SA Bioenergy Atlas

South Africa's first biomass atlas plots SA's resources

The conversion of organic waste in urban areas to biogas is price-competitive

Biomass from farming is one of the sources of energy that are being considered for South Africa. Photo courtesy DST

Biomass digesters can turn plant matter into useful energy. Photo courtesy DST

The potential of biomass as a feed for energy products in South Africa is limited due to arable land, rainfall and food security constraints. The best candidate feedstocks are urban organic waste and lignocellulose (comprising a mix of agricultural and forestry residue, and harvested invasive alien plants). It may be possible, with government assistance, to develop a sizeable energy crop industry for biodiesel manufacture based on subsistence farmland.

Bioenergy in South Africa has limited potential on account of relatively low primary productivity, largely constrained by rainfall and exacerbated by significant inter-annual variability. These factors, together with an inevitable focus on food security, combine to limit the attractiveness of energy derived from biomass.

Despite these constraints, some potential does exist. Technoeconomic assessment of options for biomass conversion to energy, and considerations such as job creation, impact on rural economies, greenhouse gas (GHG) mitigation and likely subsidies required to make energy products cost-competitive, were evaluated and resulted in the following set of feasible options for using biomass:

- Utilisation of all available urban domestic (household) organic waste, from solid waste and from wastewater, is the most feasible option, with an acceptable end-product cost. Upgrading to biomethane typically doubles the cost, and electricity generation will result in efficiency penalties.

The option requires intervention from government in respect of policy, accelerated permit processing for wastewater and solid waste facilities, and sponsoring of research and development of standardised large-scale digester and biogas upgrading technology. Some local authorities may elect to use wastewater biogas for in-situ electricity generation. Estimated contribution from feasible project options: up to 1 400MWe (electrical output of a power plant in megawatts).

- Development of household or communal digesters in rural, unserviced areas in combination with cattle dung in areas where this is available. Government will have to identify and promote technology, implement programmes to promote acceptance and safe use, and possibly serve as a source of capital for initial investments. Estimated contribution from feasible project options: up to 250 MWe.
- Combination of all available lignocellulose biomass. Invasive alien plants, plantation residues, sugar mill bagasse (what's left from cane when the juice has been extracted) and agricultural residue can make a significant contribution to electricity generation in mid-size regional power stations (typical size 50-300MW). Projects may have a limited lifetime due to the objective of the eradication of invasive alien plants over a 20-year period. Some of the project options are in areas of poor electricity availability (rural Mpumalanga, Eastern Cape, KwaZulu-Natal) and will be able to underpin one or more rural electrification projects. Costs are comparable to new electricity from coal. Estimated contribution from feasible project options: up to 1 300MWe.
- It may be possible to develop an energy crop industry on subsistence farmland as a measure to improve rural livelihoods. The most feasible option is for biodiesel manufactured from groundnut oil or sunflower oil, with byproduct sales offsetting the cost of final products. Due to the need for some form of subsidy, projects are unlikely to attract private capital. In addition, it is likely that significant effort will be required to transform rural agricultural practice. With an oil price in the order of $50 per barrel, these options are not attractive, but the situation might improve should oil prices rise to recent highs of $100 per barrel. Estimated contribution from feasible project options: 587MW, 235MWe as electricity equivalent, 570m 1/a of biodiesel, approximately 5% of current diesel consumption.

To benefit GHG emissions (greenhouse gas emissions), the eradicated biomass will have to be replaced. Options include managed Category 2 invasive plants (such as Eucalyptus) or restoration of indigenous vegetation.

Sugar cane and sweet sorghum are attractive as energy crops due to high yields and large areas suitable for cultivation. Ethanol for E10 blends (5-10% ethanol added to petrol) needs to be near anhydrous (containing no water) and is expensive to produce, making it uncompetitive. E100 (95% ethanol and 5% water), as used in Brazil, is less expensive to produce but was not considered since it does not form part of the current Biofuels Strategy.

A number of project options for a variety of feedstock and processing combinations were evaluated. Not all of these combinations are feasible, generally since smaller facilities do not have the requisite economy of scale, or the combined feedstock and transport costs are too high. The feasible options identified generally minimise the cost of production based on feedstock input, transport costs and economy of scale, but in practice the logistics of supply and local variations in density and accessibility of feedstock might limit the size of such a facility.

Impacts of the most feasible options, as described above, were also assessed in terms of environmental considerations (GHG emission mitigation, invasive alien plant eradication, better utilisation of degraded land), and socioeconomic benefits (job creation, contribution to regional economy, and access to clean energy). It is clear from the assessment of these impacts that, in general, the following holds true:

It may be possible, with government assistance, to develop a sizeable energy crop industry

- The conversion of organic waste in urban areas to biogas and possible refinement to biomethane has positive GHG emission impacts, is price-competitive with alternatives, and will result in the creation of a small number of sustainable jobs.
- The other options (based either on lignocellulose sources or on purposely cultivated energy crops) have limited or negative value in terms of GHG emission mitigation and the costs are the same or higher than those of fossil and renewable alternatives. Hence these projects will in all likelihood rather be undertaken in an effort to establish a national strategic intervention in rural areas that aims to:
  - improve water availability through eradication of invasive alien plants;
  - revitalise subsistence farming areas;
  - create jobs in extraction, harvesting and processing of biomass;
  - provide access to clean energy in some cases; and
  - develop the rural economy.
- Such a national scale strategic intervention would need to be integrated with existing government programmes (Agri-Parks, Working for Water, Working for Energy, Housing Subsidies, and programmes managed by the department of agriculture, forestry and fisheries).

To conclude:

- Bioenergy is feasible in South Africa at a relatively small scale, involving mostly processing of organic waste, residues from forestry and agriculture, and eradication of invasive alien plants.
- Feasible project options depend on the cost of feedstock, processing costs and transport costs. These factors are subject to economy of scale considerations. Furthermore, current low oil prices make bioenergy in general, and biofuel in particular, less attractive, with purposely cultivated crops being affected the most.
- Despite this, it is possible to determine short-, medium- and long-term strategies for bioenergy generation, which, in total, may be able to contribute approximately 3 500MW of electricity equivalent to the national energy mix over the planning horizon of 20 years.
- Should accessible and sufficiently dense invasive alien plants be successfully eradicated over the planning horizon, it will have a significant impact on woody biomass availability and eventually reduce capacity by approximately 1 000 MWe. Negative greenhouse gas benefits ensue should the eradicated invasive alien plants not be replaced by more or less equally productive alternatives — either as managed short-rotation coppicing stands of Category 2 plants (such as Eucalyptus), or with indigenous species.

New Bioenergy Atlas heralds South Africa's energy generation future

From page 1

Head of the Independent Power Producer Procurement Programme in the department of energy, Karen Breytenbach, says the tool will help increase public participation and opportunities available in bioenergy in the country.

"We need to ensure that our communities are fully aware of the benefits and that they are ready to use these available opportunities in renewable energy," says Breytenbach.

She makes an example of the world-class Renewable Energy Independent Power Producer Procurement Programme, which since its establishment in 2011, had created private investment in the energy sector worth about R200-billion by the end of 2015, and will lead to local communities receiving R29-billion for the 20-year period of the IPP life span.

"A total of R20-billion has already been committed to socio-economic development initiatives in communities hosting renewable energy projects. Over seven billion has been structured through the establishment of community trust," she says.

Bioenergy has the potential to create more jobs for South Africans and should be incorporated into modern energy services

Chairman of South Africa Independent Power Producer Association (SAIPPA) Thomas Garner has also welcomed the bioenergy atlas, saying it sets the stage for South Africa's transformation into a low carbon, renewable energy future.

"Mega trends determining our future are the impact of climate change, the development of technology at an increased pace according to Moore's law, and changing demographics worldwide."

He also agrees that the bioenergy has the potential to create more jobs for South Africans and should be incorporated into modern energy services as a significant contributor to the energy industry and the bio-economy.

"Of utmost importance are the principles of inclusivity, addressing energy poverty and stimulating economic opportunities in our drive to provide energy to communities currently not receiving such services," says Garner

SAIPPA and its members plan to use the Atlas to develop new, distributed energy projects which will positively impact local content, job creation, black ownership, management and control.

Garner also commends the DST for its efforts to contribute to the country's transition to renewable energy and to formalise the establishment of the bio-energy industry.

"South African carbon sink stocks are located 80% in natural systems and 94% of it is in the soil. The development of the bioenergy industry will improve this situation by impacting cultivation of energy crops without negatively impacting food and water security."

While government planning had not considered biomass as a significant future contributor to energy, the atlas shows the potential exists in bioenergy to assist in meeting future clean energy demands.