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SCHOOL OF ARTS AND SCIENCES

DEPARTMENT OF EARTH & ENVIRONMENTAL SCIENCE

COLLEGE OF LIBERAL AND PROFESSIONAL STUDIES

ENVIRONMENTAL SUSTAINABILITY ABSTRACTS

MULTIPLE-ATTRIBUTE ECOLABELS AS DRIVERS OF CORPORATE SUSTAINABILITY GOVERNANCE IN CONSUMER GOODS SUPPLY CHAINS

Robert Barnes (2017)

Readers:
James Hagan PhD, Earth & Env. Sci., University of Pennsylvania
Juan Freijo, Brambles Limited

Ecolabels are designed to provide credible information about the environmental impacts associated with a product's manufacture, use, and disposal. The practice of ecolabelling has expanded rapidly in the past twenty-five years, concurrent with increasing consumer awareness about the environmental, social, and ethical issues embedded in the physical goods supply chain. However, a lack of centralized quality control has resulted in market saturation and redundancy. These factors have engendered consumer confusion and organizational skepticism as increasing instances of greenwashing have colored perception of ecolabel reliability. Current literature about ecolabels was reviewed and three multiple-attribute ecolabels were benchmarked to identify threats and opportunities for future ecolabel success. A case history about the evaluation of a B2B supply chain ecolabel was used to identify gaps between industry knowledge and the findings of scholarly and management literature. The goals of this paper were to identify key success factors for the design and implementation of multiple-attribute ecolabels and characterize the conditions needed to enhance their role as drivers of corporate sustainability governance, with special consideration for B2B ecolabels focused on consumer goods supply chains. Several central challenges were characterized, and served as the basis for a series of recommendations for ecolabelling programs and managers seeking to design, select, or implement existing ecolabels.

ESG INTEGRATION ACROSS SUPPLY CHAIN AND BUSINESS

Pranav Chheda (2017)

Readers:

James Hagan, PhD, Earth & Env. Sci., University of Pennsylvania
Gary Survis, Insight Venture Partners

The changing nature of supply-chains and the growing importance of addressing vulnerabilities calls for a holistic approach that can navigate risks at strategic, tactical, and operational level. This paper addresses supply-chain risk through an ESG (Economic, Social, Governance) point of view. The key objective was to evaluate the benefits of ESG integration across the supply-chain to minimize the impact of disruptions. This paper hypothesizes that supply-chains can perform better when material ESG parameters are integrated in the business decision. The paper focuses on ESG as the lever for creating sustainable supply-chains, and hence discusses it as essential elements of sustainability. Using methods of system design and value-chain, the paper presents the evaluation of risks across six agricultural commodities – corn, dairy, palm oil, soybean, sugarcane and wheat. This plays a key role in showing the systemic nature of supply-chains. To further emphasize the importance of ESG, the paper looked at adaption of ESG by businesses and investors. ESG integration makes a strong business case as it helps companies reduce costs, mitigate risks and prepare for potential disruptions in the future.

WATER, SANITATION, AND HYGIENE FOR ALL: ASSESSING THE FEASIBILITY OF MEETING SUSTAINABLE DEVELOPMENT GOAL 6 IN BHUTAN

Dechan P. Dalrymple (2017)

Readers:
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James Hagan PhD, Earth & Env. Science, University of Pennsylvania

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Sustainable development goal 6 (SDG 6) strives to "Ensure availability and sustainable management of water and sanitation for all" and furthers this agenda through an integrative look at the water management cycle. The new goal builds on previous drinking-water, sanitation, and hygiene (WASH) targets from the Millennium Development Goal (MDG) period, but also expands on them so as to include wastewater management, water efficiency, integrated water resource management, and water ecosystem protection targets as well. The Himalayan Kingdom of Bhutan benefits from a combination of good governance, a historical commitment to environmental conservation, and naturally abundant water reserves, but increased pressures on its water resources coming from socio-economic and climate changes could soon have severe implications on the nation's future water security. Despite the substantial progress made in the expansion of drinking-water and basic sanitation access during the MDGs, Bhutan's limited funding and local capacities contribute to dysfunctional water supply schemes, insufficient water quality monitoring, and improper wastewater management practices, among many other issues. As it stands, these localized water quality and availability challenges and the government's failure to properly prioritize them in their national budget, greatly threatens the prospects of Bhutan meeting the SDG 6's ambitious targets by the 2030 deadline. Although this may be the case, aggressive government planning could transform expectations if: (1) water initiatives are better harmonized to maximize efforts, (2) effective wastewater management opportunities are capitalized on, and (3) successful education and advocacy strategies inform the general public of the critical importance of meeting SDG 6 to inspire future action.

PREPARING A BUSINESS CASE FOR A SUSTAINABLE PRODUCT: RADIANT CEILING PANELS

Richa Desai (2017)

Readers:
Stan Sveen, Uponor
James Hagan, PhD, Earth & Env. Sci., University of Pennsylvania

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Recent years have seen a steady growth in corporate sustainability and adoption of circular economy. More and more companies are heavily investing to improve their environmental, social and governance (ESG) aspects. However, according to R. Eccles and G. Serafeim, in order to achieve higher performance in both financial and ESG aspects, it is imperative that a company invests in innovative products, services and processes. This study conducted market research and developed a business case for one such innovative product known as the Radiant Ceilings Panels (RCP) for the Heating, Ventilation and Air Conditioning (HVAC) industry in the United States. HVAC accounts for nearly 40% of building energy consumption. Various studies have shown that radiant technology can reduce building energy consumption by up to 30% or more as well as generate higher thermal comfort depending upon the climatic conditions and geographical location. In spite of this, various economic and behavioral issues as well as failure of aligning business strategy to market needs and trends have resulted in the glacial speed of adoption of the technology. This has led to resistance from the top management at various companies to include RCP in their product portfolio. To address this issue, this study analyzed the current U.S. commercial building construction industry, green building trends, energy efficiency scenario and HVAC industry to establish the business opportunity and deliver a tangible outcome in the form of a business case by using Uponor as a case study.

ANALYZING THE POSSIBLE VALUE CREATION OPPORTUNITIES FROM SUSTAINABILITY REPORTING

Shubhneet Grover (2017)

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Consumer Packaged Goods (CPG) has seen impressive growth over the past half century by surpassing the growth projected through market analysis. CPG Industry has constantly outperformed the S&P 500 since 1985 with a compound annual growth rate (CAGR) of 10%. The tremendous financial growth however disregarded the environmental and social impacts of their business. By the 1980's, the problems of the greenhouse effect and destruction of the ozone layer came to light. The Industry also realized that there was a finite amount of resources available for their use, for example fossil fuel, which motivated the industry to make a conscious choice to invest in renewable sources of energy. The companies also started reporting on the environmental and social impacts of their products to improve their brand image. The initial push for adopting and reporting Environmental Social and Governance (ESG) issues was predominantly to improve the brand reputation and retain their existing customer segment.

But there has been a change to that perception. Multinationals are continuously adopting sustainability reporting to create value by mitigating the risk, improved governance, fostering innovation and attracting and engaging employees. The study analyzed different reporting styles, varying mostly on their definition of materiality. Each style defines materiality based on the stakeholder group it aims to reach and thus tend to be different in their approach. Three companies were analyzed for this study: Unilever, Campbell's Soup, and General Mills. The aim was to determine how reporting on sustainability initiatives can create value for companies. While there is an increase in share prices for the companies analyzed since the time they started reporting on environmental and social concerns, it cannot be conclusively stated that financial gains were solely the result of sustainability initiatives and reporting. Good governance and business strategy is an equally important part for a company's success, which too can find its root in sustainability reporting.

COMPARISON OF ENVIRONMENTAL IMPACTS OF LETTUCE GROWN IN TWO SETTINGS: CONTROLLED ENVIRONMENT AGRICULTURE VS. IN-SOIL, FIELD-GROWN AGRICULTURE

Sarah Kolansky (2017)

Readers:
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Wil Hemker, University of Akron Research Foundation

This report compares a unit of lettuce grown in two different settings: a controlled environment agriculture (CEA) greenhouse in the Northeast, and conventionally grown lettuce in a field in California. Despite being two of the driest states in the country, over 98% of the country's lettuce are grown in California and Arizona. Alternative solutions have been explored to meet the water-intensive food demands of the U.S., while not depleting surface or groundwater resources. Several growers in the Northeast region have built CEA greenhouses, with claims that they are the more environmentally-friendly alternative. Although there are savings on water and transportation miles, CEA-grown vegetables require significantly more energy during production than conventional growing. Through a literature review, a workshop at the University of Arizona's CEA Center, and discussions with experts, data and information was collected to determine the quantitative inputs for each of the growing techniques. A qualitative comparison was also conducted, to capture the benefits that were not quantifiable, like the reduced amount of pesticides on CEA-grown produce. The conclusion was that CEA grown lettuce has some environmental benefits, but must be caveated with the large amounts of energy that it requires. Some facilities use renewable energy to lower the fossil fuel requirements needed during production, and as these are developed further, the equation will change. Future studies should consider additional factors, such as shrinkage and value of water, into their analysis. CEA lettuce and other indoor lettuce systems are likely to continue to grow as customers demand more pesticide-free, fresh produce grown closer to home, and it is important that the environmental analyses are scientifically sound and include all aspects.

SUSTAINABILITY DATA DISCLOSURE AND CDP: REPORTING TRENDS, GUIDANCE, AND A CASE STUDY WITH FMC CORPORATION

Emily Woodhull Newton (2017)

Readers:
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Linda Froelich, FMC Corporation

Since 2001, CDP (formerly the Carbon Disclosure Project), has collected information on companies' management of natural resources on behalf of investors, who use this information in investment decision-making. CDP's objective is to motivate companies to measure, manage, and reduce their negative impacts on the environment through public disclosure of environmental data. CDP believes investors will use environmental information as a basis for their decisions to divert capital from companies that follow the "business-as-usual" profit maximization model to companies whose models account for financial performance as well as their environmental, societal, and governance (ESG) performance. Companies that incorporate ESG performance into their business strategies are thought to be lower-risk investments compared to companies that do not because they are preparing for the risks and opportunities presented by climate change. For sustainability professionals who are considering reporting to CDP for the first-time, there is a lack of detailed and in-depth guidance on how to best strategize and complete the CDP disclosure process. The focus of this project is to provide the necessary guidance to effectively answer the CDP climate change program with information on how to persuade a company's leadership to report to CDP, obtain sufficient resources and time to answer CDP's climate change program, and earn the highest possible score, while considering their company's current sustainability initiatives. To illustrate how the reporting process presented in this research is successful, a case study on FMC Corporation's process for answering the CDP climate change program is included. FMC achieved an A- score as a first-year reporting company and was placed in CDP's Leadership category, which includes companies that are implementing best practices in environmental stewardship. In 2015, 560 companies were in the Leadership category, and FMC was one of only fifteen in the Leadership category that were first-year reporting companies.

STUDY OF INDUSTRIAL FOOD SUPPLY CHAINS TO BUILD A SUSTAINABLE FOOD SYSTEM

Shraddha Sawant (2017)

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According to the United Nations DESA report, the world population is projected to reach 9.7 billion by 2050. To feed the growing population while reducing overall environmental impact, it is important to focus on developing a sustainable food system for the 21st century. A food system is the path of food to travel from field to fork. It involves process of raw material acquisition, processing, packaging, distribution, marketing, consumption, and disposal of food. These processes are nothing but stages of a food supply chain. Therefore, this study explores the problems of the industrialized food system from a supply chain perspective with a focus on dairy products. Using the sustainable assessment framework provided by Foodmetres, this study explores the strengths and weaknesses of the industrial food supply chain (IFSC), identifies opportunities to improve the existing model and proposes strategies and tools to enhance the overall performance of the food system. Environmental externalities imposed by industrialized agricultural systems, overexploitation of natural resources due to increasing demands, larger footprint of products due to expansion of global trade, increased emissions of greenhouse gases, reduced transparency among international food manufacturers, irresponsible consumption and disposal of food generating immense food waste are some of the major problems of today's complex food system. This study reveals how tools such as materiality matrix, life-cycle assessment, environmentally responsible product analysis (ERPA) matrix can be used to provide a holistic assessment of every stage of food supply chain. In addition to that, the study presents alternative supply chain models for a gradual transformation of the industrial food system into a more resilient food system by adopting a systems approach. This study also provides scope for further research to compare and evaluate the results of incremental as well as transformational alternatives discussed in the paper.

ENVIRONMENTAL MANAGEMENT OF PETROLEUM EXPLORATION AND PRODUCTION

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Historically, the extraction of crude reserves has been the source of environmental concern and impact, the consequences of which - oil spills, air and water pollution, soil erosion, and fires - have all been recorded at different times and places. Even though the industry has applied safety measures to provide environmental protection from petroleum activities, more can be accomplished by implementing best practices within the industry. Thus, the challenge is to meet world energy demands while minimizing negative environmental and human health impacts by using the best technological and management strategies.

Common releases from petroleum exploration and production (E&P) stage were identified and environmental impacts assessed. Case studies of different regions that have a great potential for petroleum E&P and have adopted best management practices, namely Taranaki (New Zealand), British Columbia (Canada), and Niger Delta (Nigeria) were reviewed. In-depth interviews with industry stakeholders were conducted to gain insight on the petroleum industry's best practices. Finally, an overview of environmental problems in E&P stage of the petroleum industry and recommended best approaches to achieve high environmental performance to key stakeholders in industry and government (managers, consultants, etc.) were provided.

VIABILITY OF PRIVATE FINANCING AND SHARED-SAVINGS TO IMPROVE ENERGY EFFICIENCY FOR LOW-INCOME RESIDENTS OF PHILADELPHIA

Max Davidson (2016)

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This study is aimed to demonstrate the viability of private financing to fund energy efficiency retrofits to low-income residents of Philadelphia through a Shared Savings model. This will allow investors to reap market rate returns (5% IRR) and allow low-income residents to receive energy efficiency upgrades at no upfront cost. Energy efficiency financing is on the rise, however, low-income customers are a difficult market to attract private financing. Recipients of upgrades would pay a portion of calculated savings to investors through on-bill recovery (OBR), an extra line item on the utility bill that would allow investors to recoup their capex and provide a sufficient return. The costs and savings associated with these retrofits are based on data from 18 low-income Philadelphia homes that received durable weatherization and insulation upgrades provided by Serenity Soular and the Energy Coordinating Agency of Philadelphia (ECA). The study presents two cases that demonstrate the Shared Savings structure for unsubsidized and subsidized retrofits, based on two existing subsidies. To increase investor confidence both cases assumed a loan loss reserve fund would be established, either by the City or utilities (PECO or PGW) through a system benefit charge. Both cases demonstrate that private markets and minimal intervention can be mobilized to increase the energy efficiency of low-income residences in Philadelphia, saving money and mitigating climate impacts.

FIXING AIR POLLUTION: ASSESSMENT ON BEIJING'S TRANSPORTATION MANAGEMENT POLICIES

Pinzhang Li (2016)

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Smog has been routinely occurring in Northern China since the 1990s. The Tianjin-Hebei-Beijing Triangle area has the worst record in air pollutant concentrations in China. In Beijing traffic emissions have become the primary contributor to poor air quality. Urban air pollution is not only directly linked to adverse human health outcomes, but also causing damage to public welfare and economic losses. Since the mid-2000s, the government of Beijing has been updating its air quality standards and establishing new regulations to reduce vehicle emissions, promote public health, and promote sustainable modern transportation systems. This study reviews the current air pollution status in Beijing, discusses its impacts on public health, evaluates existing policies and offers recommendations to the government of Beijing. This research found that sometimes a well-intended public policy can generate unintended results, and command-and-control style of governing in transportation management (driving bans) is not as efficient as market-based approaches (congestion pricing). In addition to this, public participation and community involvement are crucial in the decision-making process to ensure the policy is understandable and enforceable. In conclusion, this paper provides a comprehensive review of the relationship between air pollution and transportation in Beijing and offers some insights for future policy design.

UNDERSTANDING OF ECO-INDUSTRIAL PARK (EIP) DEVELOPMENT BASED ON CASE STUDY ASSESSMENT

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One trail to full acceptability and employment of industrial ecology is selection of companies within industries that provide the greatest ability to stabilize the eco-industrial park (EIP). Stability is provided by companies' ability to participate in symbiosis as both a by-product donor and recipient. The more interconnected the web of exchanges these companies can foster, the less likelihood of the EIP's collapse. This paper seeks to answer one simple question. What type of industry is the most adept at garnering the most prospective benefit for the eco-industrial park by providing the most industrial symbioses? The industries whose firms can solve this problem are henceforth referred to as spiders to highlight their web weaving abilities. To answer this conundrum, three geographically dispersed case studies of current eco-industrial parks were examined. The three cases are Ulsan EIP located in South Korea, Western Australia's Kwinana EIP, and finally Biopark Terneuzen situated in the Netherlands. The three selected parks are a mix in size, management style, rationale for creation, and age. Despite these numerous differences, a common tendency has shown bright. Chemical companies thrived as donors and receivers equally, making them the perfect spider industries. In all three case studies, chemical companies' numbers as by-product donors and input recipients nearly matched. This reinforces the notion that they can provide optimized connectance, not just simple terminal nodes of exchanges. Chemical companies demonstrated a proclivity to engage in both by-product and heat exchanges. But even in Kwinana and Terneuzen, which lack a specific chemical area, this trend was observed as well. In fact, even though most of the firms in Kwinana are metallurgy and mining based and agriculturally founded in Biopark Terneuzen, chemical companies were able to match or exceed the number of symbioses of these larger firms, despite their relatively diminutive number. This was punctuated the most in Kwinana EIP. Even though the mining companies, with a greater number of firms, were able to participate in approximately the same number of by-product exchanges as chemical companies, they were unable to match the chemical firms in the number of heat exchanges. This might lead one to hypothesize that mining and metal industries require matching by-product and input needs to facilitate their participation in symbiosis, not chemical companies. For the future, further case studies are required to validate this observation. But despite management style, size, and location, chemical type firms have demonstrated that they may be the spider's capable of interlocking the firms of an EIP into a coherent, interdependent ecosystem. These three parks lean towards the inclusion of chemical companies for enhanced stability through greater inter-connectance.

ENVIRONMENTAL, ECONOMIC AND ETHICAL IMPACTS OF FOOD WASTE: WHAT PHILADELPHIA IS DOING TO COMBAT THE PROBLEM

Aubree Murray (2016)

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Food waste occurs at every step of the food supply chain. From the farms to the supermarkets and then to our homes, we are throwing away valuable resources that could be otherwise allocated. This waste is occurring in a setting where obesity and food insecurity are happening side-by-side. The way we value our food has a lot to do with why we are wasting so much of it. One way to improve the sustainability of our food system is to reduce or eliminate these losses.

With cities and municipalities under more fiscal pressure than ever, it is understandable that local governments are reluctant to take on additional spending to address the food waste problem. However, some cities are now starting to be seen as a model for other municipalities. Many cities have come to realize the fiscal, environmental and civic benefits of undertaking these initiatives. There have been great strides made in Philadelphia where the environment is concerned; the city becomes greener each day. Philadelphia needs to embrace the problem of food waste by turning it into an opportunity.

ENVIRONMENTAL IMPACTS OF CORN AS ANIMAL FEED

Priya Sathaye (2016)

Readers:

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As the world's population grows so does the demand for food. This results in an increased amount of corn and other feed grains that are required for animal feed production. In 2013, the total greenhouse gas emissions produced from agriculture in the United States was 9%, and the overall greatest contributors to greenhouse gas emissions were electricity (31%), transportation (27%), and industry (21%). The production of animal feed requires all of these components; it requires the use of transport and electricity at the manufacturing site and on the farm. The primary impacts that arise from animal feed production develop from the excess use of nitrogen fertilizer, harmful pesticides, and the release of criteria pollutants. The purpose of this report is to investigate methods to reduce the environmental impact of corn as an animal feed by using an attributional life cycle assessment (LCA) to quantify the environmental impacts and to pinpoint which stage of the entire process has the most significant impacts. The two research questions that guide this study are as follows: *When making animal feed, which stage has the largest environmental impact? What methods can be implemented into this industry to mitigate the largest environmental impact stage as well as other contributing factors?* The functional unit of the life cycle assessment is 1 kilogram of product prior to manufacturing. After completing the life cycle assessment, recommendations to agriculture and sustainability professionals have been made based on the results of the life cycle assessment and industrial ecology principles and thus minimizing waste. These recommendations include suggesting business strategies and improvements to the farming stage and the facilities of the animal feed companies. Future work in this field will be beneficial through forming partnerships between government and industry in order to enhance data collection.

ANALYZING THE ENVIRONMENTAL IMPACT OF HYDRAULIC FRACTURING USING QUALITATIVE SYSTEMATIC REVIEW AND LIFE CYCLE ASSESSMENT

Jessica May Vickers (2016)

Readers:

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Brandon Owens, Ecomagination, General Electric

At current global consumption levels, global natural gas reserves are expected to be exhausted in 60.92 years or by 2076, illustrating the need to move towards low-carbon energy sources. Using low-carbon energy sources like natural gas for electricity generation is preferable to more carbon-intensive energy sources like coal, as less greenhouse gas emissions are released. Research is currently underway into how to use natural gas as a "bridge fuel" as the global energy system moves toward low-carbon sources. In order for natural gas to serve as a successful bridge, concerns related to the environmental impacts of hydraulic fracturing must be addressed. Previously published life cycle assessments (LCAs) of hydraulic fracturing have established a baseline of the environmental impacts of natural gas production. These LCA analyses show that the largest environmental impacts are marine ecotoxicity from cobalt emissions and water depletion from high water demand in hydraulic fracturing fluid. Fortunately, technologies and methods exist today to address these issues such as cobalt free drilling technologies, liquid carbon dioxide hydraulic fracturing fluid, recycling of produced water and incorporation of industrial symbiosis opportunities. If these technologies are successfully deployed, then the environmental impacts of hydraulic fracturing will be minimized and natural gas will be able to effectively serve its role as the "bridge fuel" as the world transitions to low-carbon energy sources of the future.

SUSTAINABILTY ISSUES IN THE SUBSCRIPTION FOOD SERVICES INDUSTRY: COMPARISON OF HOME-MADE MEALS FROM MEAL INGREDIENT BOX AND GROCERY STORE

Yangfan Xuan (2016)

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The subscription food service is a rising business. It creates a new way for people to approach fresh food and cook meals at home. Many companies in the subscription food service industry have made progress in food waste by shipping the exact amount of food needed. At the same time, they have increased the consumption of packaging materials. This study points out the sustainability issues in this industry by comparing the life cycle impacts of home-made meals from subscription ingredient boxes with meals form grocery stores. A meal consisting of chicken meat, potato and carrots is studied. Life cycle assessment (LCA) addresses the impact categories abiotic depletion, acidification, eutrophication, freshwater ecotoxicity, global warming potential, human toxicity, marine ecotoxicity, particulate matter formation, photochemical oxidation, radiation, and terrestrial ecotoxicity**.** The results demonstrate that the impacts of the meal from grocery stores are lower than for the equivalent meal from subscription meal services. The main reasons for this are using conventional food as ingredients, reduced packaging materials, and less waste in the end-of-life stage. The contribution of organic ingredients used in the subscription meal box is important for some impacts, including global warming potential and marine ecotoxicity. Packaging influences the impacts, particularly global warming potential and human toxicity. End-of-life stage also has major impacts in global warming potential and human toxicity. The findings of the study provide suggestions to subscription food industry and consumers on reducing environmental impacts from ingredients, packaging, transportation, and end-of-life stages.

SUSTAINABLE HEALTHCARE: OPTIMIZING USE OF RED BLOOD CELL PRODUCTS

B. Joy Cannon (2015)

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Costs associated with the US healthcare industry were over $3 trillion in 2014. Are these resources being used efficiently, achieving corresponding outcomes, and what are the broader impacts on US citizens? Healthcare is often primarily focused on safety and quality of care, which is appropriate, but good stewardship of resources is also important. Blood products are one of these resources, which are critical to modern healthcare and are obtained largely through voluntary donations of whole blood. Red blood cells (RBCs), a component of whole blood, are a life-saving resource for many patients, and are perishable; current standards place the refrigerated shelf-life at 42 days from donation. FDA and blood banking regulations require maintaining temperatures of 1-10°C, and discarded if outside of standards – the primary cause of in-date waste. Up to 6.7% of RBC products go to waste in hospitals: in-date blood discard estimated from 0-3%[3] and outdated (expired) blood discards from 0-5.4%; a loss of a valuable resource and costs hospitals hundreds of thousands of dollars in both direct (purchase) and indirect costs.

How can we use this resource most efficiently? Through analysis of literature on the topic a number of strategies which could be employed to reduce red blood cell waste were identified. The top strategies for efficient supply chain and optimal usage identified included stakeholder engagement, human resources and training, good inventory practices, focus on freshness, restrictive transfusion strategy, computerized decision support systems during order entry, and best practice alerts/prospective intervention.

DAYLIGHTING SIMULATION AND PERFORMANCE DESIGN FOR A PHILADELPHIA ROW HOUSE

Xiaoshu Du (2015)

Readers:
Yun Kyu Yi, Penn Department of Architecture
James Hagan, Penn Earth & Env Science

Row houses were built to fit all levels of taste and budgets. In many cities, people see row houses as the answer to high housing demand, steep land prices, and narrow lots. By the nineteenth century, “Philadelphia row” not only became a symbol of the city’s urban landscape, but it also became a widely used term to describe regularized houses in orderly rows. The row house is an economical solution to enjoying the city life while having greater privacy than living in an apartment building. Row houses provide more space for less money than most other dwelling types. Maintenance and operating expenses are lower than single-family houses. However, row houses are often criticized for being too hot in the summer and for being deep and dark, especially in the winter.

This report examines daylighting conditions for a row house, which was built in 1974, on 33 S.45th Street in Philadelphia, PA. According to the U.S. Census Bureau American Housing Survey 2013, there are 132 million housing units in the U.S. The median age of all housing units in the U.S. is 40 years (built in 1974), 40.8% of all housing units were built between 1950 and 1979. Therefore, this house not only represents a typical typology for row houses, but also for typical American urban housing. Hence, the implications from this study could be seen as a prototype for houses throughout the city, and could give homeowners hints about what they could do to optimize their interior daylight, overall comfort, and energy use.

The model house has bedrooms on the ends that receive a lot of light, while the interior core areas receive almost no light. The first floor is particularly dark. This study aims to find a range of possibilities to help distribute light throughout the building more evenly, and to improve overall comfort levels. Ultimately, these measures can be conceived at a range of scales, from minor to major renovations.

TEACHING AND PREACHING SUSTAINABILITY AND SOCIAL JUSTICE: A RESOURCE FOR CATHOLIC HIGH SCHOOL TEACHERS

John W. Eppensteiner III (2015)

Readers:

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Dan Misleh, Catholic Climate Covenant

It is widely anticipated that in 2015, Pope Francis will issue a papal encyclical (letter) to the whole of the Roman Catholic Church which will discuss the moral dimensions of protecting the environment and encourage a global movement to deal with climate change and sustainable development. With an estimated 76.7 million self-identified Catholics in the United States – including 2.8 million students enrolled in Catholic elementary schools, secondary schools, and college/universities – this represents a significant opportunity to motivate a new generation to work toward a more sustainable future. This resource provides a framework that Catholic high school teachers can use to deliver a semester-long class on the concept of sustainability, emphasizing the moral imperative to act. It is designed to impart an understanding of current and future environmental issues and the implications those issues have on human health and well-being. It is intended that the class be taught one day per week over the period of one semester, with the primary audience being high school juniors or seniors. The resource provides fifteen lessons that cover the main themes in environmental and social sustainability. The thematic areas include: systems thinking; global changes; water, food, and energy systems; consumption and waste; biodiversity; ecological economics; corporate responsibility; effective communications; innovations in sustainability; and personal impact and leadership. Each lesson includes a lesson plan – which provides an overview of the topic, guiding questions, learning objectives, suggested assignments, and resources – and PowerPoint slides – which allows the presenter to cover the selected topic in a fifty minute class period. The resource also suggests projects that students can undertake to support their learning of the subject matter. These projects, referred to as Capstones, are a way for students to demonstrate their passions and professional promise, while having a concrete impact on the advancement of sustainability.

ECONOMIC VALUATION OF THE WIND POWER INDUSTRY IN CHINA

Weiting Hu (2015)

Reader:
James R. Hagan, PhD., Penn Earth & Env Science
Andrew E. Huemmler, PhD., Penn School of Engineering

The wind power industry has experienced rapid development in China. It has brought environmental benefits such as mitigating global greenhouse gases and local air pollutant emissions, but the industry still relies heavily on government support. In China, the onshore wind industry is relatively mature, while the offshore wind industry is burgeoning and needs further development. This research uses leveled cost of electricity (LCOE) to analyze the economic feasibility of both onshore and offshore wind power projects in China. The LCOE of offshore wind projects in China is calculated based on market data and reasonable estimation. By comparing LCOEs in United States, Germany and Denmark with LCOE in China, the effects of some specific factors on LCOE are discussed. Impacts of other factors on LCOE are also studied in order to find the potentials for improvement. LCOE of wind power is then compared with LCOEs of other resources such as coal and gas in China to corroborate the necessity of government support. The estimated LCOE of offshore wind projects in China is $171.28/MWh at low discount rate (5%) and $181.88/MWh at high discount rate (10%).

EXAMINING IMPROVEMENTS IN THE RECYCLING RATE OF MOBILE PHONES

Nidhi Krishen (2015)

Readers:
James Hagan, PhD. Penn Earth & Env Science
Gary Survis, Penn Earth & Env Science

Electronic devices in general and mobile phones in particular generate large amounts of waste. Although mobile phones are small devices, they are consumed in large numbers. In the last quarter of 2014, Apple alone sold 74.5 million iPhones and the industry is expected to continue to grow. Additionally, mobile phones are replaced in shorter time-cycles than other electronics, typically 12-18 months. The majority of retired devices are stored, disposed of as municipal solid waste or reused. Very few phones are recycled. The EPA estimates the recycling rate of mobile phones to be approximately 8% in the United States.

Recycling is a particularly effective method of waste management for mobile phones. Recycling not only diverts toxic wastes from the environment but recycling processes are also able to recover raw materials, particularly metals at high concentrations, using less energy and generating less waste than material recovery from primary sources. Hence, mobile phones are a valuable secondary source of raw materials and recycling plays an important role in resource conservation. At the current low rates of recycling, a valuable opportunity to manage mobile phone waste is being missed. Understanding why these rates are low is important to improve the effectiveness of recycling.

This study examined key factors that affect consumer recycling behavior through a qualitative meta-analysis of selected studies from published literature. It also examined the current recycling programs offered by key industry stakeholders using publicly available information and assessed them qualitatively on their effectiveness in meeting consumer requirements for increasing recycling behavior.

The major findings from this research show that consumer education and awareness and convenience of collection are the primary factors in positively impacting consumer recycling behavior at the end of the use/reuse cycle. Financial incentives are important but are outweighed by inconvenience. Recycling programs offered by industry holders create convenience to consumers by offering several options for collection as does financial incentives. However, these programs do not provide sufficient consumer education and awareness to increase recycle rates. These findings are significant as they can be used to develop a framework for designing and implementing effective recycling programs and increasing the recycle rates of mobile phones.

LIGHTING TECHNOLOGY ROADMAP AND SUPPLY CHAIN ANALYSIS OF LED LIGHTING IN PENNSYLVANIA

Yikun Liu (2015)

Readers:

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Due to rapid technology advancement, the general lighting market is entering into a new era. It is becoming clearer that the addition of LED technology is disrupting the existing structure of the lighting industry which primarily consists of incandescent and fluorescent light. In the past few years, technology advances have increased the average LED luminance performance to be comparable to incandescent and fluorescent sources, and decreased the cost of LED lights to over 80%. As LEDs are becoming more approachable in the general lighting market, new business opportunities are emerging. The new EPA 111(d) rule which promotes demand-side energy saving will further accelerate both technology development and market penetration of LED lights in the US.

The LED supply chain in US is fast developing. The number of LED companies in the US as well as in Pennsylvania has doubled from 2008 to 2014. The majority of Pennsylvania LED suppliers are located near Philadelphia forming a small cluster of LED light suppliers. The LED supply chain in Pennsylvania is relatively complete except that no LED chip manufacturer is located in Pennsylvania. This gap can be filled by introducing leading LED chip manufacturers, such as Cree and Toshiba. Also, Pennsylvania needs more substrate manufacturers, especially sapphire substrate manufacturers.

Traditional luminaire manufacturers are transforming to conform to this market change. Key traditional luminaire manufacturers have already become the leading LED luminaire manufacturers, such as GE and Philips. Local lighting luminaire companies are also expanding their businesses into LED lighting. Pennsylvania should work with its local organizations to assist its traditional lighting fixture manufacturers to enter into the LED general lighting market.

ANALYZING THE INTEGRATION OF RENEWABLE ENERGY IN INDUSTRY: CASE STUDY- OWENS CORNING

Amy Ochsenreiter (2015)

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The focus of this study was to determine the viability of integrating renewable energy in industry. To illustrate this, Owens Corning, a leading building materials manufacturer, was used as a case study. In doing so, it was determined how renewable energy should be integrated in Owens Corning's facilities in the United States. Maintaining grid parity was the main factor in determining where renewable integration would make the most business sense and have the greatest environmental impact. This was examined on a state-by-state, regional, and national basis. Additionally, materiality was taken into consideration when it comes to determining to what extent renewables should be integrated. Overall, a clearer picture of where and what type of renewable energy with proposed costs was determined along with suggested considerations for industry leaders looking to integrate renewable energy.

BUILDING GREEN HOMES: AN EDUCATIONAL WEBSITE ON RESIDENTIAL GREEN BUILDING

Bailey Rowland (2015)

Readers:
Dan Garofalo, Director of Sustainability, University of Pennsylvania
Amy Hillier, School of Design, University of Pennsylvania

Green building is becoming more popular every year. There are numerous principles of green building design that improve the environmental sustainability of the building and various systems for certifying that the project is in fact sustainable. Many homes constructed in the United States have taken on these green building design principles. Homes built with sustainability in mind are better for: the environment, the health of the occupant, and cost less to operate due to energy efficiency measures. However, the average resident may not know where to start when it comes to building or purchasing a green home. This project aims to provide information to the general public about residential green building. The final product is a website that allows viewers to learn more about residential green building. The website provides information about the following green building certification systems: Living Building Challenge, LEED for Homes, Passive House, Energy Star for Homes, Home Energy Rating System, Green Globes, Net Zero Energy Building Certification, and the National Green Building Standard. Nationwide data is presented in maps to show where LEED for Homes, Passive House, and other certified homes are located throughout the country. In five case studies, individuals offer insights about residential green building in Philadelphia: Chad Ludeman from Postgreen Homes; Patrick McDonald from Onion Flats; Gabe Canuso from D^3 Real Estate Development; Janet Milkman, who obtained LEED Platinum certification on her home renovation; and Dan Garofalo, who designed and built a new home to LEED Platinum standards. The goal of this work is to educate people who are not well versed in sustainable design so that they are confident and convicted to pursue more sustainable housing.