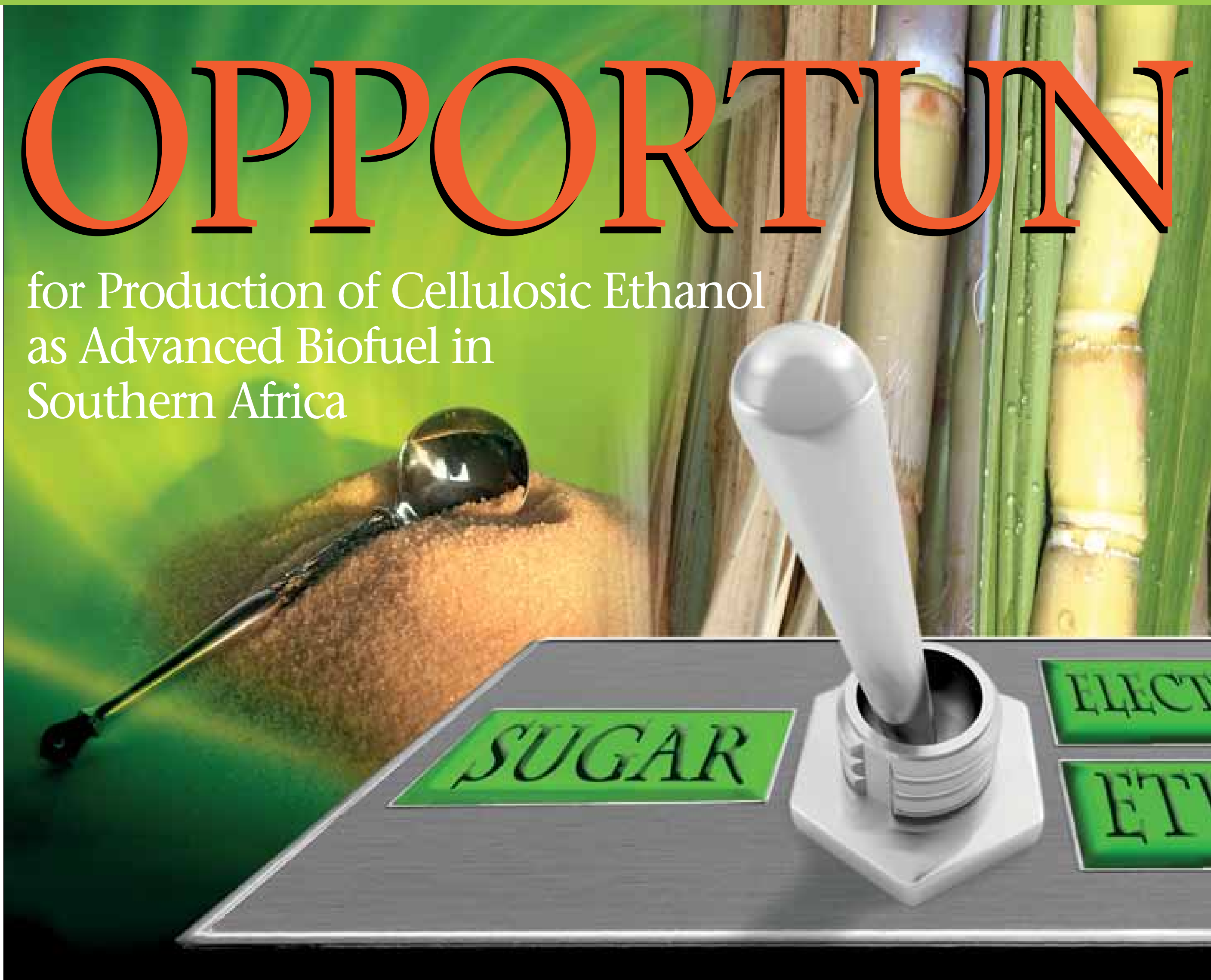
OPPORTUN

for Production of Cellulosic Ethanol as Advanced Biofuel in Southern Africa



CELLULOSIC ETHANOL IS WIDELY CONSIDERED AS ONE OF THE LEADING CONTENDERS FOR A PLACE IN A SUSTAINABLE FUEL POOL FOR FUTURE TRANSPORT. WELL-ESTABLISHED TECHNOLOGIES FOR THE USE OF ETHANOL IN GASOLINE VEHICLES AND BUS TRANSPORT ARE IN USE WORLD-WIDE, WHILE CONVERSION OF ETHANOL TO AVIATION FUEL IS UNDER CONSIDERATION FOR THE GLOBAL ROLL-OUT OF BIOFUELS IN THIS INDUSTRY.

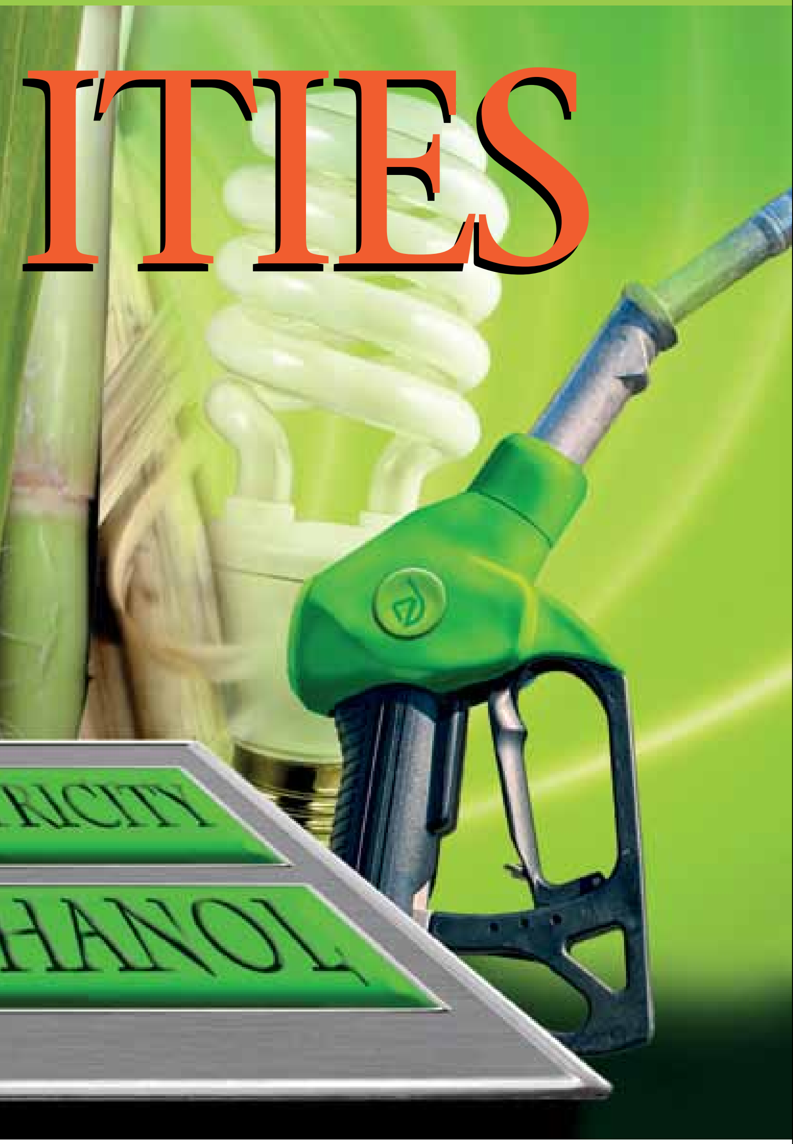
The production of cellulosic ethanol in Southern Africa should preferably be done with "waste" or residual plant biomass, to ensure sustainability of feedstock supply. Lignocellulosic (fibrous) plant biomasses are available from existing agricultural, forestry and biomass processing activities, as per the following examples:

1. Paper sludge and xylose-rich waste streams from pulp mills, paper mills and paper recycling operations. These streams are presently disposed as wastes, often to landfill, although they represent technically and economically viable opportunities for ethanol production.

2. Plant biomass presently disposed of by fires, such as burning of sugarcane prior to harvest, burning of maize residues after harvesting, in-field burning of invasive plants from clearing operations, and burning of grasslands based on traditional practice.

3. Agricultural residues that are presently under-utilised, e.g. harvesting residues from sugarcane left in the field.

4. Green waste components in municipal solid waste, presently disposed of by landfill.



Some estimates have indicated that the total production of agricultural residues in South Africa, including sugarcane bagasse residues, is in the region of 20 million (dry) tons per year, of which up to 4.2-6.7 million tons per year could be available for conversion to bio-energy products such as bio-ethanol (Potgieter, 2012). The Energy Research Centre (ERC, 2007) in Cape Town estimates that about 21 Mt of grasses are burned annually. In 2005, the organic fraction of municipal solid waste alone amounts to about 3.6 Mt (Greben and Oelofse, 2009).

Technologies for the production of cellulosic ethanol are being implemented on commercial scale already. Beta-Renewables produces 40 000 tons per year of cellulosic ethanol, primarily from wheat straw, in their Crescentino (Italy) plant using hydrolysis-fermentation technology (www.codexis.com). INEOS Bio employs a gasification-fermentation process for commercial-scale production of cellulosic ethanol in Vero Beach, Florida (USA) (www.ineos.com). South African researchers at Stellenbosch University contributed to the development of the Consolidated Bioprocessing (CBP) technology of Mascoma Corp (USA), for the production of cellulosic ethanol. This technology has been demonstrated at semi-commercial scale, and is ready for application to several of the proposed opportunities/feedstocks (www.mascoma.com). Further details on the progress towards commercialisation of second generation cellulosic ethanol are available at www.biofuelsdigest.com.

Commercial potential of cellulosic ethanol production from the proposed feedstocks could be maximised by integration of such processes into existing industrial facilities, and/or co-production of ethanol with electricity. Integration of cellulosic ethanol into existing biomass processing and/or fermentation processes will minimise the production costs of this biofuel, while also maximising environmental benefits through energy-balance integration (Van Zyl et al., 2011).

In particular, co-production of ethanol and electricity from lignocellulose will provide economic benefits compared to electricity production alone.

Production of cellulosic ethanol is always associated with co-production of electricity as secondary energy product, to maximise energy efficiency and economics. In particular, co-production of ethanol and electricity from lignocellulose will provide economic benefits compared to electricity production alone. Ethanol can be co-produced as a secondary energy product with electricity from lignocellulose, with potential for similar or improved economic attractiveness, at present prices for renewable electricity and bio-ethanol. Co-production of ethanol with electricity at large scale did not increase the capital investment required, while significantly improving the internal rate of return on capital, from 24 to 39% (see Table 1). Several industrial yeast technologies have been developed for the conversion of xylose-components of lignocellulose into ethanol, including Lesaffre, Mascoma, Terranol and Taurus. Integration/combination of ethanol production from xylose with existing molasses-based ethanol production would provide further economic/efficiency benefits, compared to the scenarios below, and also address the shortage in molasses supply experienced by local distilleries.

Table 1: Co-production of xylose-ethanol and electricity from a combined stream of sugarcane bagasse and trash at 530 000 dry tons per year.

ENERGY PRODUCTION OPTION	TOTAL INVESTED CAPITAL (US$ MILLIONS)	INTERNAL RATE OF RETURN (IRR)
Electricity Production Only Via Direct Combustion with Combined Cycles	234.5	24%
Electricity Production Only Via Biomass Integrated Gasification and Combined Cycles	301.3	29%
Co-production of Xylose-Ethanol with Electricity	241.2	39%

The co-production of electricity and ethanol, as two diverse energy products in a single facility, will minimise future economic risk compared to electricity production alone, considering the short-term discrepancy in price premiums for electrical green power compared to biofuels, due to present electricity crisis in South Africa. More balanced pricing in the use of the available biomass resources for energy (fuels and electricity) production should be anticipated in long-term planning of energy production.

Cellulosic ethanol is rapidly expanding its commercial footprint, and warrants consideration as a contributor to a renewable and sustainable energy mix for Southern Africa, especially considering the availability of lignocellulosic residues and opportunities for co-production of electricity and ethanol from available feedstocks.

References

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