Integrating bioenergy into a green economy: identifying opportunities and constraints

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BACKGROUND

Bioenergy is a renewable energy option that has the potential to contribute to a low-carbon development path and stimulate a green economy. However, since bioenergy uses land and natural resources, it is in competition with the valuable bio-based products that can be produced from biomass. These complex opportunities and constraints create difficult and complex decision-making that requires integrated approaches to limit trade-offs and support a sustainable development path.

OPPORTUNITIES AND CONSTRAINTS

Bioenergy is renewable energy generated from biological sources and used for heat, electricity or engine fuels. It has the potential to contribute to a green economy and sustainable development by:

- Contributing to a less carbon-intensive development path, since bioenergy often has a far lower carbon impact than the use of fossil fuels
- Diversifying energy supply to increase capacity and improve energy security
- Stimulating the growth of rural areas through the development of new agricultural crops and products. The use of bioenergy can generate up to two orders of magnitude more jobs than the use of fossil fuel
- Reducing foreign exchange expenditure on importing fuels.

However, there are several constraints of bioenergy development:

- The limited amount of agriculturally productive land may result in the subsequent expansion into natural areas (direct and indirect land use changes) for bioenergy production with subsequent impacts on biodiversity, water availability and soil fertility
- Market competition for agricultural products that could be used for bioenergy, i.e. food, feed, timber, fibres or chemicals could result in shortages or price increases of these commodities
- South Africa has very limited land with agricultural potential, which could lead to land use competition between biofuel crops and food, fodder or fibre crops
- Potential for short- to medium-term negative carbon impacts due to carbon release from direct or indirect land use change.

The CSIR has been involved in a number of projects attempting to understand the opportunities and constraints for biofuels, as well as the likely trade-offs. These include:

- Assessing the feasibility to supply Eskom with wood-based fuels for co-firing with coal
- Involvement in the European Union-funded Re-impact project that developed a set of tools to assist policy makers in assessing the viability of biofuel projects
- Involvement in the European Union-funded project 'Bioenergy, sustainability and trade-offs – can we avoid deforestation whilst promoting biofuels?'
- A national level assessment for the International Energy Agency to assess the potential of second generation bioenergy feedstocks in South Africa
- The development of a framework and decision-support tools to assist with analysing the complex trade-offs and decision-making of bioenergy projects, programmes and policies
- Assessing the opportunities for bioenergy from invasive alien plants
- Providing bioenergy policy recommendations and guidance at municipal and provincial level (North West Province and Tshwane Metropolitan Municipality).

BIOMASS RESOURCES IN SOUTH AFRICA

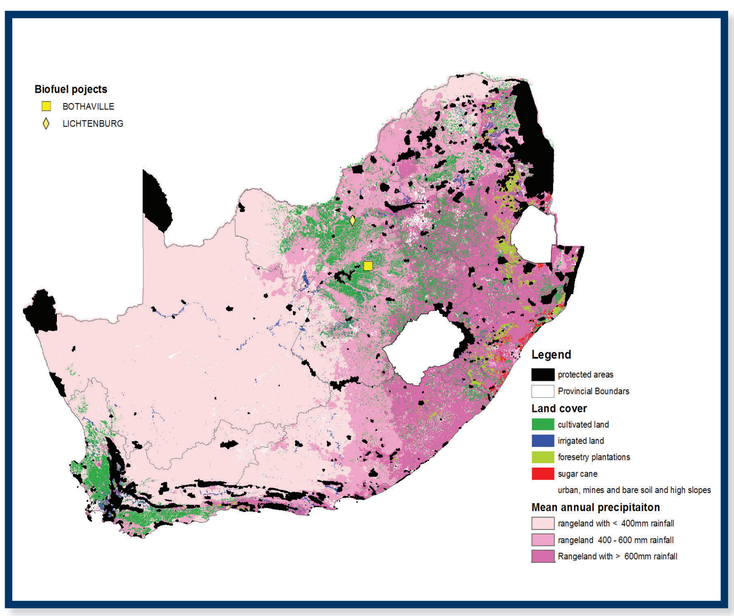


Figure 1: Agriculture, forestry and sugar cane plantations in the country. These industries generate substantive amounts of waste biomass that can be used for bioenergy purposes (Based on Von Maltitz & Van der Merwe, 2009)

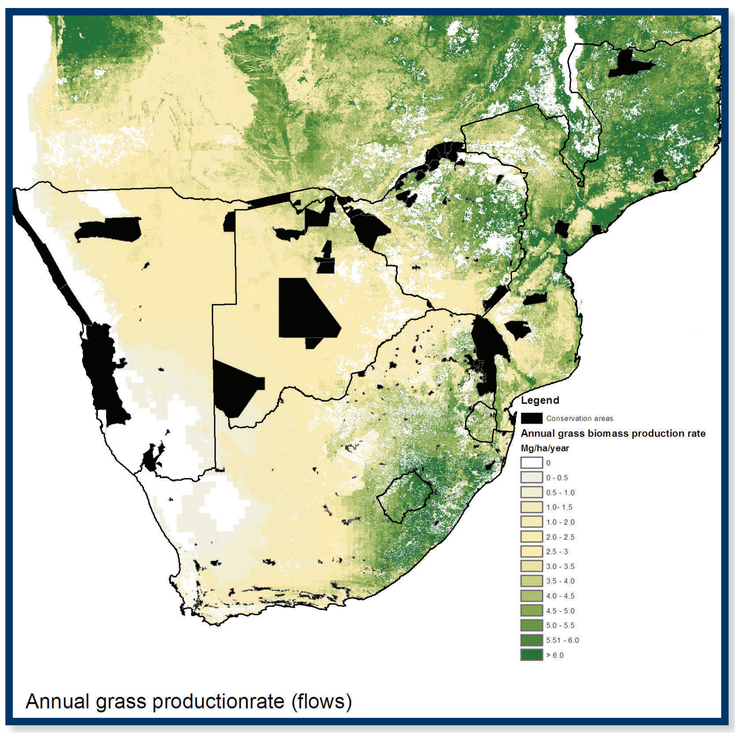


Figure 2: Indigenous grasslands could potentially provide a substantive biomass resource, but the biodiversity impacts would need to be carefully considered (Based on Scholes, Archibald & Von Maltitz, 2011)

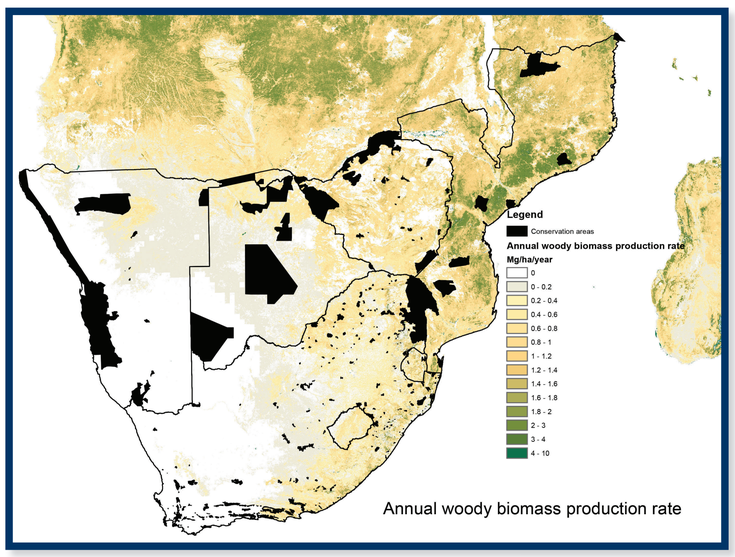
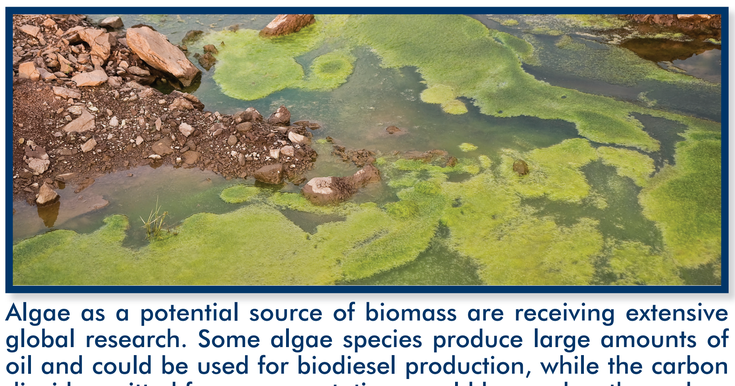


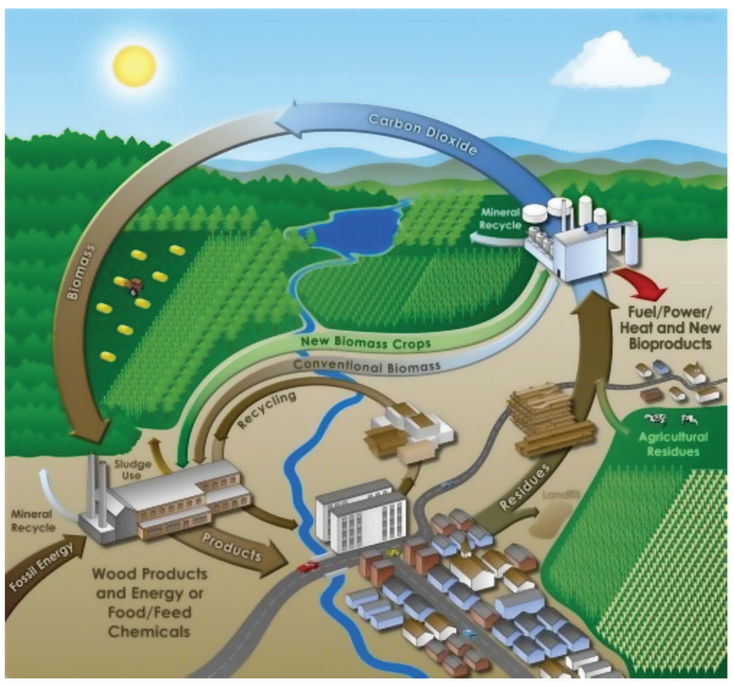
Figure 3: Wood from indigenous forests and woodlands could be sustainably harvested for bioenergy. However, a large portion of this resource is already used by communities for firewood, timber and medicines (Based on Scholes, Archibald & Von Maltitz, 2011)



Algae as a potential source of biomass are receiving extensive global research. Some algae species produce large amounts of oil and could be used for biodiesel production, while the carbon dioxide emitted from power stations could be used as the carbon source for algae production

Municipal organic wastes and wastewater have substantive energy producing potential and would help reduce waste disposal problems and costs

The CSIR has developed an analytical framework and decision-support tools to assist in assessing, managing and monitoring the sustainability of bioenergy.



Courtesy of ORNL at http://bioenergy.ornl.gov/papers/misc/bioenergy_cycle.html

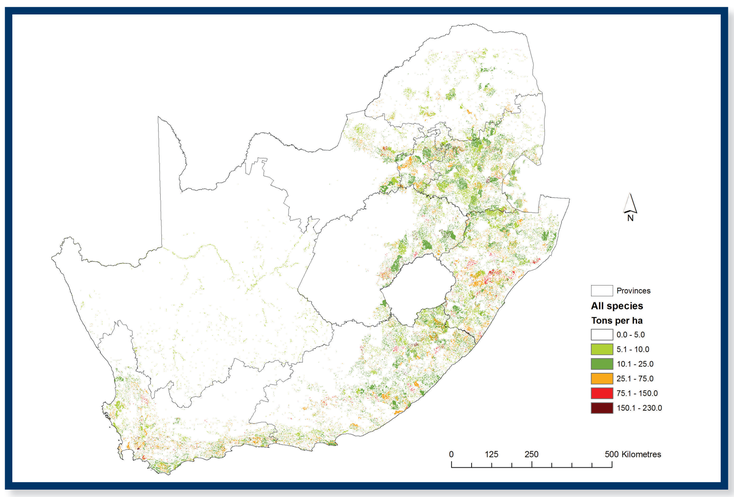


Figure 4: The biomass of invasive alien plants which are currently being cleared through the Working for Water programme, could be used for energy generation

DECIDING ON THE MOST APPROPRIATE BIOENERGY TECHNOLOGY OPTION

The wide range of bioenergy feed stocks and technology options available, and the social, economic and environmental consequences of bioenergy, means that there are difficult and complex decisions to be made when considering a bioenergy programme. The CSIR has developed an analytical framework and decision-support tools to assist in assessing, managing and monitoring the sustainability of bioenergy.

IMPROVING THE SUSTAINABILITY OF BIOENERGY THROUGH INTEGRATION WITH OTHER BIO-BASED PRODUCTS

Since bioenergy production competes with land, water and other agricultural inputs, a systems thinking approach can be used to integrate the use of biomass for bioenergy with other bio-based products (fuel, food, fibre, fodder, feed, materials and chemicals).

This includes process integration through industrial ecology and industrial symbiosis. A change from linear, isolated systems to linked, circular systems – i.e. one process' waste becomes a resource for another.

BIO-REFINERY DEVELOPMENT FOR A BIO-BASED ECONOMY

A systems perspective assesses the various bio-based production systems and valuable products, and integrates bioenergy into a bio-based green economy. This approach serves as a model for bio-refineries that produce a range of valuable products (including bioenergy) from bio-based resources.

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