

## Chapter 28

# Building a Sustainable Regional Eco System for Green Technologies: Case of Cellulosic Ethanol in Oregon

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### **ABSTRACT**

*Increasing gasoline prices, concerns about energy security, and the effect of greenhouse gases on global warming are driving demand for alternative fuels such as ethanol and biodiesel. In the United States, corn is the major source of fuel ethanol, but there are disadvantages to using crops for fuel, including increasing costs and competition with food sources. Cellulosic biomass, including agricultural waste, forestry residues, and municipal waste, offers several potential advantages as a source of ethanol, and a great deal of effort is going into the development of processes capable of converting these feedstocks into fuel.*

*This chapter begins with a brief overview of the environmental and policy drivers for cellulosic ethanol, and a description of the basic technology behind it. It then outlines a simple methodology for selecting the three primary components of a sustainable supply chain in the Pacific Northwest: feedstock, process, and distribution method. Using a weighted rating scale, the authors evaluate the alternatives for feedstocks, conversion processes, and distribution methods, and make some recommendations for an Oregon-based facility. These results are compared with the approach chosen by a new cellulosic ethanol startup, Pacific Ethanol, currently under construction in Boardman, Oregon. Although Pacific Ethanol's choices help confirm the model, the model also provides valuable information for other potential ethanol production companies based in the Pacific Northwest.*

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## **BACKGROUND / LITERATURE REVIEW**

### **Environmental Issues**

Many researchers have found that non-renewable energy resources, such as oil and natural gas, are nearing depletion due to increasing human use. The most valuable non-renewable source of energy is fossil fuels. Its price affects the entire global economy due to production instability and lack of consistent oil pricing. By comparison, renewable energy resources are able to support human energy needs without depletion. Although renewable energy resources are currently unable to completely displace all of our non-renewable energy use, many scientists are making advancements in renewable energy technology. It can be hoped that in time, science will enable the complete substitution of non-renewable energy resources for fossil fuels (McKinney and Schoch, 2003).

Fossil fuels are created by the decomposition of living organisms. These can be separated into three types: coal, natural gas and oil. Coal is a solid fossil fuel created by the decomposition of land vegetation. When compared with other fossil fuels, coal is quite abundant and easily recovered in many locations. Many developing countries depend on coal for energy because they cannot afford other fossil fuels. India and China are the main consumers of coal.

Natural gas is a vaporous fossil fuel that is abundant, useful and relatively clean compared to other fossil fuels. It is formed from the remains of marine microorganisms. Natural gas is used in many developed countries. Oil, a liquid fossil fuel, is the most widely used and valuable fossil fuel. It is also created from the remains of marine microorganisms deposited on the sea floor. Crude oil is refined and used for fuel in cars and other forms of transportation. Oil is not available everywhere on earth, but is found only in specific areas. Consequently, it is a powerful energy source that influences the world economy

through fluctuations in price, supply and demand (BBC Weather Centre, n.d.).

Energy is extracted through the process of burning fossil fuel (combustion) and then converted to other forms of the energy such as heat and electricity. Carbon (C) and Hydrogen (H) react during the combustion process to form Carbon Dioxide (CO<sub>2</sub>). Heat is released during this process. The release of CO<sub>2</sub> and heat into the atmosphere is a major contributor to the Greenhouse effect and global climate change, both of which are now an increasing concern throughout the world.

### **What is the Greenhouse Effect?**

The sun heats the earth by radiating solar rays. Some of these rays are absorbed by greenhouse gases, such as CO<sub>2</sub>, that are created by burning fossil fuel. These greenhouse gases cause the earth's temperature to rise, causing global climate change. Effects include increases in the average air and ocean temperatures, widespread melting of polar icecaps, and a rising sea level. The heating effect caused by the production of too many greenhouse gases, is known as "Global Warming." (BBC Weather Centre, n.d.) (Intergovernmental Panel of Climate Change, n.d.).

Consequently, the burning of fossil fuels is one of the most critical problems the world is currently facing. In the United States, more than 90% of greenhouse gas emissions come from the burning of fossil fuels. This is one of the major reasons for supporting the use of renewable alternative energy sources, such as cellulosic ethanol. Research shows that ethanol burns cleaner and produces less carbon dioxide (CO<sub>2</sub>) than gasoline. M. LaMonica in the NRDC study states that "making ethanol from the cellulose in agricultural and forestry waste produces less greenhouse gases than consuming gasoline from refining." (Wikipedia, 2008a). According to this study, ethanol can reduce the greenhouse gas emissions between twenty and eighty percent depending on the feedstock used to produce it.

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