead compounds, mercury and mercury compounds, polychlorinated biphenyls (PCBs), and dioxin and dioxin-like compounds. Of the 179 known or suspected carcinogens on the TRI list, 835 million pounds were disposed of or released; including lead and lead compounds, arsenic and arsenic compounds, chromium compounds, and styrene.

According to the U.S. EPA Toxics Release Inventory, which tracks their releases and transfers, almost 4.1 billion pounds of certain toxic chemicals were disposed of or otherwise released in 2007.[14] The material released or disposed of in 2007 came to almost 4.1 billion pounds. More than 20 billion pounds, about five times as much material, was recycled, treated to render it nontoxic or burned for energy, the agency said.[15]

Executive Order (EO) 13148, "Greening the Government through Leadership in Environmental Management" (April 2000), directed the Environmental Protection Agency (EPA) to develop a list of priority chemicals used by the federal Government "that may result in significant harm to human health or the environment and that have known, readily available, less harmful substitutes." In developing the list, the EPA considered toxicity, persistence, and bioaccumulation, availability of less environmentally harmful substitutes and processes, relative costs of alternatives, and the potential risk from chemicals used by federal agencies. The EO directed federal agencies to reduce the usage of these chemicals by 50% by December 31, 2006.

The first five chemicals to be identified are cadmium, lead, polychlorinated biphenyls (PCBs), mercury, and naphthalene. The Office of the Federal Environmental Executive (OFEE) notes that there are known alternatives to the five priority chemicals or products containing them. For example, electronic thermostats can be used in place of mercury-bearing switches. Solders containing copper or silver can substitute for solder containing lead, and, integrated pest management can be used in place of naphthalene.

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section 4

the government mandate for sustainability

executive summary

"[It] is the continuing policy of the federal Government… to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."[1]

National Environmental Policy Act of 1969, Declaration of National Environmental Policy

The Government has a mandate to operate in an environmentally friendly and sustainable manner. The sustainable development model provides the best decision-making model through its comprehensive consideration of economic, environmental, and social issues associated with every business decision the Government makes. As we write in the OGP publication, Sustainable Development and Society, "Getting the best value for the American people means more than choosing what appears to be the lowest first cost option. It means understanding, acknowledging, and even celebrating the choices that the Government makes across the broad spectrum of its programs and responsibilities."

Mandates are in place for energy and resource conservation and toxics reduction, as are numerous other tools and policies intended to lead us towards sustainability.

But these strategies are not considered an intrinsic part of how the Government does business; rather, they are sometimes seen as add-ons or even as obstacles to efficient operations.

Sustainability should be the Government's mission – and it needs to be easy.

"Sustainability connects our activities today to those of tomorrow with sound business and environmental practices. We have learned over the past decades that simply complying with environmental regulations will not ensure that we will be able to sustain our mission."[2]

The Army Strategy for the Environment[3]

There is more to operating sustainably than resource conservation and toxics reduction - operations need to help environmental, economic and social systems to flourish. We need an approach that makes economic decisions based on methods that are proven to work for all kinds of goods and services, including:

- using multidisciplinary, decision-making teams
- giving priority to human and ecosystem health, safety and welfare
- conserving and recycling natural resources
- preventing pollution
- eliminating toxics
- using renewables sustainably
- conserving energy and using alternatives to carbon-based energy
- restoring and protecting of public goods like clean air and water
- preventing, rather than remedying, harmful results of economic activities
- reexamining and implementing economic decision-making tools

See http://www.asaie.army.mil/Public/ESOH/doc/ArmyEnvStrategy.pdf

It is time to place government operations on a foundation that promotes sustainability

The Government can use insights from the physical and life sciences that recognize the economy as an inseparable subsystem of the environment, to promote sustainable development. Tools such as multiple criteria and value systems analysis need to be brought to bear. Cost Benefit Analysis (CBA), Life Cycle Assessment (LCA), and Life Cycle Cost Analysis (LCAA), if appropriately used, should be part of the instrument mix. The desirable end state of sustainability should guide development. (Forecasting gives only a limited view of what could happen. Backcasting gives a broader perspective on what should happen.)

The next steps towards sustainability

For decades, the Government has led the Nation in energy efficient, resource-conserving building design, construction, and operations. Our facilities have led the way in accessibility for all; our purchasing power has contributed to national adoption of better business practices and products. We have also made great progress in water conservation, use of recycled products and renewable energy sources. However, we need to be certain that existing federal laws, executive orders, and regulations, will make the Government's operations sustainable.

Operationalizing Sustainable Development

There are economic, environmental, and social consequences to every business decision we make, whether at home or at work. When we buy a cup of coffee, for example, we are considering the value we get versus the price being asked. And, consciously or not – we're deciding if the people who grow and harvest the raw materials, and the communities in which they live, are being exposed to dangerous pesticides and fertilizers, and whether or not the workers who made that cup of coffee, and those who grew, harvested, processed and transported it can support themselves and their families with respect.[4]

When we choose a building product or system, we are deciding whether the people who collect the raw materials that go into them, who fabricate, install and maintain them are earning enough for them and their families to live in dignity. And, by the manner in which we design building components, we decide if workers will be injured by the installation techniques required, and the energy that will be needed and the emissions that will be generated over the long run.

We are also deciding whether the people who collect the raw materials that go into them, who fabricate, install and maintain them, and the communities in which they live, are being exposed to dangerous chemicals and wastes. And our choices reflect the level of environmental enforcement and mitigation, and long-term degradation – or improvement – of the environment that is acceptable to us.

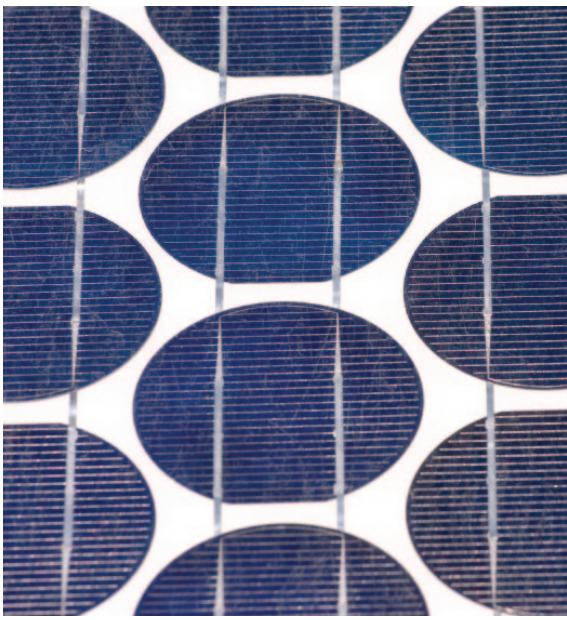
How do federal mandates measure up? Do our current policies support or slow down progress towards a sustainable future?

The Government and Sustainability

The Government has in place, numerous programs and policies for acquisition of all goods and services, and facilities intended to be sustainable. While they are generally viewed as individual, rather than integrated efforts, if implemented by Agencies as required, these programs and policies will substantially lessen the Government's negative impacts and promote economic prosperity, environmental quality and social equity. These requirements are an essential part of the Federal Acquisition System's (FAR) guiding principles, which call for not only the best value product or service to the customer, but also fulfilling the Government's public policy objectives.[5]

For example, the FARs listing of required sources for supplies and services promote resource conservation and economic efficiency by requiring Agencies to consider existing Government inventories before making new purchases. The next priority is to buy those supplies and services through programs that provide job skills training to federal prison inmates and from people who are blind or severely disabled. Only then are Agencies to use stock programs, federal supply schedules, and commercial sources.[6]

The Economy of Government Operations



Numerous laws and regulations exist to improve the economy of Government operations. The Budget and Accounting Act of 1921 established the predecessor of today's Office of Management and Budget (OMB), to implement annual centralized budgeting in the Executive Branch. Before 1921, federal Government agencies usually sent budget requests independently to congressional committees. The Congressional Budget Act (CBA) of 1974 centralized budgeting in the legislative branch. Previously, each appropriations bill was acted on separately by the Congress.

The Government Performance and Results Act of 1993 (GPRA) mandated effective management and planning to improve internal operation of the federal Government; by eliminating waste and improving the efficiency of federal programs, to retain the confidence of the American people and increase the federal Government's ability to address adequately vital public needs.

The Office of Management and Budget (OMB), in its Circular No A–11, Part 7, requires federal Agencies to develop and promote "cost effective, energy efficient and environmentally sustainable techniques or practices for siting, design and construction of all new and replacement buildings," and that new federal buildings comply with sustainable design principles. And OMB's Circular A-94 contains the basic framework for decision-making in the form of life cycle cost analysis, which "promotes efficient resource allocation through well-informed decision making."

According to FAR Part 7—Acquisition Planning, all federal acquisitions must consider life cycle cost and discuss the cost model used to develop life-cycle-cost estimates.[7]

The Government and the Environment

In the area of environment, the Government programs and policies for purchase of all goods and services, generally require that agencies must buy products that contain low or no toxic or hazardous constituents, contain the highest percentage of recovered materials practicable, use energy-efficient products,[8] and reduce indoor and outdoor water use, among other requirements. These requirements can be found in Executive Order (EO) 13423, "Strengthening federal Environmental, Energy, and Transportation Management."[9]

Mandatory Acquisition Practices of EO 13423

Federal Agencies must:

1. Use environmental management systems (EMS) to address environmental aspects of internal agency operations and activities
2. Consider life-cycle costs and savings in planning investments in all capital assets, services, and other procurements
3. Implement this Order using a cross-functional support team, consisting of procurement, legal, budget, facility and energy management, vehicle fleet management, environmental management, technical support and others
4. Purchase environmentally preferable products and services, including:
    - ¤ EPA's Comprehensive Procurement Guidelines designated products
    - ¤ Energy Star® qualified and FEMP-designated energy-efficient products
    - ¤ Water-efficient products meeting EPA's WaterSense standards
    - ¤ Energy from renewable sources
    - ¤ Department of Agriculture designated BioPreferred biobased
    - ¤ Electronic Product Environmental Assessment Tool (EPEAT) registered products for 95 percent of electronic purchases and implement an Electronics Stewardship Plan
    - ¤ EPAct-required alternative fuel vehicles and alternative fuels
    - ¤ Products containing low or no toxic or hazardous materials
    - ¤ Non-ozone depleting substances
    - ¤ Paper of at least 30 percent postconsumer fiber content
5. In its daily operations and in its owned and lease facilities, each agency shall:
    - ¤ Ensure that new construction and major buildings renovation comply with the "Guiding Principles for federal Leadership in High Performance and Sustainable Buildings;" and 15 percent of existing buildings comply by the end of fiscal year 2015
    - ¤ Reduce the quantity of toxic and hazardous chemicals and materials acquired, used, or disposed of by the agency
    - ¤ Recycle a minimum of 35 percent of its solid waste
    - ¤ Not less than 7.5 percent of the total amount of electric energy consumed by Agencies must be from renewable sources, after 2013
    - ¤ Reduce motor vehicle fleet consumption of petroleum products by 2 percent annually through the end of fiscal year 2015 and increase the total fuel consumption that is non-petroleum based by 10 % annually

EO 13423's purchasing requirements for goods and services, OMB's guidelines for capital asset planning, and the "Guiding Principles for High Performance and Sustainable Buildings" are easier to apply than the Brundtland Principles and the Triple Bottom Line. They affirm that the Government is committed to reducing its total ownership impact on the environment, cost of facilities; improving energy efficiency and water conservation; providing safe, healthy, and productive built environments; and, promoting sustainable environmental stewardship.

The Government defines sustainable building in the 2006 Memorandum of Understanding (MOU) on federal Leadership in High Performance and Sustainable Buildings.[10]

Guiding Principles for High Performance and Sustainable Buildings

I. Employ Integrated Design Principles - [Use a collaborative, integrated planning and design process that establishes performance goals throughout the lifecycle of the building; and total building commissioning]

II. Optimize Energy Performance – [Establish a whole building performance target. reduce the energy cost budget by 30 percent for new construction and 20 percent for major renovations, compared to the baseline building performance rating; install building level utility meters in new major construction and renovation projects to track and continuously optimize performance]

III. Protect and Conserve Water – [Reduce potable water indoor use by 20 percent and outdoor use by 50 percent less than the water use baselines]

IV. Enhance Indoor Environmental Quality –
[Meet current ASHRAE Standard for thermal comfort and ventilation; control moisture, achieve a minimum of daylight factor of 2 percent in 75 percent of space, with dimming and lighting controls]; use low-emitting materials, including adhesives, sealants, paints, carpet systems, and furnishings; and, protect indoor air quality during construction]

V. Reduce Environmental Impact of Materials – [Use EPA-designated products and other materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10 percent (based on cost) of the total value of the materials in the project; use USDA-designated biobased products, and other biobased products made from rapidly renewable resources and certified sustainable wood products; recycle or salvage at least 50 percent construction, demolition and land clearing waste; do not use ozone depleting compounds where alternative products are available]

The FAR requires all federal acquisitions to consider environmental and energy conservation objectives associated with the acquisition, the applicability of an environmental assessment or environmental impact statement, the proposed resolution of environmental issues, and any environment-related requirements to be included in solicitations and contracts.[11] When acquiring products and services, agencies must consider: (i) Energy-efficient products and services; (ii) Products and services that utilize renewable energy technologies; (iii) Products containing energy-efficient standby power devices; (iv) Products containing recovered materials; (v) Biobased products; and (vi) Environmentally preferable products and services.

The Government and Society

In the area of social issues, the Government invests in communities and supports a well-trained and stable workforce by requiring payment of locally prevailing wages and fringe benefits, as determined by the Secretary of Labor, in accordance with the Davis-Bacon and related Acts (DBRA), which apply to construction, supplies, and services, among other requirements. And, there are many other requirements. For example, EO13005, "Empowerment Contracting," directs Agencies to give preference in acquisition to socially and economically disadvantaged individuals, minority-owned small business concerns, and small business concerns owned and controlled by women; in order to foster "growth of federal contractors in economically distressed communities and ensuring that those contractors become viable businesses for the long term will promote economy and efficiency in federal procurement and help to empower those communities."[12]

According to FAR Part 7—Acquisition Planning, **all** federal acquisitions must consider these small businesses in their acquisition plans.[13]

Existing Tools and Strategies

These tools and strategies would, if fully implemented, significantly reduce the Government's impact on the natural environment and promote economic prosperity and social equity. They can be fully implemented now in the acquisition of all goods and services that support Government operations.

'Ready to Go' Tools

The Environmental Protection Agency (EPA), particularly the Office of Pollution Prevention, has programs to identify products and practices that reduce or eliminate waste and toxic substances in Government operations and promote recycling of materials (see http://www.epa.gov/p2/). Agencies should work with EPA to identify and eliminate use of non-compliant products and services. The EPA and the Department of Energy's Federal Energy Management Program (FEMP) also have programs that reduce energy consumption in products, services and buildings. ENERGY STAR qualified and FEMP designated products may be assumed to be life cycle cost-effective (see http://www.energystar.gov/).[14]

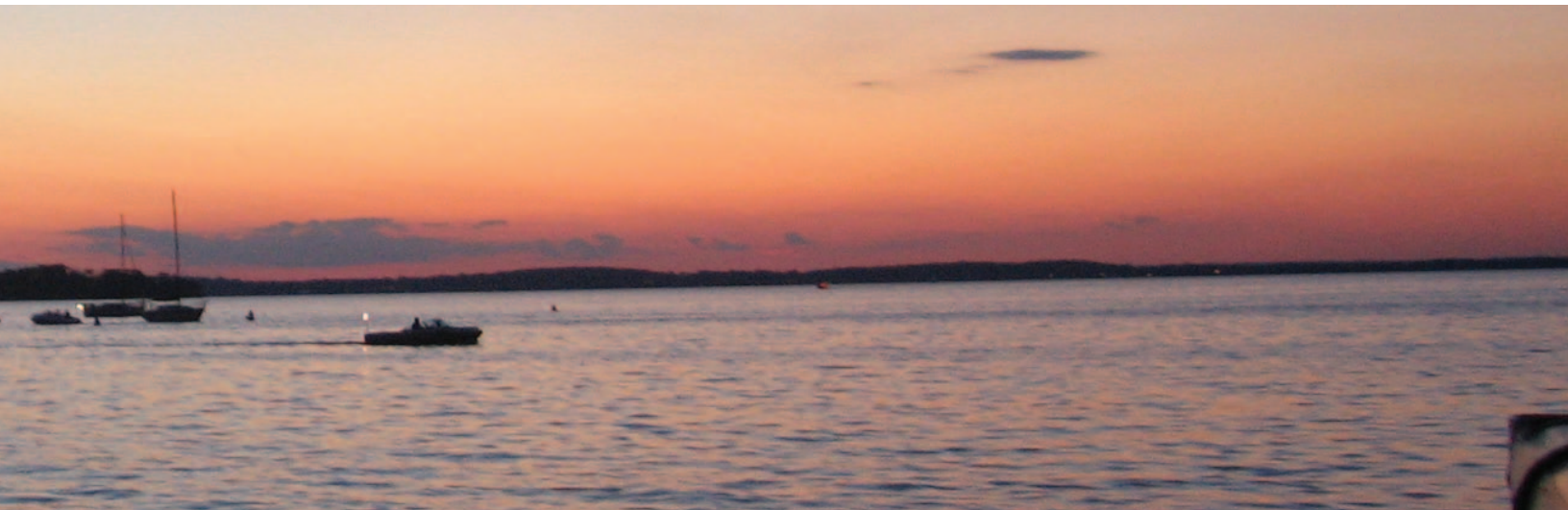
"Lake Mendota, Madison, Wisconsin." Photo credit: Jonathan Herz

Tools Needing Further Consideration

Some of the other tools used by the Government address more complex matters, and are themselves far more complex. While the elements that make up these tools are generally "transparent," they function as a sort of "Black Box," allowing their use without requiring detailed knowledge of their internal workings. These tools need further consideration:

- Office of Management and Budget OMB Circular A-11, "Preparation, Submission, And Execution of the Budget," which includes principles for capital asset acquisitions which address planning, costs and benefits, financing, and risk management requirements
- Various life cycle cost analysis (LCCA) guidelines, including:
- OMB Circular A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs,"
- FEMP life-cycle costing rules and procedures; NIST Handbook 135, "Life-Cycle Costing for the Federal Energy Management Program;" and
- Tri-Services Memorandum of Agreement on "Criteria/Standards for Economic Analyses/Life-Cycle Costing for MILCON Design"
- The National Institute of Standards and Technology's BEES® (Building for Environmental and Economic Sustainability) tool contains data on life cycle inventory results for a variety of building materials and building components
- Green Building Rating Systems, Including the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) rating system and the Green Building Initiative (GBI) Green Globes™ rating system.

How do we know whether these guidelines and tools result in sustainable choices, in the sense that they can be "carried on for a prolonged duration, or for the foreseeable future?"



How do we make Government operations sustainable - not just less harmful?

Throughout our history, there was recognition that while the market place could promote efficient allocation of resources; there were problems that it could not, or would not, resolve on its own. So the Congress and the President issued dozens of laws, executive orders and regulations to protect the environment and society from the operations of the economy, to help clean up and prevent pollution and toxics contamination, and to deal fairly with labor. Understanding some of the background will help us to understand how we arrived at the current situation of well-intended but often ineffective laws, executive orders and regulations and perhaps help us to move forward from here.

History: from Conservation to the Environmental Movement

The Government's Evolving Approach to "Environmental Quality" And "Social Equity"

Since the founding of the Republic, the Government's approach to sustainability, especially in the area of natural resources and the environment, has evolved dramatically. If anything was done at all, it was generally up to the States and local Governments to protect the environment. One of the earliest laws was in South Carolina where, in 1671, the Colonial Assembly passed a law to punish any person who released into "any of the creeks, streams or inland waters of this State any impurities that are poisonous to fish or destructive to their spawn…"[15]

Throughout the 19th Century, the policy was generally to promote settlement of newly acquired lands and exploitation of natural resources, particularly minerals and lumber. A typical sentiment was expressed by Thomas Ewbank, the United States Commissioner of Patents, in 1855. Referring to the "world as a factory" with Man in charge of it, he wrote that:

> *"[All] matter [is] brought under human influence, and made to contribute to human enjoyment… I do not think it is too much to assert that the whole was destined to pass, and that repeatedly, through human hands, preposterous as the thought may seem."*[16]
>
> *And, he was not alone in his belief that nature's resources were boundless, as in this observation:*
>
> *"A first element of progress for all time, it is preposterous to suppose the supplies of coal can ever be exhausted or even become scarce. The idea is almost blasphemous."*[17]

In his first inaugural address, President Abraham Lincoln called for the mineral resources of the Louisiana Purchase to be "developed as rapidly as possible."

The Homestead Act of 1862 privatized ten percent of all lands in the United States – 270 million acres –until it was repealed in 1985. Beginning in 1850, Congress granted over one hundred million acres of public lands to railroads, in order to help subsidize their construction and settle the American West. The Desert Land Act of 1877 granted up to 640 acres of public desert land in the West, to any citizen at a total cost of $1.25 per acre on condition that the land be "reclaimed" by irrigation, for which use of free water from other public lands was made available. And, the General Mining Act of 1872 has given away billions of dollars in mineral rights to prospectors on federal land.[18]

Abraham Lincoln, in 1862 told Congress:

> *"The immense mineral resources of some of those Territories ought to be developed as rapidly as possible… It is worthy of your serious consideration whether some extraordinary measures to promote that end can not be adopted..."*[19]

There was little consideration of the external effects of these laws; which, historians have said, contributed to monopoly power, environmental degradation, and pollution.

As early as 1850, Patents Commissioner Ewbank tempered his enthusiasm for development, warning:

> *"… the waste of valuable timber in the United States, to say nothing of firewood, will hardly begin to be appreciated until our population reaches fifty millions. Then the folly and shortsightedness of this age will meet with a degree of censure and reproach not pleasant to contemplate ... [T]he vast multitudes of bisons slain yearly, the ceaseless war carried on against them, if continued, threatens their extermination, and must hereafter cause deep regret."*[20]

As the effects of development and exploitation were noted, starting in with a bill to set aside the Yosemite Valley in California as a public park in 1864; Congress began passing bills to slow the unrestrained exploitation of Nature. Laws included those limiting fur hunting (1870), protecting fisheries (1871), banning unpermitted logging on government property (1875), creating forest reserves (1891) and the first national wildlife refuge (1892).

In 1890, to try to "rebalance" distortions in the market, the first antitrust law was passed.

In the area of economy and equity,[21] there were many advances and retreats over the years. An 1808 federal law prohibited the importation of slaves, but not slavery itself. President Van Buren declared a ten-hour workday without reduction in pay for all federal employees on public works projects. In 1840, President Lincoln's 1863 Emancipation Proclamation freed slaves in southern areas occupied by Union forces, and the13th Amendment to the Constitution banned US slavery in 1865.

In 1868, the Congress enacted the first eight -hour workday, but it only applied to federal employees on public works projects. The federal Bureau of Labor was established in 1884 as part of Department of the Interior. Between 1881 and 1905 alone, there were more than 37,000 labor strikes in the United States.

In the 1890's the so-called "Progressive Era" arrived, with efforts at a wide range of economic, political, social, and moral reforms. In his First Annual Message to Congress, in 1901, President Theodore Roosevelt said:

> *"The National Government should demand the highest quality of service from its employees; and in return, it should be a good employer. If possible legislation should be passed… to do away with the competition of convict contract labor in the open labor market... [Provision] should be made to render the enforcement of the eight-hour law easy and certain. In all industries carried on directly or indirectly for the United States Government women and children should be protected from excessive hours of labor, from night work, and from work under unsanitary conditions. The Government should provide in its contracts that all work should be done under "fair" conditions, and in addition to setting a high standard should uphold it by proper inspection, extending if necessary to the subcontractors."*

As concerns about environmental destruction came to the forefront, President Roosevelt called for protection of water supplies through the "wise administration of the forest reserves." He called for setting aside forest reserves for "the wild forest creatures."[22]

By 1907, things were getting out of hand, environmentally. Commercial waterways were silting up because of erosion caused by over logging, and our mineral wealth was being wasted. That year, in his Inaugural Address, Theodore Roosevelt recognized that conservation and the proper use of our natural resources would be necessary if were to maintain the material basis for our way of life. In his Seventh Annual Message to Congress, President Roosevelt asserted that:

> *"The conservation of our natural resources and their proper use constitute the fundamental problem which underlies almost every other problem of our National life... We must show foresight, we must look ahead. As a nation we not only enjoy a wonderful measure of present prosperity but if this prosperity is used aright it is an earnest of future success such as no other nation will have. The reward of foresight for this Nation is great and easily foretold. But there must be the look ahead, there must be a realization of the fact that to waste, to destroy, our natural resources, to skin and exhaust the land instead of using it so as to increase its usefulness, will result in undermining in the days of our children the very prosperity which we ought by right to hand down to them amplified and developed. For the last few years, through several agencies, the Government has been endeavoring to get our people to look ahead and to substitute a planned and orderly development of our resources in place of a haphazard striving for immediate profit."*[23]

By 1909, a corporate income tax was established, along with the Department of Commerce. In 1913, a permanent income tax was established and the Department of Labor was created, "to foster, promote and develop the welfare of working people, to improve their working conditions, and to advance their opportunities for profitable employment."[24]

Franklin Roosevelt's "New Deal" established a variety of basic social security programs that are still with us today. They include:

- **1931 -** The Davis-Bacon Act requiring payment of prevailing wages to workers on public construction projects
- **1935 -** The Wagner Act (National Labor Relations Act) protected the right of workers to organize for collective bargaining. Also in 1935, the Social Security Act was approved
- **1936 -** The Public Contracts Act (Walsh-Healey Act) established labor standards, including minimum wages, overtime pay, and safety standards; and banned child and convict labor on all federal contracts. The Fair Labor Standards Act created a $.25 minimum wage and time and a half for hours over 40 per week.
- **1938 -** A 44 hour workweek and minimum wage of 25 cents/hour was established, covering about 20% of all workers
- **1943 -** An executive order banned discrimination against any employee or applicant for employment under a public contract, because of race, , creed, color or national origin.
- **1948 -** The first federal Government conference on industrial safety
- **1949 -** Child labor is prohibited

In the 1960s, in response to growing national social problems, several major laws were passed, including:

- **1963 -** The Equal Pay Act prohibited wage differences for workers based on sex
- **1964 -** The Civil Rights Act prohibited discrimination in employment based on race, color, religion, sex or national origin
- **1968 -** The Age Discrimination in Employment Act made it illegal to discriminate in hiring or firing person between 40-65 on the basis of age
- **1970 -** Congress passed the Occupational Safety and Health Act (OSHA)

And, while there were some programs involving more than just conservation before his administration; it was not until President Lyndon Johnson that the Government committed itself to not just conservation, but also environmental protection.

In 1965, President Johnson called for action against the degradation of the environment by poisons and chemical waste products that threatened the health of the world. In doing so, he also captured some of the ideas of sustainable development, saying:

> *"The air we breathe, our water, our soil and wildlife, are being blighted by the poisons and chemicals which are the by-products of technology and industry... The same society which receives the rewards of technology, must…take responsibility for control."*[25]

> *"… Our conservation must be not just the classic conservation of protection and development, but a creative conservation of restoration and innovation. "Its concern is not with nature alone, but with the total relation between man and the world around him. Its object is not just man's welfare but the dignity of man's spirit."*[26]

Johnson's "Great Society" programs had broad implications for society and social equity. In the area of the environment, there were new laws to improve air and water quality, land and water conservation, solid waste disposal, and reduce motor vehicle air pollution He also signed into law the Endangered Species and National Historic Preservation Acts; and, probably most importantly, the National Environmental Policy Act of 1969, known as NEPA. In the area of equity, there were many new laws, as well. The two Civil Rights and Voting Rights Acts forbade job discrimination and the segregation of public accommodations and housing discrimination, and assured minority registration and voting. Johnson declared War on Poverty with the Job Corps, Food Stamps, Head Start, and Medicare and Medicaid.

In the '60's people began to realize that what needed protection was not just nature, but humans, as well. In 1969, the Cuyahoga River caught on Fire. In his January 1970 State-of-the-Union Address, President Richard Nixon recognized that:

> *"Restoring nature to its natural state is a cause beyond party and beyond factions. It has become a common cause of all the people of this country. It is a cause of particular concern to young Americans, because they more than we will reap the grim consequences of our failure to act on programs which are needed now if we are to prevent disaster later.*

> *"Clean air, clean water, open spaces--these should once again be the birthright of every American...*

> *"We still think of air as free. But clean air is not free, and neither is clean water. The price tag on pollution control is high. Through our years of past carelessness we incurred a debt to nature, and now that debt is being called."*[27]

Another important factor in the acceleration of resource depletion and pollution was, and still is, population growth and urbanization. In 1800, the U.S. population was 5.3 million, with 6.1 people per square mile. By 1860, the population was 31.4 million, with 10.6 people per square mile in a much larger territory. In 1910, the population had reached 92.2 million, with 26 people per square mile.[28] There were 179.3 million Americans in 1960, with 50.6 people per square mile. In 2009, the U.S. population exceeded 306.1 million, with over 86 people per square mile. The Census Bureau estimates that, by 2040, the U.S. population will grow to 405.7 million.

During this same period, the World's estimated population increased from about 969 million in 1800, to 1.75 billion in 1910, to 3 billion in 1960. Today, there are an estimated 6.7 billion people on the planet. The Census Bureau estimates population growth from 6 billion in 1999 to 9 billion by 2040.[29]

"Our civilizations are at risk because we are misusing natural resources and disturbing natural systems. We are pressing the Earth to the limits of its capacity. Since the industrial revolution, human numbers have grown eight-fold. Industrial production has risen by more than 100 times in the past 100 years.

"This unprecedented increase in human numbers and activity has had major impacts on the environment.

"The capacity of the Earth to support human and other life has been significantly diminished. In less than 200 years the planet has lost six million square kilometers of forest; the sediment load from soil erosion has risen three-fold in major river basins and by eight times in smaller, more intensively used ones; water withdrawals have grown from 100 to 3600 cubic kilometers a year.

"Atmospheric systems have been disturbed, threatening the climate regime to which we and other forms of life have long been adapted. Since the mid-eighteenth century, human activities have more than doubled the methane in the atmosphere; increased the concentration of carbon dioxide by 27%; and significantly damaged the stratospheric ozone layer.

"Pollution of air, soil, fresh waters and the oceans has become a serious and continuing threat to the health of humans and other species. Humanity is causing emissions of arsenic, mercury, nickel, and vanadium that are now double those from natural sources; zinc emissions are triple and those from cadmium and lead are respectively five and eighteen times higher than natural rates.

"Most astonishing of all, the 5.3 billion people now [1991] on Earth are already using 40% of our most elemental resource - the energy from the sun made available by green plants on land.

"Yet despite this vast takeover of nature, hundreds of millions of people struggle in poverty, lacking a tolerable quality of life. One person in five cannot get enough food properly to support an active working life. One quarter of the world's people are without safe drinking water. Every year millions of children die from malnutrition and preventable disease. Such conditions are grossly unjust. They also threaten the peace and stability of many countries now, and of the whole world eventually."[30]

International Union for Conservation of Nature and Natural Resources/
United Nations Environment Programme/World Wide Fund for Nature

Increasing awareness of environmental degradation led to the first Earth Day celebration on April 22, 1970, when 20 million Americans demonstrated in favor of environmental reform. In the area of equity, the Occupational Safety and Health Act of 1970 protected workers from harm on the job. Perhaps the greatest environmental accomplishment of that period was NEPA, the National Environmental Policy Act of 1969.

Although we seem to use NEPA in a limited way, it addresses all of the principles of sustainable development. NEPA was the first comprehensive federal law to establish the broad national framework for protecting our environment. Eight years before publication of the Brundtland Principles, It established a national policy to account for and to mitigate the Government's negative impact, by requiring impact statements for federal actions having a significant effect on the environment. NEPA procedures make environmental information available to public officials and citizens before decisions are made and before actions are taken. The Act states:

> *"The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the federal Government… to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."*[31]

Assessing its effectiveness after twenty-five years, a study by the Council on Environmental Quality (CEQ) found NEPA's most enduring legacy to be "a framework for collaboration between federal agencies and those who will bear the environmental, social, and economic impacts of agency decisions."[32] The CEQ study identified five elements of the NEPA process critical to its effective and efficient implementation:

1. "Strategic planning — the extent to which agencies integrate NEPA's goals into their internal planning processes at an early stage;
2. "Public information and input — the extent to which an agency provides information to and takes into account the views of the surrounding community and other interested members of the public during its planning and decision-making process;
3. "Interagency coordination — how well and how early agencies share information and integrate planning responsibilities with other agencies;
4. "Interdisciplinary place-based approach to decision-making that focuses the knowledge and values from a variety of sources on a specific place; and
5. "Science-based and flexible management approaches once projects are approved."[33]

The study also highlighted the cumbersome nature of typical NEPA implementation that keeps it from being fully effective. But, the CEQ also cited numerous benefits that remind us of its importance today:

> *"[Agency] managers who have learned to use NEPA have discovered it helps them do their jobs. NEPA's requirements to consider alternatives and involve the public and other agencies with expertise can make it easier to discourage poor proposals, reduce the amount of documentation down the road, and support innovation. NEPA helps managers make better decisions, produce better results, and build trust in surrounding communities."*[34]

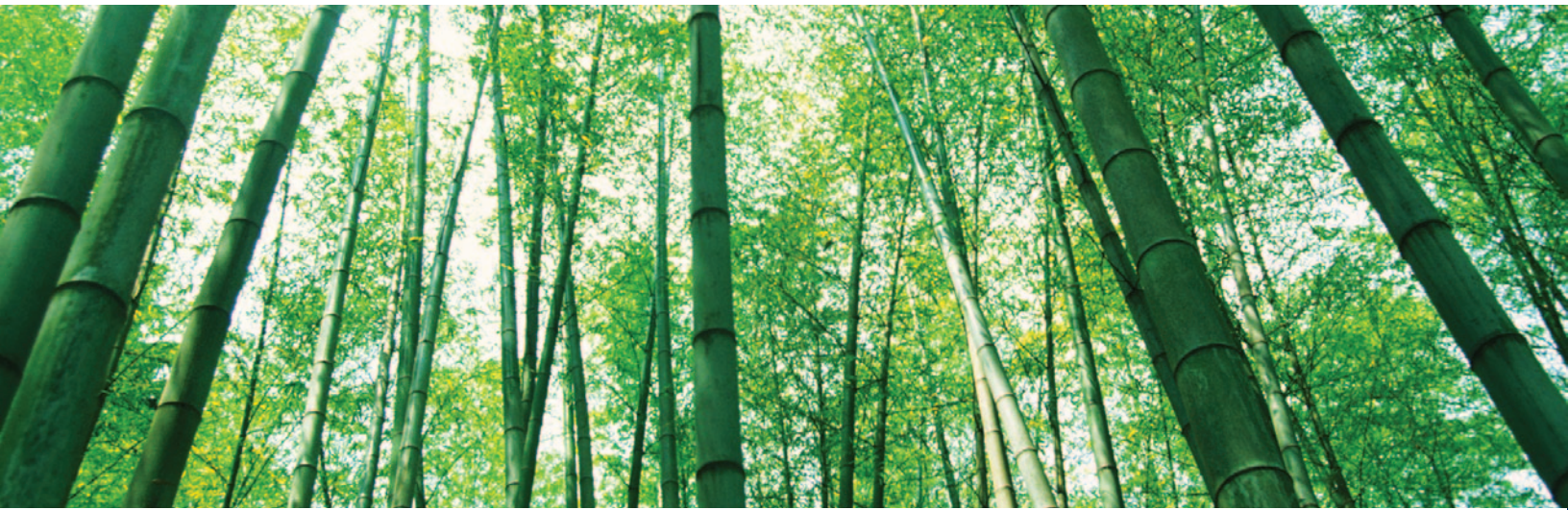
Another benefit is its collaborative nature:

> *"Experience with the NEPA process has shown that better decisions — those that meet the needs of the community and minimize adverse impacts on the environment — require the integrated perspective that can only be obtained by incorporating expertise and information from many fields and sources…"*[35]
>
> *The basic doctrine of NEPA requires the federal Government to use all practicable means and measures to protect environmental values. It does not require consideration of the costs versus the benefits of protecting and restoring the environment. In fact, it calls for the use of "all practicable means and measures, including financial and technical assistance…to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."*[36]

The Government's Evolving Approach To "Economic Prosperity"

Historians seem to agree that - at times throughout American history – Government spending was not always based upon well-informed decision-making, particularly in the areas of river and harbor improvements and public buildings, where the most common economic decision-making process was "logrolling" - which allowed passage of actions of interest to each legislative member without great analysis. This approach to decision making did not always lead to the efficient resource allocation. Congressman Davy Crockett was one of the first to apply the term to legislation in 1835.

The New York Times, in an 1879 article entitled, "Log-Rolling in Congress," stated, "It is a discouraging fact that very few propositions before Congress stand or fall on their intrinsic merits."[37] A few years later, the Times suggested that, "no more public buildings should be authorized by Congress until a sound and rational system was substituted for the present system of logrolling."[38]



Cost Benefit Analysis

Of course, not all decisions were made in this manner. Secretary of the Treasury Albert Gallatin is cited as one of the first to compare the costs and benefits of public projects to justify their approval. In his 1808 "Report on Internal Improvements," proposing a system of roads and canals, Gallatin wrote:

> *"The general utility of artificial roads and canals, is at this time so universally admitted, as hardly to require any additional proofs. It is sufficiently evident that, whenever the annual expense of transportation on a certain route in its natural state, exceeds the interest on the capital employed in improving the communication, and the annual expense of transportation (exclusively of the tolls,) by the improved route; the difference is an annual additional income to the nation."*[39]

The River and Harbor Act of 1902 introduced a formal method of evaluating the long-term value of proposed projects, based on estimated costs and benefits. In the following years, boosted by the Flood Control Act of 1936, cost benefit analysis (or CBA – sometimes referred to as "Benefit Cost Analysis) became more widely used, but due to the lack of guidance, it was applied differently by Government agencies using a wide range of criteria. In 1950, Government economists identified uniform practices for informal internal use; but a common analytic approach was not officially adopted across the Government until 1965, with the adoption of the "Planning Programming Budgeting System."

The advantage of CBA over other methods is that it provides a coherent framework for data collection and identification of information gaps to decide whether a project should be implemented (or to decide among different projects). One additional benefit lies in the fact that CBA provides one aggregate metric (such as a Cost-Benefit ratio, an internal rate of return, or net benefit in monetary terms), boiling everything down to a single number. Projects with the greatest net benefits are the logical choices. In theory, CBA applies traditional economic concepts of efficient resource allocation, resulting in economically efficient projects.

The PPBS was superseded in 1972 by OMB Circular A-104, "Comparative Cost Analysis for Decisions to Lease or Purchase General Purpose Real Property." In 1981, CBA became a requirement in every regulatory-impact analysis.[40] Since then, CBA has been applied to almost every type of government acquisition.

OMB Circular A-104 was in turn superseded in 1986, by OMB Circular A-104 (Revised), "Evaluating Leases of Capital Assets," which was superseded by OMB Circular A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs."

"A-94" broadly applied benefit-cost and cost-effectiveness analyses to evaluate federal programs and determine whether agencies have considered and properly dealt with all the elements. OMB's goal is "to promote efficient resource allocation through well-informed decision-making by the federal Government."

As cost-benefit analysis became more commonly used, during the 1960s and 1970s, questions about its accuracy and fairness emerged. In response, economists began incorporating the ideas of present value, opportunity costs, sensitivity analysis, distribution effects and equity issues.

Over the years, Cost Benefit Analysis has incorporated the idea of Life Cycle Cost Analysis (LCA), which includes not only first and operational costs, but also future capital replacement, financing, and disposal costs, stated in present value. This approach to LCA assumes that upstream factors (i.e., before acquisition) and downstream factors (after disposal) are indirectly reflected in those predicted costs. These guidelines are founded upon the assumptions of neoclassical economics: that, when functioning correctly, the market will efficiently allocate resources and balance production and consumption in a way that maximizes social welfare.

The National Energy Conservation Policy Act of 1978 (NECPA), which required federal agencies to reduce consumption of nonrenewable energy resources, was the first to specifically apply life cycle cost methods to the design of new federal buildings and major renovations. Its intent was to "reduce the growth in demand for energy in the United States, and to conserve nonrenewable energy resources … without inhibiting beneficial economic growth."[41] NECPA called for the Secretary of Energy to develop implementation guidelines, in consultation with the Director of the Office of Management and Budget, the Secretary of Defense, the Director of the National Institute of Standards and Technology, and the Administrator of the General Services Administration, utilizing:

> *" … practical and effective present value methods for estimating and comparing life cycle costs for federal buildings, using the sum of all capital and operating expenses associated with the energy system of the building involved over the expected life of such system or during a period of 25 years, whichever is shorter, and using average fuel costs and a discount rate determined by the Secretary "*[42]

CBA went from being just an analytic tool to being the standard decision-making process in 1981, with EO 12291, which required a regulatory impact analysis for every major governmental regulatory initiative. This requirement was confirmed in 1994 by EO 12866, which stated:

> *"federal agencies should promulgate … regulations … made necessary by compelling public need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well-being of the American people…agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures … and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity)… "*[43]

The attraction of CBA is that it takes complex decisions and tries to make an apples-to-apples comparison of all benefits and all costs in terms of money. Of course, the accuracy of the outcome of a Cost-Benefit Analysis Is dependent on how accurately costs and benefits have been estimated.

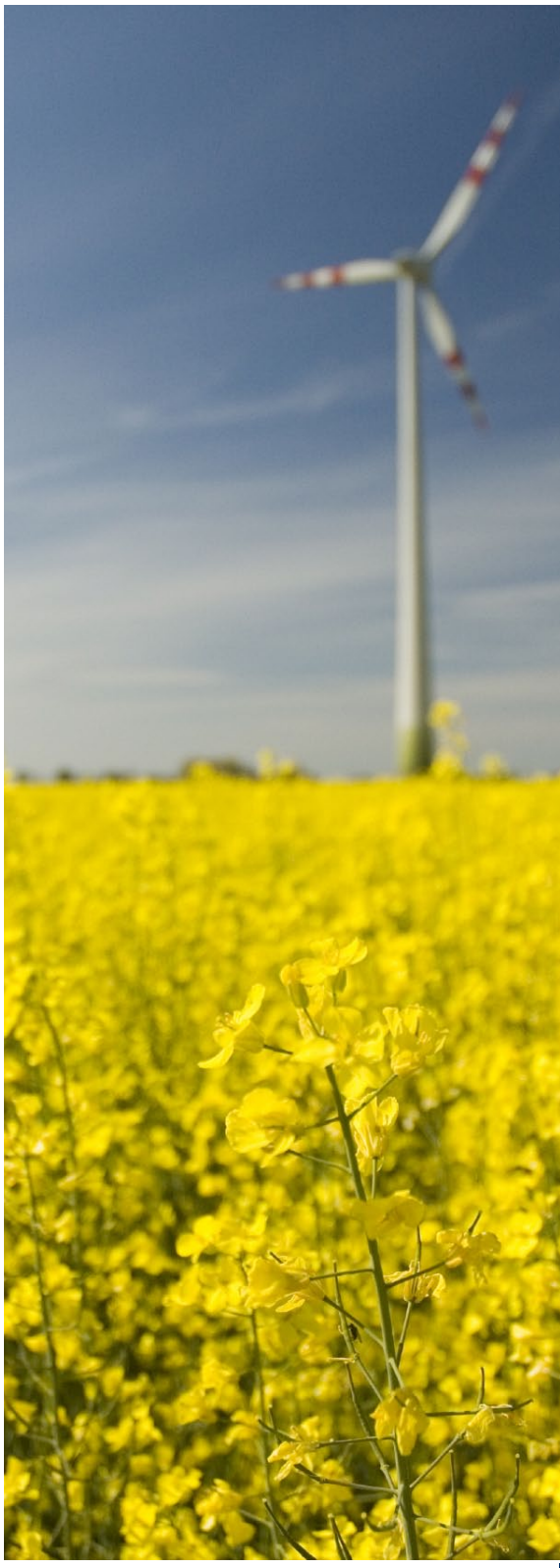
COST BENEFIT ANALYSIS APPROACHES

There are significantly different types of benefit-cost analysis is currently in use, particularly in the ways that BCA is used by the U.S. Government and within Europe. Economist John Graham describes them as:

1. The Kaldor-Hicks Approach. This is the traditional approach, distinguishing features include willingness to pay (WTP) as a measure of benefits, and opportunity costs as a construct for costs. A specific problem of this approach is how to deal with low income populations, whose willingness to accept (WTA) is likely to be large, but whose WTP is by definition going to be small.
2. The Social Well-Being Approach. In this approach, the unit of analysis is not money; rather, it is some interpersonal measure of wellbeing. Public health fields, for example, often use quality adjusted life years, though there is also an entire literature about how to measure happiness and use it as a measure.
3. The Social Welfare Function. This approach uses an interpersonal measure of well-being, but also adds a measure of equity into the equation. It is typically theory-driven, but it the UK government has recently introduced distributional income weighting into their benefit cost analysis.
4. Social Risk Analysis. This analysis recognizes that variability and uncertainty exist, and should be explicitly addressed and incorporated into the benefit-cost analysis. Accounting for variability and uncertainly is particularly important if you have vulnerable populations who are different from average people.
5. The Multi-Objective Method/Regulatory Impact Analysis. This approach is a portfolio of methods, which includes benefit-cost analysis among many other tools, and has no single normative foundation. This suite of methods creates a lot of discretion for analysts to choose which method and normative foundation(s) to use.[44]

There are many forms of CBA. Government tends to base its analysis on the Kaldor-Hicks foundation.

In 1999, EO 13123 directed federal Agencies to use LCC to evaluate energy and water conservation and renewable energy projects. EO 13123, which was incorporated into EO 13423 in 2007, uses LCC to identify more accurately the true costs of programs, processes, products, and services, to determine the cost effectiveness and cost-benefit value of government services. Traditionally, LCC has used the benefits and costs over the life of the material, asset, or program (including decommissioning or disposal) to evaluate investment decisions. However, we are learning that ignoring the "upstream" costs, leading up to our acquisition and "downstream" impacts after disposal of a product or service can omit major costs and impacts. So, in addition to the other considerations added to LCC in the 1960's and 1070's, like present value, opportunity costs, and equity issues; we realize that it is necessary to factor in those upstream and downstream costs – through the entire lifecycle - if we are to make the right investment decisions.



Life Cycle Analysis (LCA)

Life Cycle Assessment (LCA) expands the traditional, limited focus of Life Cycle Cost analysis, and allows us to make business decisions based, not only on expenses over the life of the material, asset, or program, but also on the environmental impacts. It is a standardized methodology for identifying and evaluating environmental burdens throughout the societal life cycle of a product. Based on International Organization for Standardization (ISO) standards, LCA is a society-level evaluation method, as it takes account of impacts on health and the environment no matter where they occur or whom they affect. LCA does not specify or account for the timing of impacts, and it adopts a practically unlimited time horizon.

The Federal Management Regulations[45] state that LCA should be applied within a life-cycle assessment framework that accounts for both the costs over the asset life and the environmental consequences of investment decisions on upstream (e.g., extraction, production, transportation, and construction), ongoing (e.g., health impacts on tenants and the community), and downstream (e.g., decommissioning and disposal) costs. The value of LCA is to quantify the health, environmental, and social impacts of products or purchases that are not otherwise readily seen or known. These quantified impacts can then be used for better decision making.

Although the process can be resource, time, and labor-intensive, LCAs are useful tools that, if applied transparently and with understanding of possible biases in methodology, can help lead us to make sustainable choices. Over time, a number of tools have been developed that try to incorporate lifecycle cost and lifecycle assessment thinking and fill in the information gaps that can lead us to the unsustainable choices.

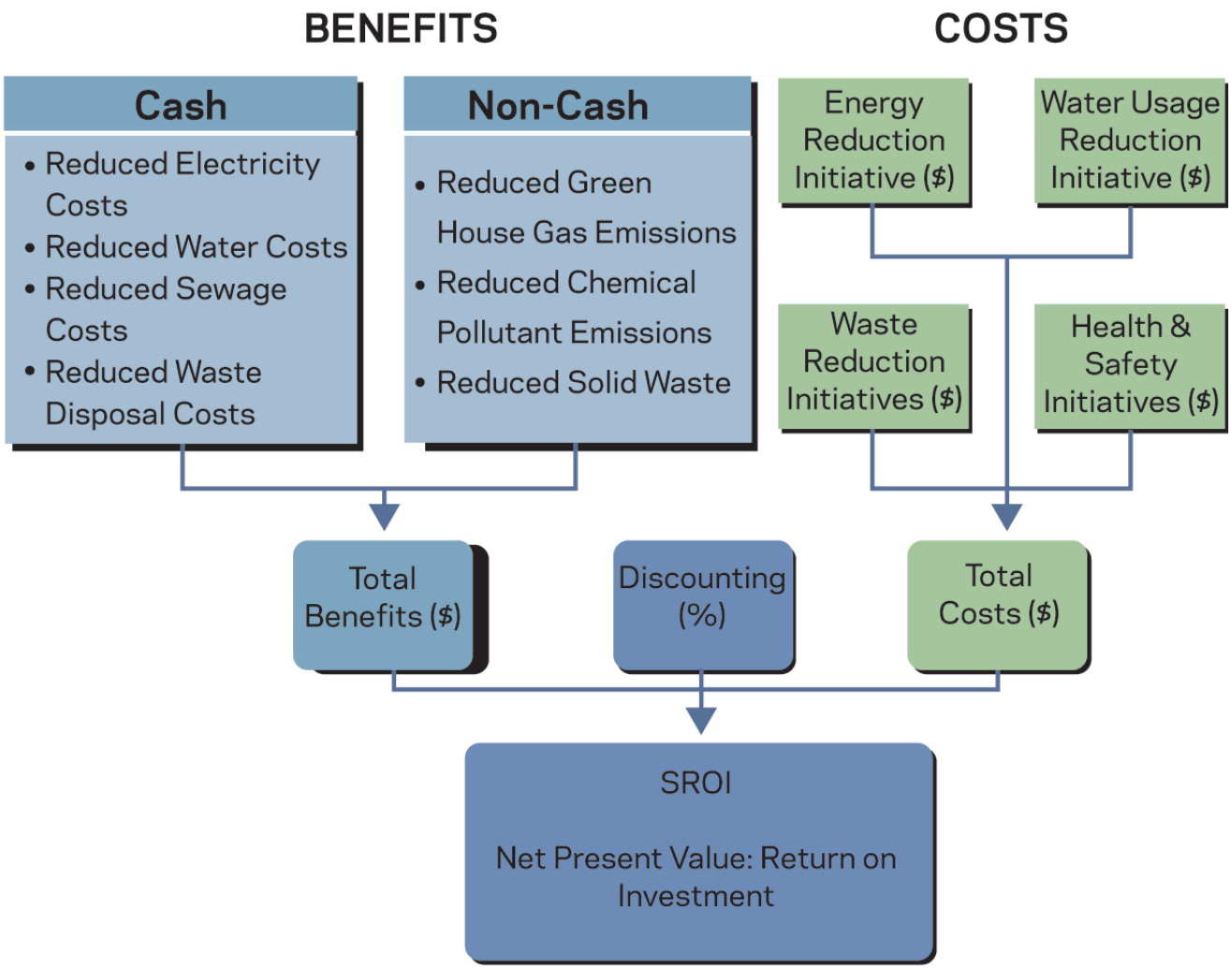
LCC and LCA Tools

Among the Tools for Life-Cycle Costing and Life-Cycle Assessment, Umberto® integrates LCA and LCC to model material and energy flows systems along a product's entire life cycle. SimaPro LCA software contains a wealth of detailed and transparent life cycle inventory data on thousands of processes. It also contains the most important life cycle impact assessment methods. The ATHENA® Impact Estimator uses an LCA methodology to evaluate whole buildings and assemblies and enables users to compare the environmental implications of industrial, institutional, commercial and residential designs–both for new buildings and for major renovations.

Building Life-Cycle Cost (BLCC) Programs developed by the National Institute of Standards and Technology (NIST) enables users to conduct economic analyses by evaluating the relative cost-effectiveness of alternative buildings and building-related systems or components. Energyplus is a building-energy simulation program for modeling building heating, cooling, lighting, ventilating, and other energy flows. Carnegie Mellon's BIDS (Building Investment Decision Support Tool) is a case-based decision-making tool that calculates the economic value added of investing in high performance building systems using a framework of multiple life-cycle variables. NIST's BEES® (Building for Environmental and Economic Sustainability) contains data on life cycle inventory results for a variety of building materials and building components. BEES uses a tool based on the EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) that assists in impact assessment for Sustainability Metrics, Life Cycle Assessment, Industrial Ecology, Process Design, and Pollution Prevention.[46]

Another tool is the HRD, Inc., Sustainable Return on Investment Tool that is intended to identify projects that would yield the greatest economic, environmental and social benefits.[47]

SUSTAINABLE RETURN ON INVESTMENT



Courtesy of Chris Behr, HDR, Inc.

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