Bioenergy Projects and Sustainable Development

Which types of bioenergy projects offer the greatest development benefits?

Key Findings

- We evaluated how the potential for sustainable development benefits differs across 12 bioenergy project types, examining project design documents for 76 Clean Development Mechanism (CDM) bioenergy projects in India, Brazil and Sub-Saharan Africa.
- Although bioenergy projects are often viewed as providing a wider array of sustainability benefits than other efforts to reduce greenhouse gas emissions in developing countries, the claimed sustainability benefits in the CDM bioenergy projects we examined vary as widely as among all other CDM project types.
- There is no system in place to ensure that claimed sustainable development benefits are delivered. On-site reviews of individual projects have found that they not always are, and that negative impacts may also arise that are not mentioned in project documents.
- Bioenergy projects that rely on agricultural residues claim to offer the greatest number of potential sustainable development benefits, including direct and indirect employment, technology transfer, and environmental benefits. These projects already account for close to 85 per cent of registered bioenergy projects and resulting emission reduction credits.
- Forest projects using industrial residues, including black liquor and forest residues from sawmill waste, claimed the fewest sustainable development benefits, no more than industrial gas (HFC, N_2O), industrial energy efficiency, or fossil fuel switch CDM projects.
- The greatest sustainable-benefits from bioenergy projects so far have been direct employment or supplemental income generation opportunities, such as from gathering residues. The primary environmental benefits have been improved air quality (from avoided open burning) and avoided water or soil contamination.
- Few bioenergy projects – only 1 in our sample – claimed to provide improved rural energy access, a project to install 100 village gasifiers in India. Most projects generate energy for on-site facility needs or to supply the national grid.
- Though much of the concern around bioenergy expansion has focused on energy crops competing with food production, few CDM bioenergy projects rely on dedicated energy crops – less than 10 per cent of the projects we reviewed. Given the limited sample, our study cannot provide much insight into the potential sustainability benefits or challenges of energy crop projects.

Bioenergy and sustainable development

Biomass energy or 'bioenergy' is possibly the most confounding of energy sources. It comprises a wide range of resources, options, markets and scales, from grid electricity to household fuels. Modern bioenergy sources, such as liquid biofuels, biomass-fired electricity, or methane from animal wastes, are often viewed as important components of a low-carbon, energy-secure future. By reducing dependence on expensive and imported fuel, bioenergy can stimulate local economies. In addition, in developing countries, new employment opportunities, income from the sale of agricultural residues, and infrastructure built for bioenergy projects could help reduce rural poverty, most often the extreme poverty that is the target of the Millennium Development Goals.

Global studies suggest that bioenergy demand will rise significantly by 2050 as part of the push to reduce greenhouse gas emissions. Projections of bioenergy potential range from 100 to

Rice husks biomass Thailand ©Flickr/acaaron816 Aaron May

300 exajoule (EJ) by 2050, up from roughly 45 EJ now. Much of the increased demand for biofuels – as well as the potential for supply – is expected to come from developing countries, in several of which small-scale power and heat from agricultural wastes (e.g. rice and coconut husks), as well as bagasse power, from sugar cane after extraction, are increasingly common. Yet the role of bioenergy in supporting broader sustainability goals is uncertain. Much bioenergy use today still occurs in poorer households and rural areas, and the materials are often harvested unsustainably. Where new bioenergy crops are planted, they can compete with food, feed, and fibre production, and the use of crop and forestry residues can harm soil fertility.

Given the wide range of potential outcomes, there is a need for a better understanding of how well different bioenergy project types can foster sustainable development. This analysis aims to identify the projects types with the greatest potential in this regard.

CDM 'laboratory' for review

Bioenergy projects are supported through many different types of international programmes. We focus here on projects under the Clean Development Mechanism (CDM) – 76 altogether. The CDM's standardised project documentation and relatively large project volume provide a unique laboratory, and every CDM project must demonstrate to its host country's satisfaction that it contributes positively to sustainable development. This documentation provides a wealth of material to examine the claimed sustainable development benefits.

There are no standard sustainable-development guidelines or requirements under the CDM, however; instead, the criteria are developed by the host country and evaluated on a project-by-project basis. Building on prior studies, we evaluated the purported sustainable-development benefits of CDM bioenergy projects using a uniform set of measures, and we rated project types by their potential in this regard. It is important to note that this approach focuses on *potential* benefits, as indicated by the project design, not *realised* benefits. No countries currently require that these benefits be monitored, reported or verified, nor are sustainable-development benefits evaluated as part of the validation process; in fact, realisation of sustainable-development benefits is not a requirement at the national or the international level.

In developing our methodology, we reviewed several analyses of CDM bioenergy projects, and found that they came to significantly different conclusions about sustainable-development benefits. Those studies generally did not differentiate among bioenergy projects, however, and thus considered activities as diverse as industrial sawmill waste and village-scale bio-gasifiers as a single category. Our study classified bioenergy projects into 12 categories for comparison.

The project sample

In the CDM pipeline from Jan. 9, 2010, there were a total of 291 registered and 381 at-validation bioenergy projects, making up close to 6 per cent of total CDM projects. Agricultural sector projects, both registered and at validation, dominated the category, making up 85 per cent of bioenergy projects; the other 15 per cent involved the forestry sector. Figure 1 shows a detailed breakdown.

The 76 projects in our sample were drawn exclusively from India, Brazil and Sub-Saharan Africa. India and Brazil are home to the majority (65 per cent) of all registered biomass energy

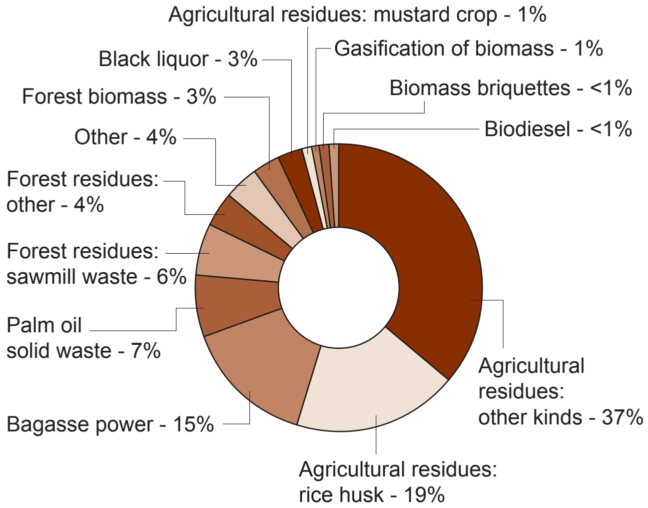

Figure 1. Registered and at-validation bioenergy projects, by type.

projects, but given the European Union emphasis on using CDM for less-developed countries going forward, bioenergy projects in India and Brazil registered after 2012 would be ineligible for use in the EU ETS. Thus we also included registered and at-validation projects in Sub-Saharan Africa, as it could well represent an emerging region for CDM biomass energy projects.

Evaluation of sustainable development benefits

Several authors have developed different criteria and evaluation approaches for reviewing the potential sustainable-development benefits of CDM projects. To ensure our results were comparable with those of prior studies, we applied the most comprehensive approach we found in the literature, called the 'development dividend'. The version we used was developed by David Disch and is based on a set of 15 indicators, focusing on local and community benefits. The environmental, economic and social indicators developed by Disch incorporate indicators from several prior studies and are well suited to comparing project types versus individual project performance. The questions are:

Environmental

- Does the project reduce local air pollution?
- Does it reduce local water or soil pollution?
- Does it reduce natural resource degradation?
- Does it improve waste management?
- Does it 'green' the energy production?

Economic

- Does the project create new employment?
- Does it source material or inputs from local supplies?
- How does it initiate technology transfer?
- Does it extend public infrastructure?
- Does it contribute to the energy security of the country?

Social

- How did the project involve local stakeholders?
- Does it have a clear rural and/or pro-poor focus?
- Does it contribute to health and safety standards?
- Does it share some of the profits?
- Does it provide training and education?

Using these questions, we assigned each sampled project a score (0, 0.5, or 1) for each criterion based on a review of the project's project design document (PDD) submitted to the CDM.

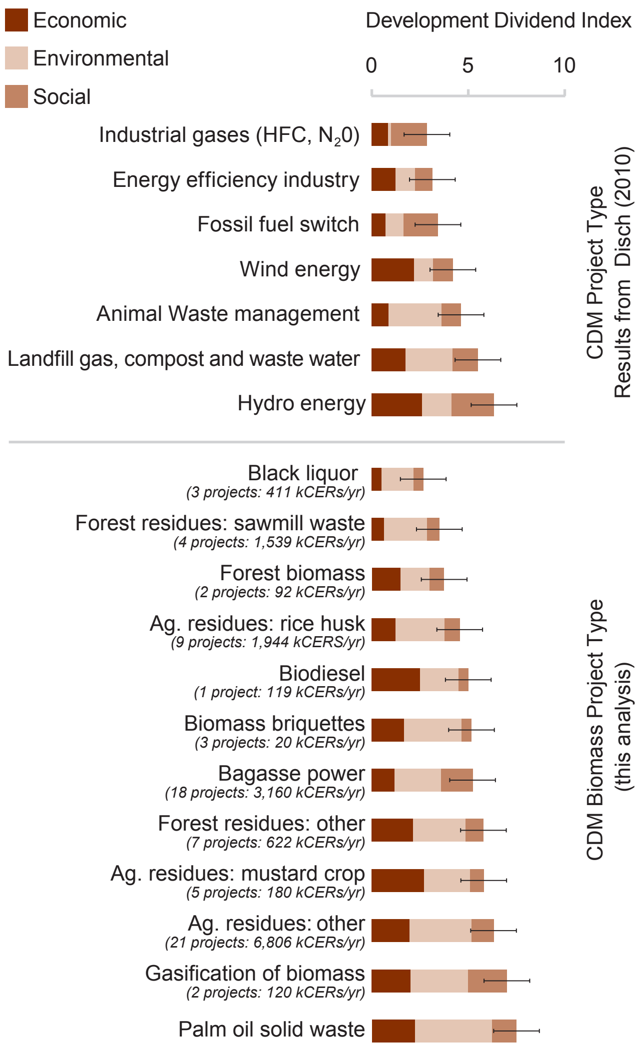

Figure 2. Sustainable development benefits across project types. Number of claimed economic, environmental and social SD criteria and ±1 standard deviation are shown for each project type. Results for specific biomass energy projects are from this analysis. Results for other CDM project types are from results in Disch (2010). Number of biomass projects indicates the number of projects sampled in this study. The number of kCERs/yr, is the total number of kCERs/yr for all registered projects of that project type in the CDM pipeline.

Results

The most common sustainable-development benefits claimed in project documents were renewable energy production (100 per cent), stakeholder identification (99 per cent), waste reduction (82 per cent), employment generation (60 per cent) and indirect income generation through local sourcing of feedstock (57 per cent). The claimed benefits varied both across project types, and among individual projects of the same type.

Black liquor, forest biomass, and forest residues: sawmill waste projects consistently claimed the fewest number of sustainable-development benefits.

Bioenergy projects that rely on agricultural residues claim to offer the greatest number of potential sustainable development benefits; more than 80 per cent of projects in the agricultural residue: mustard crop, agricultural residues: other, and palm oil solid waste projects categories had above-average claimed benefits. All said they would provide indirect income from local sourcing of biomass, and many also offered direct employment, technology transfer, energy security, improvement of air/water/soil quality, and reduction of natural resource degradation.

Projects sourced from on-farm (non-industrial) residues (e.g. mustard crop, other) tended to claim more sustainable-development benefits than projects using industrial residue sources (e.g. sugar cane, rice husks, sawmill and paper mill wastes). A likely reason for this is that industrial-residue projects most often do not provide indirect income from gathering of field residues, since they use materials already available from industrial processes (e.g. sugar cane waste for bagasse or sawmill residues). Industrial residue projects also typically use the energy they generate on site, without contributing supply to the regional grid, and they don't tend to produce new jobs.

Figure 2 shows how the bioenergy project types compare with non-bioenergy CDM project categories, as evaluated by Disch using the same questions. Black liquor projects notably fall below industrial gas projects, for example, and forest biomass and forest residue: sawmill waste projects are comparable to fossil fuel switch and wind energy projects. Gasification of biomass and palm oil waste projects, meanwhile, claim more sustainable-development benefits than any of the CDM categories examined by Disch. This comparison suggests that claimed sustainable-development benefits vary as much across bioenergy project types as within the full CDM pipeline.

Bagasse biomass Brazil ©Flickr/RoyalOlive Gustavo Oliveira

Discussion

With the shifting focus of the CDM to prioritise projects in under-represented regions, bioenergy projects could well take on added prominence, as least-developed economies are generally agriculturally based, often with significant biomass resource bases and a policy priority of spurring rural economic activity. Our results suggest that certain bioenergy projects may be particularly well-suited to providing sustainable-development benefits. On-farm residue projects show particular promise to create new income streams from collection of residues. The primary environmental benefits of bioenergy projects, meanwhile, appear to involve cleaner air (from avoided open burning) and reduced water and soil contamination.

Policy options and considerations

- To the extent that project documents are good predictors of project performance, our study suggests that some bioenergy project types offer significantly greater sustainable-development benefits than others – some better than most non-bioenergy CDM project types. Given this wide variation, policymakers should avoid grouping all bioenergy projects together when comparing the merits of CDM project types.
- Some bioenergy project types – particularly on-farm residue projects – show great potential to provide rural sustainable development through direct and indirect employment, a particularly great need in places such as rural India. Policymakers may choose to prioritise these types of bioenergy projects in the approval processes.
- To improve bioenergy projects' potential to improve rural energy access by providing a decentralised fuel source, policymakers may wish to prioritise the provision of energy to rural households. Encouragement of ongoing efforts to introduce new standardized CDM methodologies in areas such as rural electrification and charcoal production could improve this situation.
- The sustainability impact of bioenergy projects should be more closely examined through on-site evaluations following a standardised approach. This is particularly important given recent pronouncements by the European Union and the United Nations Framework Convention on Climate Change Secretariat on the need to emphasise sustainable development benefits in the development of market mechanisms. There is a clear need to verify whether the benefits claimed in project documents are being delivered, and to monitor and evaluate projects' performance in this regard.

However, other potential benefits that might be expected from bioenergy were not found in this review of projects – most notably, improved energy access. In our review, only one project in our sample, the one to install 100 village gasifiers in India, claimed to improve energy access, while most projects generate energy for on-site facility needs or to supply the national grid. Many grid-connected projects and even on-site use projects claim to improve energy security by improving supply (or reducing grid demand), but it is not possible to evaluate the validity of those claims based on the project documents. Furthermore, to the extent that these projects reduce grid demand, they may reduce the stable customer base for electric utilities and thus create instability in the emerging electric sector.

Lastly, while the discussion globally around bioenergy has focused primarily on liquid biofuels production, there are very few registered or at-validation biofuel CDM projects. In the regions we examined, there was only one liquid biofuel project, a biodiesel project from jatropha plantations located in the Democratic Republic of Congo. We also found very few projects – only 7 in our sample – that used dedicated energy crops, which are of particular concern for their potential to compete directly with food crops. Given the limited sample, our results cannot provide as much insight into the sustainable-development potential of energy crop projects.

Biomass India ©Anja Kollmuss

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