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Cleaner bioprocesses for promoting zero-emission biofuels production in Vojvodina

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ABSTRACT

In this study, the policy, market conditions and food security of biomass energy sources are assessed for supplying the future needs of Vojvodina. The Autonomous Province of Vojvodina is an autonomous province in Serbia, containing about 27% of its total population according to the 2002 Census. It is located in the northern part of the country, in the Pannonia plain, in southeastern Europe. Vojvodina is an energy-deficient province. The incentives to invest human and financial resources in the research and development of cleaner bioprocesses are high, considering the benefits which might be achieved in terms of environment protection and manufacturing costs. In the near and medium tenu, the development of bioprocesses for waste recycling and resource recovery might be one of the most viable options, considering much research work has already been done. In Vojvodina, there are technological solutions that biofuels produced in a closed cycle, so that the quantity of waste reduced to a minimum. These solutions include the stillage (remainder after distillation) used for fattening cattle, and cattle excrement to produce biogas and manure as fertilizer. The energy required for the production of bioethanol is obtained combustion lignocelullose residual waste from the production of basic raw materials starch, or biogas. Ash from the burned biomass returned to soil as a source of minerals for plants and replacement of mineral fertilizer. Such a closed cycle is economical for small farms in Vojvodina.

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1. Introduction

The Autonomous Province of Vojvodina is an autonomous province in Serbia, containing about 27% of its total population according to the 2002 Census. It is located in the northern part of the country, in the Pannonia plain. Vojvodina is an energy-deficient province. The indigenous reserves of oil and gas are limited and the country is heavily dependent on the import of oil. The oil import bill is a serious strain on the country's economy and has been deteriorating the balance of payment situation. The country has become increasingly more dependent on fossil fuels and its energetic security hangs on the fragile supply of imported oil that is subject to disruptions and price volatility [1–4]. Hydropower, biomass, biogas, biofuels, wind power, solar energy and geothermal energy are the major resources to provide Vojvodina with most of its renewable energy in the future [5–9].

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Proponents of biotechnology claim that it offers a wide range of environmental benefits. In the most extreme case this could mean the development of the perfect crop: seeds that require reduced or nil pesticides or herbicides; reduced water and soil, and produce crops with higher nutritional benefits which, in some cases, ripen just in time to be bought to reduce wastage. Indeed, this appears to be a perfect example of a cleaner production application [10]. On the other hand, biotechnology opponents claim that it will:

- Decrease gene pools making diseases more devastating;
- Facilitate the transfer of genetically modified genes to wild species which could radically damage ecosystems;
- Lead to a general dependence on capital and technology intensive agricultural systems.

The concept of "cleaner technology" has been defined by the Organisation for Economic Cooperation and Development (OECD) as: "...technologies that extract and use natural resources as efficiently as possible; that generate products with reduced or no potentially harmful components in all stages of their lives; that minimize releases to air, water and soil during fabrication and use of the product; that produce durable products which can be recovered or recycled as far as possible; and are energy efficient." [11].

What the technology will eventually offer lies somewhere between these two extremes. We begin this report with a brief discussion of the cleaner production approach.

2. The cleaner production approach

The traditional approach to environmental management has been reactive pollution control approaches, while progressive companies have recently adopted proactive pollution prevention strategies. Preventative strategies include Industrial Ecology, Ecologically Conscious Management, Life Cycle Analysis, Design for the Environment, Dematerialization, Design for Efficient Longevity, and Sustainable Product Development among others [10].

A main objective of proactive strategies is the development of clean technologies, defined by The Commission of the European Communities as "any technical measures taken at various industries to reduce or even eliminate at source the production of any nuisance, pollution or waste, and to help save raw materials, natural resources and energy". The more philosophical cleaner production approach is defined by Huisingh to be "An ongoing process involving technical as well as attitudinal, motivational and other non-technical factors that are essential for corporations to benefit from the preventative approach." Baas et al. argue that cleaner production is philosophically and methodologically grounded, stating that it is: "The conceptual and procedural approach to production that demands that all phases of the life-cycle of a product or of a process should be addressed with the objective of prevention or the minimization of short and long term risks to humans and the environment" [10].

Ultimately the objective of proactive approaches is to achieve sustainable production capabilities, where (for the purpose of this discussion) environmental and economic systems are in balance. Baas states that cleaner production is an effective approach to understanding the "best ways of fostering the development of a paradigm shift toward sustainable production and service organizations and products". As such, it could be argued that biotechnology offers cleaner production opportunities if environmental implications are considered, which in turn can lead to more sustainable forms of production. However, it will be shown that this is very much dependent upon the technological trajectory followed. A number of authors claim that environmental issues are becoming increasingly important in the decision making process of firms [10]. This is generally influenced by pressures from customers, environmental activists, shareholders, government regulatory agencies and community groups. We argue that environmental issues are especially relevant for agricultural biotechnology firms, as they can potentially offer both environmental risks and benefits.

3. Cleaner bioprocesses

Two of the premises of sustainable development are that economic growth has to be in harmony with the environment and that a rational and sustainable use of natural resources has to be implemented. In congruence with such premises, industrial development has to change from the degradative to the sustainable style. To meet such a purpose, adoption of cleaner production systems is essential.

The United Nations Environment Programme (UNEP) defines the cleaner production concept as "the continuous application of an integrated preventive environmental strategy to processes, products and services to increase eco-efficiency and reduce risks to humans and the environment". One of its distinctive features is that reduction of the quantity and toxicity of all emissions and wastes is made before they leave the process stream. Also, the entire life cycle of the product, from raw material extraction to the ultimate disposal of the product, is evaluated to reduce negative impacts. In the case of services, environmental concerns should be incorporated into design and delivery.

Eco-efficiency is a concept promoted by the Business Council for Sustainable Development. It involves "the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life while progressively reducing ecological impacts and resource intensity, throughout the life cycle, to a level at least in line with the Earth's estimated capacity".

The cleaner production strategy may be implemented through a sequential path (Fig. 1) according to the specific needs and availability of funds, always within an integrated approach.

It is clear that adoption of clean production systems by industries calls for fundamental changes, not only at the technological level but also at the legislational level. Innovation and adoption of clean technologies should be a paramount target of research and development groups world-wide. Accordingly, new incentives and policies should be promoted in the near future [12].

Although new regulation systems will be required to accelerate the adoption of cleaner technologies, the striking feature of this movement is that industries are expected to adopt them

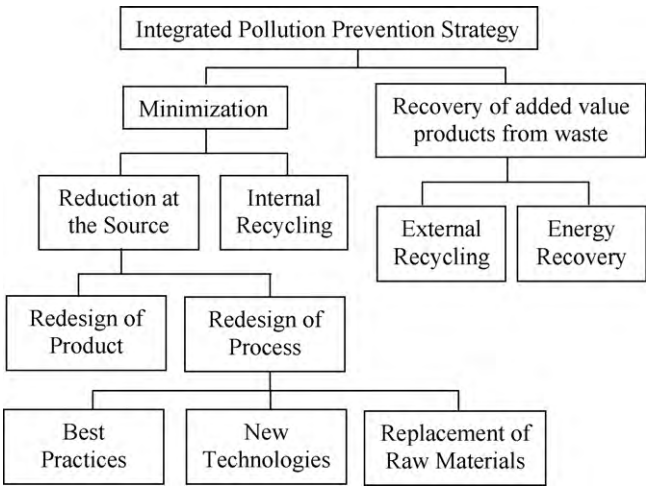

Fig. 1. Different actions for the implementation of the cleaner production strategy.