Our Environmental Handprint

The Good We Do

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***Abstract*—The environmental handprint is the good we do for the environment. It builds on the concept of the environmental footprint. The potential of the handprint is unlimited. One's personal handprint can be magnified by influencing the actions of others and can be accumulated over a career. The handprint's positive feedback harnesses the power of creativity, idealism and profit. Case studies relating to wind power, solar cookers, and Leadership in Energy and Environmental Design (LEED) illustrate the development of collective handprints.**[1]

Keywords—ecological, environmental, footprint, handprint, Leadership in Energy and Environmental Design, LEED, renewable energy, solar cooker, wind energy.

I. Introduction

The environmental handprint refers to the good we do for the environment. The handprint complements the ecological footprint, but the concepts are not the same thing. We will look briefly at the origin of the ecological footprint and then report the current state of handprint thinking to clarify the difference between the two concepts. The authors have been exploring the subject and will include some of our experiences.

The really exciting aspect of the handprint is its limitless potential. The idea of applying handprint thinking over time is relatively new. We will explore the idea of one's career as an environmental handprint. Finally we will show how being part of a collective environmental handprint is a worthy aspiration.

A note on terms: The authors use the term "environmental handprint" or just "handprint." Others use the qualifiers "ecological" and "carbon." In this paper we draw no distinction between these usages.

II. The Footprint Foundation

The idea that became known as the ecological footprint was developed by Dr.William Rees at the University of British Columbia [1]. His doctoral student Mathis Wackernagel further developed the concept in research from 1990 to 1994 [2]. They originally called the concept "appropriated carrying capacity", but in 1992 Rees suggested that they use the phrase "ecological footprint" as a more user-friendly term. Wackernagel and Rees brought this concept to a larger audience in 1996 when *Our Ecological Footprint: Reducing Human Impact on the Earth* was published [3]. They define ecological footprint analysis as "an accounting tool that enables us to estimate the resource consumption and waste assimilation requirements of a defined human population or economy in terms of a corresponding productive land area [4]." In other words, the ecological footprint compares uses of natural resources with the ability of nature to replenish those resources. The fun part is that the results can be expressed in how many planets' worth of resources are being used.

Since then others have expanded on the metaphor, leading to the terms "environmental footprint" and "carbon footprint."

Here are some ways the authors of this paper are minimizing their ecological footprint.

--Washing clothes in cold water and air drying them on wood and bamboo racks

--Using public transportation instead of owning a car

--Emphasizing traditional foods that do not require refrigeration, such as rice and dried lentils

--Shopping for local food at farmers' markets and food cooperatives

--Seeking alternatives to plastics wherever possible

--Using tankless demand water heaters and an efficient furnace

--Living in a passive solar earth-sheltered home. N. Blackburn's family has a utility bill of about $30 per month.

--Mitigating the remaining footprint. J. Biemer and W. Dixon bought 13 tonnes of carbon offsets (for 2012) from The Nature Conservancy for $195 at $15 per tonne of $CO_{2\ equ}$ [5].

III. HANDPRINT: AN IDEA WHOSE TIME HAS COME

Over the past several years various people and groups have more or less independently proposed using the handprint concept. All agree that the handprint represents something beneficial.

The Centre for Environmental Education (CEE) in India proposed the handprint as a symbol of environmental and social action in 2007 at UNESCO's 4th International Conference on Environmental Education held at Ahmedabad, India [6]. CEE's online handprint tool addresses the environment, society and the economy. Suggestions include exchanges, sustainable investing, support of healthcare initiatives and participating in Global Buy-Nothing Day.

In 2009, J. Biemer wrote an *ODE Magazine* blog that began, "Hands build. Hands heal [7]." Biemer's handprint workshops acknowledge the good we have already done and encourage us to be specific about the good we intend to do.

Gregory Norris came to the handprint idea after years of modeling life-cycle impacts (i.e., footprints) for consulting clients. *Time Magazine* reported on his work in 2012 [8]. Norris teaches the handprint concept in the Harvard classroom. He developed the www.handprinter.org website which encourages us to reduce our net carbon footprint to zero by influencing others to reduce their footprints [9][10].

Rocky Rohwedder searches world-wide for "ecological handprints" that foster human needs *as well as* reducing environmental impact. He is particularly interested in inventions and practices in developing countries that benefit the women, children and the social infrastructure. Innovations he reports include: solar lighting in Bangladesh, efficient cooking in Darfur, Ghana, and Guatemala, and tree planting in Kenya [11]. Rohwedder encourages people to submit related stories to www.ecologicalhandprints.org .

A fundamental attribute of all handprint thinking is that, in principle, there is *no limit to the good you can do*. In contrast, with the footprint the best you can do by yourself is no impact, and the closer you get to that ideal the harder it gets.

Another strength of the handprint is that *the positive energy of doing good is self reinforcing*. A positive feedback loop such as the handprint can sustain itself once it is established [12]. Attendees at the 2013 IEEE Conference on Technologies for Sustainability will tell others what they learned, and they in turn will tell others.

While the handprint may seem like the opposite of the footprint, they are not exclusive. They are really *complementary* ways of thinking. Think of the human form. Our feet are good for grounding us; our hands are good for reaching. Table I shows how handprint thinking broadens our range of responses to environmental (as well as social) challenges. Recycle *and* plant a tree. Use cloth shopping bags *and* find ways your career can serve the environment.

TABLE I.
THE FOOTPRINT *AND* THE HANDPRINT

Foot Print Thinking		**Handprint Thinking**
The harm we do		The good we do
Limited resources		Unlimited potential
Reduce /Reuse/Recycle		Recover/Restore
Admonish		Influence/Educate/Inspire
Measure quantities	+	Count accomplishments
Calculate		Appreciate/Celebrate
Resist destruction		Advocate protection
Problem Solving		Entrepreneurism

While reducing our footprints, the authors are creating handprints:

--Converting lawns yards into a "food forests"

--Replacing invasive plants with native plants

--Hosting and teaching workshops related to sustainable living

--Participation in Portland, Oregon's annual Village Building Convergence to build community and foster sustainable building practices

--Supporting organizations that advance environmentally friendly practices and products (see the authors' biographies)

--Writing about the environmental handprint

--Protecting the Rio Bravo in Belize and the Valdivian Coastal Reserve in Chile. This was a result of buying carbon offsets from the Nature Conservancy [13].

IV. APPLYING HANDPRINT THINKING TO OUR CAREERS

What if each of us thought of our careers as opportunities to create our lifetime environmental handprint? Think of your personal handprint as a measure of success, parallel to other accomplishments and pay and influence. A person's professional environmental handprint is akin to his or her legacy.

At some level we are talking about living the values we already share. We care about the welfare of our grandchildren, or at least we will. We love nature in one form or another. We know the implications of Climate Change. Most of us want to leave a quality legacy, or at least we will. Can we see something of ourselves in the lives of the following handprint heroes?

Rachael Carlson took a job in marine biology. She also liked literature. In Carson's private time she wrote *The Sea Around Us*, a layman's guide to our oceans [14]. Building such awareness of nature could be seen as adding a new dimension to her environmental handprint. With her publishing Carson made enough money to focus on writing on full time. However the need she saw was in a different field. It took four years to

write *Silent Spring*, a carefully-documented book about the problems associated with pesticides [15]. With the curtailing of the use of DDT, bald eagles and other raptors started their slow recovery. The book strongly influenced the founding of the U.S. Environmental Protection Agency [16]. Carson died before seeing the full impact of her game-changing book, but she left behind a world-class environmental handprint.

Martin Shain and Roger Phillips co-founded BacGen, which focused on saving energy in municipal water and wastewater treatment facilities [17]. To build this company, the partners hired professionals who could use a systems approach to retrofit and change how each facility operated. Integral to their approach was training plant operators, who often held their jobs for decades. Thus each plant was able to reduce its energy usage by 20 to 30%. This saved municipalities money, reduced sludge build-up, and reduced the need for utilities to build new power plants. This is a worthy career handprint not only for the principals and employees of BacGen but for each municipal facility operator [18].

In 1974 Rudy Gable (not his real name) was J. Biemer's manager at Rockwell International, in the aerospace industry. One day Gable gave Biemer two books to read, *The End of Affluence* by Paul Ehrlich and *The Limits of Growth* by Donella Meadows *et al* [19][20]. (Both books are about carrying capacity, i.e., footprint thinking.) The manager also invited Biemer to hear a presentation about the problems with nuclear power. The ballot initiative that Gable supported failed to pass; but, within a year, Biemer quit his job, returned to college, and joined a consulting firm specializing in solar energy. The resulting career in energy conservation and sustainability is to some extent Gable's unseen handprint.

Craig Wohlgemuth, an electrical engineer with whom Biemer worked, facilitated a multi-organizational effort to develop, test and deploy efficient motors and variable speed drive controllers [21]. Barry Kennedy, another co-worker, led electric utility efforts to demonstrate and deploy efficient transformers with no toxic chemicals, and he wrote the definitive book on the subject [22].

Some questions one might ask are: Do I have a side passion that, when combined with the skills of my profession can produce extraordinary results, like Carson? Do I have the temperament to become an entrepreneur in service of the environment, like Shain? Am I a systems analyst, like Meadows? Can I inspire a young professional, like Gable? Can my organization help others be less wasteful, like BacGen? Am I broadly connected in my industry, like Wohlgemuth? Am I willing to document what I have learned about helping the environment, like Kennedy? Am I responsible for a machine that can be operated much more efficiently, like those treatment plant operators? Do I need to leave an industry that does more harm than good?

Creating an environmental handprint is more a matter of *creating* an opportunity than being given an opportunity, especially over the arc of a career. Every industry has environmental implications. At some level, we are talking about personal motivation. Is there a hero's story with which I resonate? Am I willing go beyond business as usual for the sake of a better world?

V. CREATING OUR COLLECTIVE HANDPRINTS

The extraordinary potential of the environmental handprint becomes apparent when we think of collective accomplishments.

Nearly every major environmental breakthrough is a collective handprint. Passage of the Wilderness Act of 1964 required eight years of work and some sixty revisions [23]. Every member of the United Nations signed the Montreal Protocol of 1987 to phase out chlorofluorocarbons and close the hole in the ozone layer [24]. Decades of collaboration between the U.S. government and private enterprise are driving the cost of solar electricity down to earth. The current initiative seeks to break the $1 per watt installed barrier [25]. Restoring Portland, Oregon's Johnson Creek Watershed is, after almost thirty years, still a work in progress [26]. Two years ago, for the first time in half a century, three salmon were found upstream after spawning.

No wonder those who take part in such adventures refer to their experiences as "war stories."

A plaque hangs on Biemer's wall that reads, "Bonneville Power Administration Energy Conservation Team, 1981-1986: Pioneered the systematic development of energy conservation as a utility power supply… and caused the installation of measures that are saving the Northwest ratepayers 550 average megawatts and $200 million a year in 2004." This collective handprint, a conservation power plant, is a source of great pride.

Three modest case studies were compiled for this paper to demonstrate how the handprint concept helps us understand and create societal-scale environmental transformations.

--*Appendix 1.* "Power from the Wind – Creating A Revolutionary Handprint"

--*Appendix 2.* "Solar Cookers – A Technology Handprint in the Making"

--*Appendix 3.* "Leadership in Energy and Environmental Design (LEED) – A Process Handprint in the Making"

The Wind Power case study in Appendix 1 follows wind power development from its origins in Persia to the present day. The story naturally divided into three parts, indicating how different kinds of development were needed to advance wind power's environmental handprint.

--*Evolution.* Individuals tried new things with varying degrees of success. The lack of scientific understanding was a limiting factor. The sheer number of innovations gradually changed the state of the art.

--*Entrepreneurism*. Niche breakthroughs carried the technology. English mine operators successfully applied wind

power to pump water out of coal mines. From the late 1920's to the early 1950's rural Americans bought 30,000 Jacobs Chargers.

--*Policy*. The case for societal good eventually complemented the gathering experiential base to establish a world-class industry. Policy activism led to large-scale wind-power production.

These activities are not necessarily distinct in time nor even sequential. Development of patent policies aided wind technology development. Holland commercialized industrial grinding and pulping windmills by the early 1800's, long before lightweight blades would double the net power production.

Significant set-backs abounded, both on the project level and on the industry level. Projects failed. Steam engines displaced industrial wind power in Europe. Rural electrification curtailed the American rural windmill market.

Documentation proved valuable in translating wind power setbacks into an industrial scale handprint.

People in many professions contributed to the collective wind power handprint. These included operators, inventors, engineers, businessmen, policy analysts, and politicians.

The Solar Cooker case study in Appendix 2 assesses the development of a technology which has yet to be embraced by mainstream commerce. A thriving subculture fuels innovation. The author of Appendix 2 is establishing the savings potential of larger-scale adoption of solar cooking in the U.S. This is a precursor to collaboration with utilities for the purpose of displacing the purchase of fossil fuel generated power. This kind of strategy has worked to mainstream compact fluorescent light bulbs and many energy efficient appliances.

Shared handprint thinking can translate analysis into action. If enough people share the vision, we can go to the moon. "Here is what we need to do to make solar cooking a mainstream reality…. Here is what we need to do to make any large-scale environmental handprint a reality...."

The Leadership in Energy and Environment Design (LEED) case study in Appendix 3 describes concerted effort to demonstrate more sustainable buildings. LEED is an example of a long-term partnership between the public and business which is led by a non-profit organization, the Green Building Council. LEED is on the front line in the conversation about "quantifying sustainability." LEED is now widely used in internationally.

LEED focuses, for the most part, on individual buildings. The greater collective handprint manifests in the *influence* LEED has on overall building industry practices – and ultimately the overall efficiency of the world's building stock.

The collective handprint is much more than the sum of all of our individual efforts.

VI. CONCLUSION

Footprint thinking is a useful tool; handprint thinking takes even further. We can create handprints in addition to minimizing footprints. We can do so at home and on the job, individually and collectively.

The metrics of environmental handprints include the metrics of accomplishment: a park, a cleaned-up superfund site. Also the metrics of the handprint include small steps in service of a major outcome: experiments, technology innovations. Demonstrations, pilot projects, and even failed programs from which much is learned can be handprints. It is empowering to see our part, our handprint, in big picture outcomes.

The environmental handprint breaks through the barrier of diminishing motivation to reduce consumption. Whereas the footprint is negative feedback, the handprint represents a more powerful positive feedback loop. We can magnify our handprint by influencing others and persisting in our efforts. Invention, entrepreneurism, and altruism (personal and societal) help create handprints. Thus the environmental handprint engages the power of creativity, profit and idealism.

APPENDIX 1. POWER FROM THE WIND – CREATING A REVOLUTIONARY HANDPRINT.

by Jon Biemer, P.E.

To provide a historical case study for wind power, *Power from Wind, A History of Windmill Technology* by Richard L. Hills and *Wind Energy in America, A History* by Robert W. Righter are summarized below [27] [28].

A. Historical Wind Technology Development – Evolution

Vertical shaft "carousel" wind machines were used for irrigation in Persia around 900 AD. The horizontal shaft pole windmill, used in England to grind grain, increased the maximum efficiency by as much as 55.3 percent. In 1745 Edmund Lee patented a fan tail to automatically turn the windmill into "the eye of the wind". In 1759 John Smeaton conducted scale model tests to improve the sail design.

In 1888, inventor Charles Brush built a five story windmill to charge batteries for lighting his laboratory and home in Cleveland, Ohio. The Brush windmill was featured in the December 12, 1890 issue of *Scientific American*. The windmill operated 20 years before the construction of the local electrical grid rendered the windmill obsolete.

In 1918 Albert G. von Baumhauer used a wind tunnel to apply aeronautical principles to windmill design. Adrian J. Dekker rounded the leading edge of the blade. This led to a lighter weight propeller-like design which could operate in light winds, essentially doubling the cumulative power output.

B. Historical Business Ventures – Entrepreneurism

From the late 1500's through the early 1900's the Dutch applied windmills to industrial uses such as sawing logs, oil extracting, flint grinding (for making pottery), barley hulling

and paper making. The steam engine eventually replaced many of these windmills.

Between the U.S. Civil War and the 1930's, hundreds of companies manufactured the iconic American windmill. Its lattice tower and a ring around its multiple blades were reliable enough to pump water unattended.

Craftsmen Marcellus and Joe Jacobs created the three-bladed DC electric generating windmill with a fly-ball governor to feather the blades when the wind was dangerously strong. From 1927 to the early 1950's about 30,000 Jacobs Windchargers were sold, mostly to farms and ranches in mid-America. Rural electrification curtailed the market for on-site electric generation.

In 1941 Palmer Putnum managed the first megawatt-scale windmill project with the financial backing of S. Morgan Smith Company, a manufacturer of hydro turbines. The Putnum machine, atop Grandpa's Knob in Vermont, ran two years. Problems with a large bearing interrupted operation during World War II, and a blade failure proved to be too expensive for the financial backer. While the machine failed to prove that bigger was better at the time, Central Vermont Public Service learned how to keep water behind dams when the wind was blowing. The public-private partnership, and the engineering involved were carefully documented by J. Wilber and P. C. Putnum [29][30].

C. The Government Gets Involved – Policy

Professor Poul la Cour, a contemporary of Charles Brush, conducted on-going research and demonstration of electricity-generating windmills with the support of the Danish government. Between 1891 and 1907, forty windmills were built under la Cour's direction. This effort established an ongoing local capacity for windmill manufacturing.

Beginning in 1933 V.N. Kresnovsky, in Soviet Crimea, first used a synchronous converter to tie a power generating windmill into the local electrical grid. That windmill survived until dismantled to support war effort.

Percy Thomas, an engineer in the Federal Power Commission, closely tracked the Grandpa's Knob wind project. In 1950 Thomas unsuccessfully championed legislation to support a network of large grid-connected windmills. However he established the principle that renewable energy could reduce oil imports. Government interest in wind power was eclipsed by post-WW2 government promotion of nuclear power.

In 1973 the Organization of Petroleum Exporting Countries (OPEC) raised the price of oil significantly. In the wake of the ensuing oil shocks, dedicated policy staff in the Carter Administration crafted the 1978 Public Utility Regulatory Act which reduced utility reliance on central-station power generation. Insiders at the California Energy Commission, supported by Governor Jerry Brown, established a policy that made wind power a profitable investment. From 1983 to 1986 there were 12,553 wind generators installed on three California passes.

The "wind boom" was followed by a "wind bust." The poor reliability of windmills made by start-up manufacturers was a major factor, even though supported by a government demonstration effort at Rocky Flats Colorado. The industry-saving exceptions were durable Danish-built windmills, direct descendants of early twentieth-century demonstration projects.

In the early 1990's J. Biemer managed the Resource Supply Expansion Program. This collaborative effort led to long-term utility power purchase agreements from wind farms in the Pacific Northwest.

Since then, industrial-scale wind farms have become common around the world. The Roscoe Wind Complex in Texas, the largest in the U.S., has a capacity of 781 MW [31]. The largest off-shore wind farm is London's Thames River Estuary with an installed capacity of 630 MW [32]. As of 2012 China has installed 62.7 gigawatts of wind farm capacity – on their way to 100 gigawatts by 2015 [33]. The cumulative handprint of the pioneers continues to grow.

APPENDIX 2. SOLAR COOKERS – A TECHNOLOGY HANDPRINT IN THE MAKING

by Natalia Blackburn, P.E.

Though there are numerous styles of solar cookers, a simple solar cooker consists of an insulated box in which is placed a black cooking pot containing, for example, an uncooked stew. The box is lidded with clear glass or plastic, and then is oriented toward the sun. Even such a simple device will heat the stew to 250-300°F in 4 to 6 hours, the same time that it takes a crock pot to do the same task.

There are many refinements to this basic box solar cooker, for instance reflectors and sun-tracking devices. There are also other types of solar cookers such as panel cookers, parabolic cookers, and evacuated glass tube-in-tube cookers. Some types can reliably reach 450°F, and at least one solar cooker made in the U.S. has enough solar collecting area to grill meat [34]. Inventors in the U.S. are currently developing solar oven prototypes that may one day replace the conventional oven.

A. Evolution

Ancient Greeks, Romans, and Chinese used curved mirrors for military purposes to concentrate sunlight so that a nearby object would be set on fire [35]. The Sun was used for drying and preserving foods as far back as the 1200's; the first recorded effort to solar cook food occurred in 1767 [36]. Over a dozen cookbooks describing how to make and use a solar cooker are available. A subculture of U.S. solar cooks thrives as evidenced by the SolarCooking Yahoo group and their cooker designs, tweaks, and recipes [37]. The Citizens for Solar, a non-profit organization based in Tucson, Arizona, recently had its 31st Annual Solar Potluck and Exhibition [38].

B. *Entrepreneurism*

The Solar Cookers World Network wiki, now consisting of over 1900 web pages, is primarily a volunteer effort [39]. Solar cooking is currently a cottage industry; there are no mass market solar cookers in the U.S. Preliminary estimates indicate that an energy savings of $26 per year for the average U.S. household can be expected from solar cooking [40]. At present solar cooking in the U.S. will only be adopted by households that are "doing the right thing" and/or trying to live "off the grid".

Solar cookers also have international market potential.

C. *Policy*

Community benefits of solar cooking need to be considered in purchase transactions before solar cookers can be commercialized. These benefits include improved air quality, reduced childhood diseases, reduced deforestation, reduced CO_2 emissions, and reduced power plant and pipeline construction.

One model for incorporating these external benefits is provided by the commercialization of compact fluorescent light bulbs (CFL's). Once CFL's started appearing on the shelves at $2 a bulb with a sticker explaining that the utility rebate had already been applied, the bulbs sold by the millions. Over the last two decades related strategies have worked for many energy efficient appliances [41].

One barrier to such a policy development for solar cookers is the need to reliably determine the savings potential. Preliminary work of this kind has been done for solar cookers in less-developed rural areas where the fuel displaced by the use of solar cookers is either wood or charcoal [42]. Also there is a study in progress in the U.S. to estimate the energy saving of solar cooking for a typical American household which includes a monitoring and verification component [43]. Savings from reduced air conditioning and reduced peak demand can also be quantified.

Commercialization with policy support also depends on industry consensus regarding solar cooker performance standards. This will give consumers a way to make educated choices.

The solar backyard barbeque can become an American institution if enough advocates, entrepreneurs and policy makers share a collective handprint vision. "Do you want some of my special secret-recipe solar-cooked chili to go on that burger?"

APPENDIX 3. LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN – A PROCESS HANDPRINT IN THE MAKING

by Natalia Blackburn, P.E.

Leadership in Energy and Environmental Design (LEED) is a group of rating systems for buildings which attest to the sustainable practices incorporated into a building's construction and/or its continuing operation. The rating systems are overseen by the non-profit U.S. Green Building Council (USGBC) [44].

LEED is a process, not a physical technology. Qualifying a building project for a LEED rating consists of choosing the rating system and selecting a group of appropriate credits that can be met by a given project. The higher the number of credits that can be successfully documented, the higher the LEED rating achieved, from bronze, silver, gold, to the highest level of platinum. The credits fall into one of six areas: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation in Design.

A. *Evolution*

Originally in 1998, LEED was a single rating system covering new commercial construction only (LEED NC version 1.0). It has been under continuous improvement ever since. Version LEED NCv2.2 was released in 2005 and LEED 2009 four years later. During the years of second and third revisions, there has been a branching out to specialized rating systems: rating systems for different phases of new construction, such as core and shell, and commercial interiors; and rating systems developed specifically for healthcare facilities, schools, retail, homes, and others occupancies. Also there has been a rating system developed for operation and maintenance of existing buildings during that time [45].

The first version of LEED (LEED NCv1.0) reflected a "this is the best we've got for now" attitude with quantity-based methodologies for energy and atmosphere credits and water efficiency credits (based on plumbing fixture water use specifications and spreadsheets). The first version took a more *quality* based approach in the documenting requirements for credits relating to reused, recycled, and locally produced material. The methods and techniques developed were sometimes rough, sometimes first attempts, and ever-changing depending upon review comments from earlier projects.

B. *Entrepreneurism*

The USGBC has created an organization and processes that are intended to make the development of the rating systems consensual.

LEED has pioneered the use of a rating system associated with sustainable site considerations, recycling, and reusing materials and resources. Also there are rating system mechanisms that allow for incubating what may become points in future rating systems. These mechanisms include Innovation in Design Credits for which a project team writes up a new credit and submits it for USGBC approval for that particular project. The USGBC's library of pilot credits contain proto-credits which can be used in a project. This process promotes the beta testing of new design ideas. There are also priority regional credits which give extra points for credits dealing with special concerns in a region. For instance, in much of California, credits having to do with water are the region's priorities, and you can double up points by achieving

certain water related credits. All of this "quantifying of sustainability" has not been without controversy [46].

Twenty years after the adoption of the first LEED system, LEEDv4 has tremendous changes in the Materials and Resources credits. Entrepreneurism continues as supporters of differing methodologies vie for acceptance within the LEED framework. There are credits which may utilize Life Cycle Analysis (LCA) options, others that include options for Environmental Product Declarations (EPD's), and others that refer to specific certifications such as those of the Forest Stewardship Council and the Cradle to Cradle Program [47].

C. Policy

LEED initially tracked U.S. energy policy developments. During the 1970s the U.S. saw its first building energy regulations. The heating and cooling computer modeling programs became more uniform in their underlying methodologies, partly because code bodies insisted that, for a heating and cooling program to be used to show compliance to a regulation, the program must meet certain standards. This encouraged designers, code officials, and the public to rely on these energy modeling programs.

Even in the 1990's government attention to sustainability was still primarily equated with energy savings. Water efficiency had its foot in the sustainability door by the 1990's with water use standards and spreadsheet tools because you could at least estimate gallons of water.

Numerous state and local entities have supported the demonstration of LEED rated buildings. Portland, Oregon's five-year (2005-2009) Green Investment Fund program was among them [48].

LEED is thus an example of a growing non-profit/pubic/business environmental handprint relating to our built environment. The use of LEED is growing worldwide. Ironically, the more sustainable business practices that are mainstreamed due to the catalytic influence of LEED the less the impact of LEED can be directly measured.

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