

M. Cihan AYDIN, PhD

Ercan IŞIK, PhD

Ali Emre ULU, MSc

Bitlis Eren University
Faculty of Engineering and Architecture

EMERGING SUSTAINABLE/GREEN CLEANING PRODUCTS: HEALTH AND ENVIRONMENTAL RISKS

Keywords: Sustainable Development, Sustainable Construction, Green, Cleaning

A b s t r a c t

Sustainable development aims to bring a new perspective to our lives without compromising customer needs and quality. Along with sustainable development many innovative solutions came out. One of them is sustainable green cleaning products and techniques. Today, emissions from conventional cleaning products may cause severe health and environmental issues. Especially sick building syndromes such as eye, skin and respiratory irritations are main health effects of them. They may also contribute to global warming, ozone layer depletion, aquatic toxicity, and air pollution. It has already been proven that misuse, storage, disposal and production stages of cleaning products can cause stream pollution. As an emerging and innovative sustainable technique “green cleaning” refers to environmental improvements such as pollution and greenhouse gas emission reduction, conservation of resources, preservation of wildlife, and reduction of plastic and waste that arise from used conventional techniques. Green cleaning products contribute these improvements using less or no harmful chemicals and Volatile Organic Compounds (VOC). Green cleaning products also encourage the usage of recyclable and renewable materials. Main purpose of this article is considered as while illustrating and questioning present conventional cleaning products’ necessities, values, environmental and health impacts, to obtain an understanding the benefits of sustainable green cleaning products and methods for the more sustainable and healthy indoor atmosphere and environments in the buildings.

Introduction

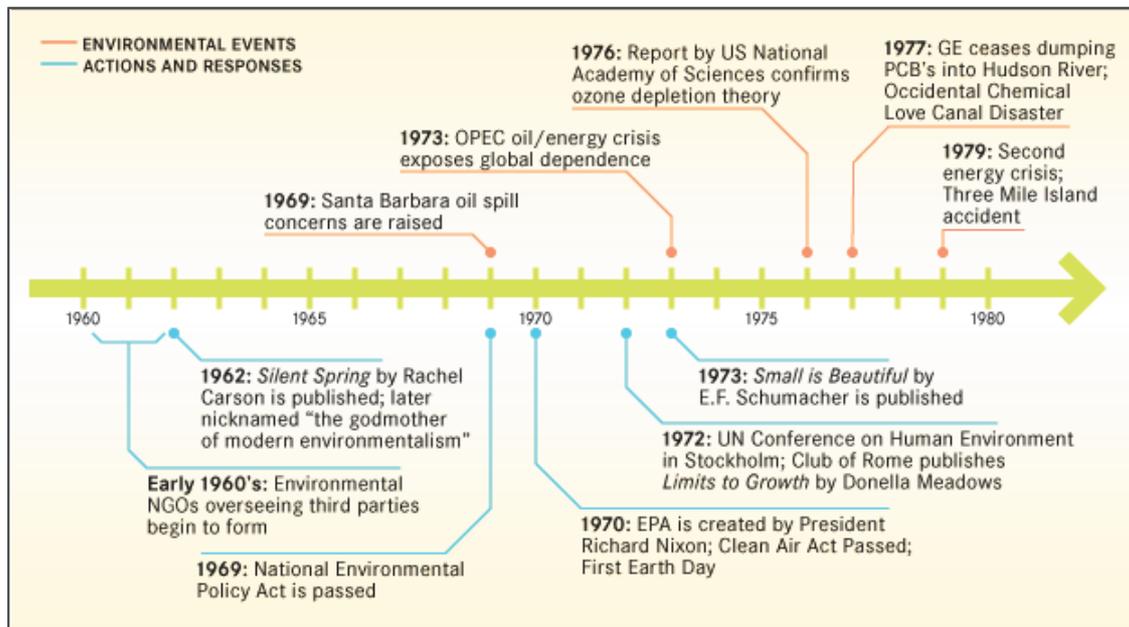
Sustainable development aims to bring a new perspective to our lives without compromising customer needs and quality. Most recognized definition of it is development that fulfills the mutual and individual needs of present society within the limits of nature. Sustainable development keeps the balance, and is considered a process to achieve long-term needs of human beings. Along with the sustainable

development, a term has come out which was “green”. Although green and sustainability concepts are interchangeable, there are conceptual differences between them that are sustainability tripod (environment, economic and social), focus area, tactics and strategy, scale, political orientation, risks or excesses and definition of success (Yanarella, Levine, & Lancaster, 2009). The green term refers to environmental improvements such as pollution and greenhouse gas emission reduction, conservation of resources, preservation of wildlife, and reduction of plastic and waste that arise from used conventional techniques. Green cleaning products contribute these improvements in buildings by reducing indoor air and stream pollution because of their less or no chemical and Volatile Organic Compounds (VOC), and using recyclable and renewable materials.

“Green” is a promising idea for both human being and planet’s future. Day by day, new products and idea are developing to divert our habits from conventional to alternative “eco-friendly” products. People begun to questioning current cleaning products’ impacts onto the environment because pesticide pollution effects of used techniques started to reveal in the 1960s (Meyer, 2010). Since 1980, many conventional and environmental friendly ‘green’ cleaning products have been developed and manufactured (USEPA, 2001). Many cleaning product manufacturers have already recognized the potential and importance of the green products. Cleaning product manufacturer companies and people will get more consciousness about to decide which products they will choose.

The living areas should be eliminated from dirt, dust, harmful microorganisms and bacteria to live a healthy and productive life. While cleaning is essential to the people, it is also important to choose right way when making places clean. Otherwise, while destroying harmful dust, germs and bacteria; human health and the environment can be damaged. Several studies have already proved that most conventional cleaning products are emitting the harmful chemicals and VOCs to the atmosphere. (Kapur et al., 2012; Nazaroff et al., 2004; Segura, 2014). Main purpose of the report was while questioning present conventional cleaning products’ necessities, values, environmental and health impacts in order to obtain an understanding about green cleaning movement and products in the buildings. Figure 1 illustrates some important actions and movements of green cleaning from the beginning to 1980.

Fig. 1 Environmental Movements and Actions (Meyer, 2010)



Source: *Keen to be green 50 years of people, planet, and profits, 2010* from http://landor.com/pdfs/k9/RMeyer_KeenGreen_7June10.pdf

Importance of Sustainable Green Cleaning

Green cleaning is one of important leg of achieving sustainable development when considered its benefits to the environment and human health. Especially, when the importance and benefits of green cleaning in hospitals, schools, libraries, homes and institutional buildings are considered, its importance would be seen obviously. Green cleaning products improve workers and students' performance, creativity and productivity (McMorrow, 2002). By using some green cleaning products like microfiber mops, 68 tons of dangerous substance can be eliminated (Moretti & Geiger 2008). More importantly, green cleaning products do not contain harmful or toxic chemical compounds as conventional counterparts such as heavy metals (arsenic, lead, cadmium, cobalt, chromium, mercury, nickel, selenium), 2-Butoxyethanol, phthalates, and phenolic that cause cancer, asthma, and chronic and allergic sicknesses (Dougherty, 2011; Nazaroff et al., 2004; Steinemann et al., 2011).

Another concern related to cleaning products is phosphorous compounds. One of the main reason of eutrophication in the bays and lakes are the phosphorous, and about 700 pounds of algae can grow using only one pounds of phosphorous (USDOE, 2008). Eutrophication is a

process that occurs when the ecosystem enriches with chemical nutrients such as nitrogen and phosphorus. Normally, it naturally happens in a longtime; however, phosphorus included cleaning products accelerate the process and dead zones occur and water quality decrease in the bays and lakes (Dugan et al., 2011).

Cleaning is generally defined as “*the removal of visible soil (for example, organic and inorganic material) from objects and surfaces and normally is accomplished manually or mechanically using water with detergents or enzymatic products*”¹. This definition might have worked so far; however, it may include something like ‘...using water with environmentally and human health friendly cleaning products’. Since, as cited and mentioned in previous section, several articles and surveys claim that chemicals used in cleaning products are harmful. Today, everyone agrees on that cleaning is indispensable. Studies already have proven that cleanness is also an important aspect in the workplace to improve the work quality and prevent from hazards (Culver et al., 2002).

According to a survey conducted by Corporate Express US results almost 1/3 people suffering from allergies due to bad indoor environmental conditions and 83% of the workers want to see green cleaning products in their offices. A comprehensive study by Culver indicates that less harmful cleaning products improve the worker performance and productivity up to 5 percent. By doing so, between \$30 billion to \$150 billion could be gained each year (Culver et al., 2002). There are also other facts that point the importance of cleaning product selection for human health and environment. A study showed that institutional cleaning industry uses about 5 billion pound chemicals which most of them identified as harmful to the both environment and human health (Case, 2003).

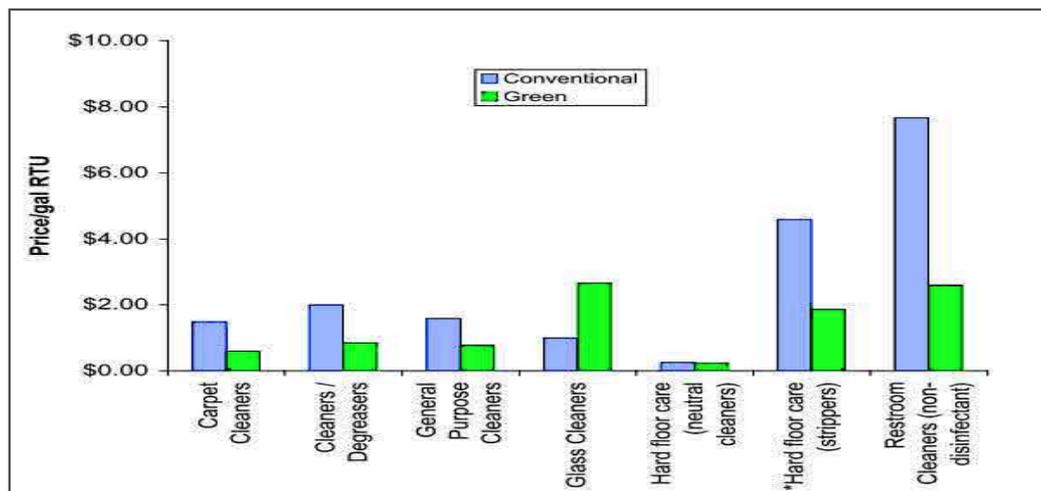
Consequently, green cleaning products are less harm to the environment and mediatly to the human health. By using these environmental friendly products, it has been seen that amount of sickness on people who work in an indoor decreased. Plus, green products do not emit harmful chemicals which exposure to primary and secondary air pollutants, so environmental pollution, caused by conventional products, would be eliminated (Ashkin, 2008).

¹ William A. Rutala, P. D., M.P.H., David J. Weber, M. D., M.P.H., & (HICPAC), t. H. I. C. P. A. C. (2008). Guideline for Disinfection and Sterilization in Healthcare Facilities. 158.

Comparative Life Cycle Cost (LCC) and Assessment (LCA) of Industrial and Institutional Cleaning Products

When deciding if a product is environmentally friendly and sustainable, there are some criteria to evaluate it. LCC and LCA seeks whole steps of the product to determine whether the product is environmentally friendly or not. In order to make the right evaluation on green products costs, some factors should be considered such as chemicals used, application methods, content of products, spent energy, labor requirements, reusability, recyclability, health and environmental impacts and benefits, and transportation costs (Espinoza et al., 2010; Barringer H.P., 2003; Larsson et al., 2009).

Fig. 2 Price comparisons of green and conventional cleaning products sold as concentrates. Ready-to-use (RTU) products not included

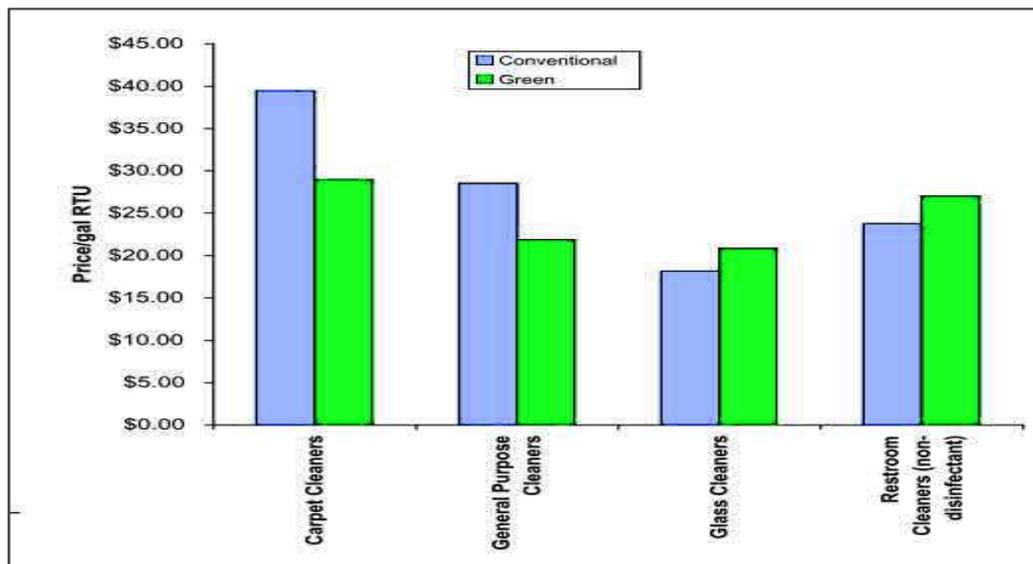


Source: Espinoza, T., Geiger, C., & Everson, I. (2010). *The Real Costs of Institutional "Green" Cleaning*.

Green cleaning products were more expensive when they first came out. That's why people had some reluctance to choose them even though they care about the environment. However, over the time this fear has reduced because new technologies and studies brought new ideas and solutions to this problem (Ashkin & Holly, 2008; Espinoza, et al., 2010). Today, price differences between conventional and green cleaning products are almost same. Also, some green products are cheaper in the market, except a few product category such as glass cleaners and non-disinfectant restroom cleaners (Espinoza et al., 2010). The reasons of some green cleaning products still more expensive than conventional ones

are counted as transportation and ingredient costs of them (Clifford & Martin, 2011).

Fig. 3 Price comparisons of green and conventional RTU cleaning products. Products sold as concentrates not included



Source: Espinoza, T., Geiger, C., & Everson, I. (2010). *The Real Costs of Institutional "Green" Cleaning*.

As seen in the figure 2, there are no significant price differences between concentrated green and conventional cleaning products except floor care products and glass cleaners. Similarly, in the 3rd figure, there is also no statistically significant differences exist in the terms of ready to use (RTU) category. Moreover, the study states that aerosols are 27, ready to use products are 15 times expensive than concentrated ones. Use of concentrated products is a cheaper choice than RTU counterparts for the both industries and institutions. On the other hand, weak point of the concentrate cleaning products than RTU products is that concentrate products require extra time and educated janitorial staff or automatic dilution equipment when dilute them.

Life cycle assessment (LCA) means "a comprehensive examination of a product's environmental and economic aspects and potential impacts throughout its lifetime, including raw material extraction, transportation, manufacturing, use, and disposal" (EO 13101, Section 201). In the literature there are some studies that exist to evaluate the LCA of the cleaning products (Kapur et al., 2012; Larsson et al., 2009). These studies

aim to research life cycle environmental impacts that are associated with cleaning products.

The study performed by Kapur A. looks into the environmental impacts of GS-37-compliant (green products) versus conventional products which are not certified by GS-37. The study investigated the environmental impact categories which are climate change, ozone depletion, human toxicity, photochemical oxidant formation, terrestrial acidification, freshwater eutrophication, freshwater ecotoxicity, agricultural land occupation, natural land transformation, water depletion and fossil depletion. Study examines the impact categories under four values which are Glucoside-Based Compliant, Hydrogen Peroxide-Based Compliant, Conventional Ready-to-Use (RTU) and Conventional Concentrate (Kapur et al., 2012). Glucoside-Based Compliant and Hydrogen Peroxide-Based Compliant are major certified compounds of I&I types green cleaning products by the GS-37. Table 1 illustrates the result of findings below.

Table 1 Life cycle impact assessment results of general-purpose cleaning products (Kapur et al., 2012)

	Glucoside -Based Compliant	Hydrogen Peroxide- Based Compliant	Conventio nal RTU	Conventional Concentrate
Climate Change	4	3	1	2
Ozone Depletion	1	3	2	4
Human Toxicity	3	4	1	2
Photochemical Oxidant Formation	3	4	1	2
Particulate Matter Formation	3	4	1	2
Ionizing Radiation	3	4	1	2
Terrestrial Acidification	3	4	1	2
Freshwater Eutrophication	3	4	1	2
Marine Eutrophication	2	4	1	3
Agricultural Land Occupation	1	4	2	3
Urban Land Occupation	1	4	2	3

	Glucoside -Based Compliant	Hydrogen Peroxide- Based Compliant	Conventio nal RTU	Conventional Concentrate
Natural Land Transformation	1	2	4	3
Water Depletion	3	4	1	2
Metal Depletion	2	4	1	3
Fossil Depletion	3	2	4	1

(Legend= 1: highest impact; 4: lowest impact)

Another study that seeks the LCA of the floor cleaning is done by Larsson in Europe in 2009. Study aims to look into pros and cons of a new floor care method which is called Twister™ pad. The method is used to clean and polish floors only using water (in some conditions chemicals may be required). Twister™ method requires a floor care machine (scrubbing or combined) to get high quality cleaning, but it is not a must (Larsson et al., 2009). There is also no specific machine required to use this method. Also, authors state the method works on several floor types such as natural stone, terrazzo, wax-treated and polish-treated. According to the results, Twister™ pad has showed minimum environmental impacts in the terms of human health, ecosystem quality and resources when compared with two other floor care methods which studied previously.

Conclusion

Conventional cleaning products have carried the cleaning load too long. Besides the cleaning it brought also some unintended consequences for the people and environment. First one, it has affected people's health, especially custodial workers'. Second, it has affected environment (particularly indoor environment) by their dangerous chemical contaminants. Conventional green cleaning includes several hazardous, toxic even carcinogenic substances. Committed regulations has reduced and banned some of the used chemicals in conventional cleaning products. However, the allowed levels of the chemicals still show sicknesses, injuries and environmental pollution. In the terms of green cleaning regulations this could be said that manufacturers do not have to worry about it because green cleaning products already does not include toxic chemicals and no or low VOCs. When public people's and

institutes' interests rise to the green cleaning products, the products retail prices decreased. Supply and demands to green cleaning products have increased. While some studies show the true face of the conventional cleaning products, some have showed health and environment benefits of the green cleaning products.

As a result, it is certain that cleaning is indispensable; however, the ways through achieving it could be changed. Sustainable green cleaning products can do it. These products change the way of cleaning without sacrificing both human and environmental health. When concluding this report, we are confident saying that green cleaning products are not something to be ignored. Based on researches, green cleaning products are different and superior from conventional ones in the terms of cost, benefits, safety, health, and production phases.

References

- [1] Ashkin, S. P. (2008). Greening the Cleaning. Environmental Services-HFM Magazine.
- [2] Case, S. (2003). Cleaning Up the Supply Chain. Inside Supply Management.
- [3] Christina Moretti Contributors: Chris Geiger, K. P. (2008). Responsible Purchasing Guide Cleaners. In M. J. S. Chris O'Brien, Dave Tilford (Ed.), Cleaners (2nd edition ed., pp. 60): Responsible Purchasing Network
- [4] Clifford, S., & Martin, A. (2011). As Consumers Cut Spending, 'Green' Products Lose Allure. SOUTH KINGSTOWN JOURNAL.
- [5] CPPPP, C. P. P. P. P. (1999). How to Select and Use Safe Custodial Chemicals. U.S. EPA Region X, California EPA-County of Santa Clara.
- [6] Culver, A., Feinberg, M., Klebenov, D., Musnikow, J., & Sutherland, L. (2002). Cleaning for Health: Products and Practices for a Safer Indoor Environment. INFORM, Inc.
- [7] Dugan, J., Airoidi, L., Chapman, M., Walker, S., & Schlacher, T. (2011). 8.02 Estuarine and Coastal Structures: Environmental Effects, A Focus on Shore and Nearshore Structures. in-Chief: Eric Wolanski, Donald McLusky (eds) Treatise on Estuarine and Coastal Science. Academic Press, Waltham, 17-41.
- [8] Espinoza, T., Geiger, C., & Everson, I. (2010). The Real Costs of Institutional "Green" Cleaning. From http://www.greenbusinessca.org/media/article_uploads/the_real_costs_of_green_cleaning_v6.pdf
- [9] H. Paul Barringer, P. E. (2003). A Life Cycle Cost Summary. Paper presented at the International Conference of Maintenance Societies (ICOMS®-2003).

- [10] Kapur, A., Baldwin, C., Swanson, M., Wilberforce, N., McClenachan, G., & Rentschler, M. (2012). Comparative life cycle assessment of conventional and Green Seal-compliant industrial and institutional cleaning products. *The International Journal of Life Cycle Assessment*, 17(4), 377-387. doi: 10.1007/s11367-011-0373-8
- [11] Kisch, S. (2013, February 12). *The Evolution of Green Cleaning*. BSCAI Services.
- [12] Larsson, H., Lindahl, M., & Svensson, N. (2009). Life cycle assessment of floor care - A comparative study of the Twister™ method and floor care methods using polish and wax. Environmental Technology and Management Department of Management and Engineering (IEI) Linköping University.
- [13] McMorrow. (2002). Nation's Businesses Find Improved Work Environment & Health with Green Cleaning. *Corporate and Institutional Facilities Market Trends & News*.
- [14] Meyer, R. (2010). Keen to be green 50 years of people, planet, and profits. From http://landor.com/pdfs/k9/RMeyer_KeenGreen_7June10.pdf
- [15] Nazaroff, W. W., & Weschler, C. J. (2004). Cleaning products and air fresheners: exposure to primary and secondary air pollutants. *Atmospheric Environment*, 38(18), 2841-2865. doi: 10.1016/j.atmosenv.2004.02.040
- [16] Segura, R. (2014). Highlighting The Importance Of Cleaning. 2015, from <http://www.cleanlink.com/hs/article/Highlighting-The-Importance-Of-Cleaning--16953#>
- [17] Steinemann, A. C., MacGregor, I. C., Gordon, S. M., Gallagher, L. G., Davis, A. L., Ribeiro, D. S., & Wallace, L. A. (2011). Fragranced consumer products: Chemicals emitted, ingredients unlisted. *Environmental Impact Assessment Review*, 31(3), 328-333. doi: 10.1016/j.eiar.2010.08.002
- [18] USDOE, D. o. E. (2008). *Reducing Phosphorous Pollution to Improve Water Quality*.
- [19] USEPA. (2001). EPA PILOT PROGRAM IDENTIFIES CLEANING CHEMICAL TOXINS.
- [20] William A. Rutala, P. D., M.P.H., David J. Weber, M. D., M.P.H., & (HICPAC), t. H. I. C. P. A. C. (2008). *Guideline for Disinfection and Sterilization in Healthcare Facilities*. 158.
- [21] Yanarella, E. J., Levine, R. S., & Lancaster, R. W. (2009). Research and Solutions: "Green" vs. Sustainability: From Semantics to Enlightenment. *Sustainability: The Journal of Record*, 2(5), 296-302. doi: 10.1089/sus.2009.9838
- [22] Young, G. (2013). Transcript of History of Green Cleaning - Eco Week 2014, from <https://prezi.com/dyv3ja-oftnf/history-of-green-cleaning-eco-week-2014/>