



SUSTAINABLE TECHNOLOGY AND ALTERNATIVE ENERGY SOURCES IN THE FOOD INDUSTRY

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Abstract: *Increasing population and living standards as well as the practice of engineering cause the consumption rate of materials to grow. Finding ways to use materials more efficiently is a prerequisite for a sustainable future. Design for environmental sustainability is the long-term view: from adaptation to a lifestyle that meets present needs without compromising the needs of future generations. Technology plays a very important role in sustainable development because it is one of the most significant ways in which we interact with our environment, we use technologies to extract natural resources, to modify them for human purposes, and to adapt our man-made living space. Sustainable agriculture and food production combines the goals of environmental and economic health and social equity. Sustainable technologies use less energy, fewer limited resources, do not deplete natural resources, do not directly or indirectly pollute the environment, and can be reused or recycled at the end of their useful life.*

Key Words: *environmental sustainability, sustainable development, sustainable technologies, food production.*

INTRODUCTION

The rapid increase of human activities since the industrial revolution caused that huge quantities of resources and energy have been consumed in relatively short time. That mass consumption and the large production has significant influences on the earth's ecology, exhausting non-renewable resources and causing some environmental problems by polluting the air, water and soil. The current pattern of unsustainable, inequitable and unstable asymmetric demographic and economic growth has forced many segments of society to come together in facing a critical challenge: *how can societies across the world meet their current basic human needs, aspirations and desires, without compromising the ability of future generations to meet their own needs?* The development path, in the past few centuries, has been ultimately detrimental to the health of our surrounding ecological context. We are consuming an increasing share of the natural resources available to us on this planet, and we are creating sufficiently

large amounts of waste and pollution such that the earth can no longer assimilate our wastes and recover from the negative impacts. This is a result of a growing population as well as new technologies which make it easier for us to access natural resources and also require the consumption of more resources [1].

Technology plays a very important role in sustainable development because it is one of the most significant ways in which we interact with our environment; we use technologies to extract natural resources, to modify them for human purposes, and to adapt our man-made living space. It is through use of technology that we have seen drastic improvements in the quality of life of many people. Unsustainable technology has been the result of linear rather than cyclic thinking. The paradigm shift from linear to cyclic thinking in technological design is the crux of the shift from unsustainability to sustainability. Sustainable development offers a new way of thinking which is connected with human requirements to improve our quality of life taking in account the limitations imposed on us by our global system. It requires unique solutions for improving our situation but without degrading the environment and the well-being of other people. Although there is no general agreement regarding the precise meaning of sustainability, most interpretations and definitions of the term "sustainable" refer to the viability of natural resources and ecosystems over time, and to the maintenance of human living standards and economic development [2].

The industrial engineering consumes of materials and is dependent on a continuous supply of them. Increasing population and living standards cause the consumption rate to grow - something it cannot do forever. Finding ways to use materials more efficiently is a prerequisite for a sustainable future. Recent global attention to the issues and challenges of sustainable development is forcing industries to conduct self-assessments to identify where they stand within the framework for sustainability, and more importantly, to identify opportunities, strategies and technologies that support achieving this goal. Design for environmental sustainability is the long-term view: that of adaptation to a lifestyle that meets present needs without compromising the needs of future generations. The time-scale is measured in decades or centuries and the adaptation required is much greater [3].

Sustainable engineering is the process of using energy and resources at a rate that does not compromise the natural environment, or the ability of future generations to meet their own needs [4]. This is the time where people try to reach sustainable development through to achieve zero landfill status, minimize storm water discharge and pollutant loadings into protected waters of the state, reduce energy consumption, and attempt to create self-supporting infrastructures. Considering the costs of energy, inefficiency of generating waste, the sustainable development is something for what in the future will need to focus on. Many of the critical environmental problems we face today are related to water, energy food security and waste. These involve low tech solutions which are available now and can be applied immediately; information on these technologies can be distributed broadly using electronic networks.

SUSTAINABLE TECHNOLOGY AND NATURAL ENVIRONMENT

There are a lot of possibilities to reduce the environmental burden of industrial production exist. For example, optimization of the environmental performance through good housekeeping, total quality management, application of end-of-pipe techniques, recycling of wastes, non-renewable products substitution or adaptation clean technological innovations. Clean technology is the most important factor for economic growth of industries and it seems to play a main role not only in the idea of cleaner production, but also in sustainable development. The development of clean technology seems to be the main factor of company's strategy. Each companies, which want to reach the competitive position on the market and want to be environmental friendly should compile the strategy of technology. The risk of initiation a strategy of technology may be limited across accumulating, processing and using in decision making process information about techniques, products, machines, capital and human resources and environmental parameters. The basic actions of preparation of technology's strategy contains a recognition of all using technologies in company and an identification of all components of technology, which are being with object of scientific investigations. Analyzing of all components of technology is very important. It helps in the selection of suitable techniques of production, which should guarantee established productivity, quality of realized processes and allows to manufacture ecological products. The initiation of the new technology is very expensive process, however in long period of time, technology is one of main factors, which influences on quality of products. The better quality of products causes not only the growth of competitiveness, but what is more, it influences on the productivity of process, as a result that the modern technologies influence on shortening the duration of the production cycle and increasing the number of products. The rate of technology innovation depends on modernity of technology and it can be improves by the transfer new kinds of technologies, which is developed in recent years. In practice, a technology and realization of technological processes is in exact relationship from elements of working and natural environments. Steering of technological processes cannot be realized without consideration of all settings in company processes and external environment [5].

Because of the fact that the process technologies should be carried out from a cleaner production point of view, the development of sustainable technology should be based on the general cleaner production aims. The technological process, which based on clean technology should tend to reducing or minimizing the amount of:

- resources consumed;
- waste and emissions generated;
- the hazards of the waste and emissions generated (mainly by usage substitution of input materials);
- the risk of accident or malfunction.

Cleaner production is defined as the continuous application of an integrated preventative environmental strategy to processes and products to reduce risks to humans and the environment. For production process, cleaner production includes conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and

- The trend of global economic development is toward an increasing global interdependence in food and energy; markets for food are global, making it routine for food commodities to be transported large distances relative to where they were grown.
- Lack of money coupled with high population density encourages exploitation of land and increases pressure to produce exports, thereby creating unsustainable conditions.

Sustainable farming practices also view the land as a system, incorporating soil type, climate, invasive species and other pests, topography, and climate into an understanding that allows site-specific decision that are the best fit. The following general principles can be used as a guide when selecting appropriate management practices.

- The selection of species and varieties well suited to a farm site will match crops to soil and foster better growth and pest resistance.
- The diversification of crops (including livestock) and cultural practices to enhance the biological and economic stability make the system-diversified farm ecologically resilient and support more biodiversity. Optimal levels of diversity may be achieved by integrating crops and livestock.
- Soil management to enhance and protect its quality recognizes soils as living systems; a healthy soil is the key to productivity over the long term.
- For the efficient and humane use of inputs in moving to sustainable farming practices, it is not enough to substitute a synthetic product for a natural one. It also means substituting a more complete scientific understanding for those synthetic or conventional inputs.

Some resources which are used, by definition are unsustainable and our dependence on fossil fuels is a good example. Fossil fuels are the predominant energy source for humans, and their use has increased exponentially over the past 60 years. Fossil fuels (petroleum, coal, and natural gas) are finite resources, no longer being created by natural processes at a rate that would render them usable by humans.

With innovation, it is possible to substitute one resource for another and, in many cases, to develop entirely new ways to meet our needs. The use of timber for fuel was changed by coal and oil about 150 years ago, and in the last two generations the nuclear energy capability was developed. These fuel sources, however, have heavy waste output, and the effects of pollution on humans and ecosystems have almost never been included in the equations of profit.

Research on renewable energy is expanding rapidly and productively.

Renewable energy is energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished).

toxicity of all wastes. Successful application of cleaner production in companies depends on property management, maintenance, adequate infrastructure and training of people [4,5,6].

The minimization of waste and emissions and reductions in material and energy inputs are the most important environmental aims. Sustainable technological development and innovations do not automatically lead to total reduction of environmental burden of industrial production. However, technological innovation is an important factor and seems to play a central role in the long-term initiation of cleaner production.

FOOD PRODUCTION AND RENEWABLE ENERGY

Large areas of land worldwide have been converted for agricultural production. The increasing use of technology, fuels, and chemicals has dramatically increased crop production, but has also created the chronic agricultural impacts. Sustainable agricultural combines the goals of environmental, economic and social equity. In order to ensure sustainable productivity of food, these are some basic set of objectives and approaches for achieving sustainability [7,8]:

- Land remains the paramount resource base for all societies and is one of the universal forms of wealth. The cultural landscape that develops in any location strongly reflects the character and quality of this land.
- Land and quality soils are a finite resource; the overuse of soils is a long-term form of degradation, and recovery takes long time periods. No matter what the circumstance, land will continue to provide the primary base from which human sustenance is derived.
- The prime agricultural lands have already been developed in virtually all countries. The recent rate of land conversion has been intense; more land has been converted to cropland since 1945 than in the eighteenth and nineteenth centuries combined. The remaining land may support agriculture, but will not be as productive.
- The development of additional lands for agricultural purposes will require substantial investments to increase soil fertility, make water available, drain excess water, irrigate, and control erosion.
- Climate change will, in ways unknown, change the extent and distribution of land suitable for agricultural production, requiring shifting patterns of crop production.
- Traditional agricultural systems, some of which were sustainable, are disappearing.
- Non-fossil-fuel inputs (e.g. water, phosphorus) for industrial agriculture are also finite and should be managed with care.

Most recently, the prospect of solar and wind energy, both renewable, promise for energy with minimal pollution. Geothermal and tidal energy are also potentially infinite and non-polluting. However, as long as traditional fuel resources remain profitable, there is little hope for a rapid conversion to cleaner or renewable fuel sources.

Biomass, a renewable energy source, is biological material from living, or recently living organisms, such as wood, waste, (hydrogen) gas, and alcohol fuels. Biomass is commonly plant matter grown to generate electricity or produce heat. In this sense, living biomass can also be included, as plants can also generate electricity while still alive. The most conventional way in which biomass is used, however, still relies on direct incineration. Forest residues, for example (such as dead trees, branches and tree stumps), yard clippings, wood chips and garbage are often used for this. However, biomass also includes plant or animal matter used for production of fibers or chemicals. Biomass may also include biodegradable wastes that can be burnt as fuel. It excludes such organic materials as fossil fuels, which have been transformed by geological processes into substances such as coal or petroleum. Industrial biomass can be grown from numerous types of plants, including hemp, corn, poplar, willow, sugarcane and a variety of tree species, ranging from eucalyptus to oil palm (palm oil). The particular plant used is usually not important to the end products, but it does affect the processing of the raw material. Although fossil fuels have their origin in ancient biomass, they are not considered biomass by the generally accepted definition because they contain carbon that has been "out" of the carbon cycle for a very long time. Their combustion therefore disturbs the carbon dioxide content in the atmosphere. Biochemical conversion makes use of the enzymes of bacteria and other micro-organisms to break down biomass. In most cases micro-organisms are used to perform the conversion process: anaerobic digestion, fermentation and composting. Other chemical processes such as converting straight and waste vegetable oils into biodiesel are trans esterification. Another way of breaking down biomass is by breaking down the carbohydrates and simple sugars to make alcohol. However, this process has not been perfected yet. Scientists are still researching the effects of converting biomass.

Using biomass as a fuel produces air pollution in the form of carbon monoxide, NO_x (nitrogen oxides), VOCs (volatile organic compounds), particulates and other pollutants, in some cases at levels above those from traditional fuel sources such as coal or natural gas. Black carbon - a pollutant created by incomplete combustion of fossil fuels, biofuels, and biomass - is possibly the second largest contributor to global warming.

On combustion, the carbon from biomass is released into the atmosphere as carbon dioxide (CO₂). The amount of carbon stored in dry wood is approximately 50% by weight. When from agricultural sources, plant matter used as a fuel can be replaced by planting for new growth. When the biomass is from forests, the time to recapture the carbon stored is generally longer.

Biofuels are a wide range of fuels which are in some way derived from biomass. The term covers solid biomass, liquid fuels and various biogases. Biofuels are gaining increased public and scientific attention, driven by factors such as oil price spikes, the

need for increased energy security, concern over greenhouse gas emissions from fossil fuels, and government subsidies.

Liquid biofuel is usually either bioalcohol such as bioethanol or oil such as biodiesel. Bioethanol is an alcohol made by fermenting the sugar components of plant materials and it is made mostly from sugar and starch crops. With advanced technology being developed, cellulosic biomass, such as trees and grasses, are also used as feedstocks for ethanol production. Ethanol can be used as a fuel for vehicles in its pure form, but it is usually used as a gasoline additive to increase octane and improve vehicle emissions [9].

Biodiesel is made from vegetable oils, animal fats or recycled greases. Biodiesel can be used as a fuel for vehicles in its pure form, but it is usually used as a diesel additive to reduce levels of particulates, carbon monoxide, and hydrocarbons from diesel-powered vehicles. Biodiesel is produced from oils or fats using transesterification and is the most common biofuel in Europe.

CONCLUSION

The minimization of waste and emissions and reductions in material and energy inputs are the most important environmental aims. Sustainable technological development and innovations do not automatically lead to total reduction of environmental burden of industrial production. However, technological innovation is an important factor and seems to play a central role in the long-term initiation of cleaner production.

Sustainable development and idea of cleaner production is a central target in environmental science and plays a key role in the growth of global economies. Therefore, modern industrial and manufacturing food companies should apply technologies designed to minimize pollution and use of finite resources. These technologies tend to improve the global environment and humans life.

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ODRŽIVE TEHNOLOGIJE I ALTERNATIVNI IZVORI ENERGIJE U PREHRAMBENOJ INDUSTRIJI

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Sažetak: Prehrambena industrija u praksi koristi velike količine materijalnih dobara pa je ovisna od kontinuiteta snabdevanja tim dobrima. Održive tehnologije u prehrambenoj industriji uključuju procese i sisteme u korištenju sirovina, materijala, uređaja i tehnika koje omogućavaju zaštitu od zagađenja životne sredine.

U ovom radu dat je kratak pregled širokog spektra tehnoloških pitanja na industrijskom nivou, uz naglašavanje potrebe za integrisanim pristupom i razumevanjem različitih komponenti održivog sistema u prehrambenoj industriji. Održive tehnologije u prehrambenoj industriji baziraju se na konceptu korištenja manje energije, bez iscrpljivanja prirodnih resursa, a da direktno ili indirektno ne zagađuju životnu sredinu. Prema konceptu tehnološke održivosti, materijalna dobra treba da se mogu ponovo koristiti ili recikliraju na kraju njihovog korisnog vijeka trajanja.

Eko-efikasnost resursa u industriji hrane zahtijeva korištenje obnovljivih izvora energije, a u cilju samnjenja korištenje foslnih izvora. U tu svrhu posebno su pogodne solarna energija, energija vjetra, geotermalna energija te enrgija iz biogoriva koji se dobija iz otpada prehrambene industrije. Za sada takvi sistemi često imaju visoke kapitalne troškove. Međutim, projektovanje ekološke održivosti je dugoročna vizija koja treba da se prilagođava životnom stilu, uz zadovoljavanje potreba sadašnjih i bez ugrožavanja potreba budućih generacija. Tehnološki razvoj će biti održiv, ako uzima u obzir socijalne, ekološke kao i ekonomske faktore.

Održiva poljoprivreda i proizvodnja hrane kombinuju ciljeve zaštite životne sredine, ekonomske održivosti kao i socijalne jednakosti.

Ključne riječi: održiva tehnologija, energija, prehrambena industrija