9. Carbon finance for woodfuels

Carbon finance involves investments in greenhouse gas emission reduction/ avoidance projects and the creation of financial instruments that are tradable on a market. Three market-based mechanisms exist within the Kyoto Protocol: emissions trading, joint implementation (JI) and the Clean Development Mechanism (CDM). There is also an active voluntary carbon market, the Voluntary Carbon Standard (VCS) programme. Institutions such as the World Bank, the European Investment Bank, Agence Française de Développement and the Japan International Cooperation Agency invest in climate change mitigation projects through carbon markets as well as within the framework of JI and the CDM. Brazil, India and Mexico are eligible for the CDM but not JI.

CLEAN DEVELOPMENT MECHANISM

The CDM allows countries included in Annex B of the Kyoto Protocol to carry out projects in developing countries to obtain certified emission reduction (CER) credits as part of efforts to meet their emissions targets. Establishing additionality is one of the most important requirements for the acceptance of a project under the CDM; that is, it must be shown that the emission reductions would not have occurred without the CDM project.

To be validated, a proposed CDM project must use an approved baseline and monitoring methodology (UNFCCC, 2010); if no approved methodology is applicable the project developer can propose a new methodology. Table 40 summarizes approved methodologies related to woodfuels.

Asia, particularly India and China, dominates CDM investments, with more than 60 percent of total investments; Latin America is in second place with around 25 percent of total investments. Reasons for the skewed distribution of projects may include the stability of the governments and economies of those regions, and the level of industrial development, which makes it easier to use existing methodologies without the need for complicated adaptations or the development of new methodologies.

WOODFUELS IN THE CDM – CASE STUDIES

According to the register of CDM projects, approximately 600 projects at various stages (from registered to issued) are directly or indirectly related to woodfuels. They are mainly in the following six areas: co-firing generation of electricity; power generation with biomass; switch from fossil fuels to biomass; switch from fossil fuels to wood-based pellets; ethanol production; and direct combustion of woody biomass. The great majority of these projects are in Asia or Latin America. Below, three cases in which woodfuels are used in different processes are described. Table 41 compares these and other projects in terms of their scale and estimated greenhouse gas reductions.

TABLE 40
Approved methodologies related to woodfuels

Large-scale methodologies directly or indirectly related to woodfuels	Small-scale methodologies directly or indirectly related to woodfuels
AM0007: Analysis of the least-cost fuel option for seasonally operating biomass cogeneration plants – version 1	AMS-I.C: Thermal energy production with or without electricity
AM0036: Fuel switch from fossil fuels to biomass residues in heat generation equipment – version 3	AMS-I.D: Grid-connected renewable electricity generation
AM0042: Grid-connected electricity generation using biomass from newly developed dedicated plantations – version 2	AMS-III.B: Switching fossil fuels
AM0082: Use of charcoal from planted renewable biomass in the iron ore reduction process through the establishment of a new iron ore reduction system – version 1	
ACM000: Consolidated methodology for grid-connected electricity generation from renewable sources – version 11	
ACM0003: Emissions reduction through partial substitution of fossil fuels with alternative fuels or less carbon-intensive fuels in cement manufacture – version 7.3	
ACM0006: Consolidated methodology for electricity generation from biomass residues – version 10	
ACM0018: Consolidated methodology for electricity generation from biomass residues in power-only plants – version 1	

Notes: AM = approved methodology; ACM = approved consolidated methodology; AMS = approved methodology for small-scale projects.

TABLE 41
Examples of CDM projects using woodfuels

Name of CDM project activity	Host party	Project participants (authorized by host party)	Fuel	Scale
Penha renewable energy project	Brazil	Penha Papeise Embalagens Ltd., key associations	Woody biomass	Small
Fuel switch from fossil fuels to biomass briquettes for steam generation at the chemicals manufacturing plant of Lanxess India Pvt. Ltd	India	Lanxess India Pvt Ltd	Biomass	Small
Kim Hock biomass energy and wood recycling plant	Singapore	Kim Hock Corporation Pte Ltd	Woody biomass	Small
Waste heat use at Votorantim Celulose e Papel plant in Jacarei, Brazil	Brazil	Votorantim Celulose e Papel S.A., Ecopart Ltda.	Black liquor	Small
Thermoelectric power plant of 20 MW driven by biomass originating from recently planted energy forest dedicated to the project – Ute Rondon II	Brazil	Eletrogoes S.A	Woody biomass	Large
Empee Distilleries 10 MW woody-biomass-based power project, Tamil Nadu	India	Empee Distilleries Ltd.	Others	Small
Rajang wood-waste biomass project	Malaysia	Bahagaya Sdn Bhd	Woody biomass	Small

Thermoelectric biomass power plant, Rôndonia, Brazil

This project involves the installation of a biomass thermoelectric plant, Rondon II, in the municipality of Pimenta Bueno. The plant is designed to complement energy production at an existing hydroelectric scheme by burning wood harvested from the area to be flooded by the hydroelectric scheme's reservoir and from a recently established bioenergy forest plantation. This will lead to the reduction of CO_2 emissions through the substitution of electricity generated from fossil fuels with renewable energy originating from biomass.

In the absence of project activities the alternatives for disposing of the biomass removed from the reservoir would be wood decay and/or wood burning without treatment or use for energy purposes. In addition, land in the vicinity of the project site would remain in a degraded condition with no social or productive use.

The project is expected to produce approximately 160 000 MWh of electricity per year. The methodology used was AM0042, version 2 (see Table 40).

Empee Distilleries woody biomass power project, India

The proposed project, based in Mukudi village, Pudukottai District, Tamil Nadu, is expected to generate 10 MW of electricity using woody biomass as fuel. The principal species to be used are *Prosopis juliflora*, *Eucalyptus* spp. and *Casuarina* spp.; other types of biomass will be used as auxiliary fuels. Approximately 1 MW of the electricity generated will be used for internal consumption and the balance

Methodology	Annual emission reduction *(tCO_2/year)*	Average annual emission reduction *(tCO_2/year)*	Total emission reduction by 2012 *(tCO_2)*	Total estimated emission reduction by 2020 *(tCO_2)*	Total estimated emission reduction by 2030 *(tCO_2)*
AMS-I.C	29 526				
AMS-III.B		60	365	365	365
AMS-I.C	26 228				
AMS-III.Q	27 296	17 536	95 536	245 664	3 684 960
AM0042	102 465	102 409	418 575	1 024 653	1 024 653
AMS-I.D	27 567	28 457	135 221	366 213	597 205
AMS-I.C AMS-III.E	26 662	28 310	77 663	307 336	594 889

(9 MW) will be exported to the Tamil Nadu Electricity Board grid, which constitutes part of, and is connected to, India's southern regional electricity grid. The plant will substitute electricity generated by fossil fuels.

The woodfuels to be used in the plan will be purchased from local producers. At present biomass is used as domestic fuel, as animal fodder, for thatching, and as fuel for local thermal-energy-consuming industries such as brick kilns. However, these activities only consume about 30.3 percent of the total biomass generated in Pudukottai District. The remaining 69.7 percent is left on the land to decompose aerobically and is available for other purposes. Domestic users will not be required to change their biomass fuel consumption habits, given that ample supply is available.

Kim Hock biomass energy and wood recycling plant

Kim Hock Corporation is a wood and metal recycling company based in Singapore; the project aims to use wood waste as fuel for a boiler with a capacity of 35 tonnes per hour designed to supply steam and electricity for internal plant use. In addition, wood waste that is surplus to requirements for the boiler will be converted to wood pellets as a renewable fuel source that will be sold on the open market.

The project will reduce emissions by displacing fossil fuel from the conventional oil-fired boiler and fossil-fuel-generated electricity from the local grid system. The project will use biomass boiler technology that will allow the plant to be operated solely on wood waste generated by landscaping and waste-disposal companies. This waste is currently incinerated.

REJECTED PROJECTS

Not all submitted projects are successful in attaining registration and being issued with CERs. Some are rejected at the stage of registration, others later after a review of issuance; examples of the former include two from Brazil and one each from India and Malaysia. These are plants running entirely or partly on biomass, including wood (such as from sawmills, wood waste, woodchips, branches and the tops of trees). The reasons for rejection include (IGES, 2010):

- failure to substantiate the prevailing-practice barrier;
- lack of sustainability of the project activity;
- a flawed investment analysis (e.g. the investment analysis did not reflect the net revenues that would continue to accrue to the project activity beyond the crediting period).

VOLUNTARY CARBON STANDARD

The VCS is a programme within the voluntary carbon market to provide a global standard for voluntary offset projects. It was founded by the Climate Group, the International Emissions Trading Association and the World Business Council for Sustainable Development. VCS offsets must be real (i.e. they must have happened), additional (i.e. be beyond business-as-usual activities), measurable, permanent, independently verified and unique (i.e. not used more than once to offset emissions). All the carbon offsets generated under the programme – "voluntary carbon units" (VCUs) – are registered within the VCS Registry System.

The VCS programme can recognize greenhouse gas offset programmes that meet VCS criteria; programmes approved under the VCS are the CDM, JI and Climate Action Reserve. Such approval can mean recognition of greenhouse gas credits; validator and verifier bodies; and methodology elements. The sectoral scope of the VCS is almost identical to that of the CDM; it contains 15 sectors, including energy industries (renewable/non-renewable sources) within which all wood-based energy projects fall.

About 25 biomass-based projects in the UNFCCC database are in India and Brazil. One of the two Indian examples is a 6 MW power plant that uses wood residues, sawdust and other biomass feedstock; no coal has been used since 2006. Using CDM methodology AM0042 (see Table 40) the project achieved 37 479 tCO_2eq in net emission reductions (24 260 estimated annual VCUs) during the monitoring period. About 32 000 tonnes of wood waste were consumed, which was 33 percent of total fuel consumption (Rithwik Power Projects Limited, 2008).

The remainder of the projects are in Brazil; most are ceramics factories undertaking a fuel-switch in their kilns from either heavy oil or native wood from forests without sustainable forest management to:

- wood from native forests with a sustainable management plan;
- wood from afforestation (e.g. eucalyptus biomass obtained from regulated forest areas) and afforestation wood residues (e.g. woodchips and sawdust);
- wood from reforestation areas (*Eucalyptus* spp. and *Pinus* spp.);
- algaroba wood and eucalypt wood;
- residues from cashew trees (e.g. prunings);
- forestry residues;
- wood residues from construction and industries;
- sawdust (from sawmills);
- non-fossil-fuel-based fraction of industrial waste (e.g. pallets and wooden packages).

The methodology employed for fuel switching from heavy oil to wood in small-scale projects is CDM methodology AMS-I.C (see Table 40). In two such projects the estimated annual VCUs are 42 304 and 27 771. The shift was entirely to wood of different origin (from the above list), involving 100 000 m^3 per year and 75 000 m^3 per year, respectively. Total project emission reductions are 106 877 and 71 812 tCO_2eq, with average monthly emission reductions of 3 562 and 1 995 tCO_2eq, respectively (VCS, 2010; Social Carbon, 2008; Social Carbon, 2009).

For a wood-to-woodfuel switch, CDM methodology AMS-I.E (see Table 40) is employed. Estimated annual VCUs range between 9 000 and 65 000, while the average monthly emission reductions are 600 to 4 000 tCO_2eq (VCS, 2010).

Another project is a co-generation project involving a new biomass boiler (burning only wood residues) and an 8 MW turbine to replace oil-fired boilers and reduce the consumption of grid electricity. The CDM methodology deployed is ACM0006 (see Table 40). The project generates an estimated 76 743 VCUs annually (VCS, 2010). During two monitoring periods (from 1 January 2002 to 31 December 2007 and from 1 January 2008 to 31 October 2008), emission reductions amounted to 388 452 + 85 057 = 473 509 tCO_2eq, with average monthly emission reductions of 5 774 tCO_2eq (EcoSecurities, 2008).

TRANSACTION COSTS (SMALL-SCALE VERSUS LARGE-SCALE APPLICATIONS)

The CDM is likely to entail considerable costs in baseline development, project registration, verification and certification. The "activities implemented jointly" (AIJ) pilot phase and the Prototype Carbon Fund programme give indications of these costs. According to Michaelowa and Jotzo (2005) there is evidence that:

- projects with high implementation costs have high transaction costs as well;
- transaction costs will be higher in countries with an inefficient regulatory framework, putting them at a competitive disadvantage vis-à-vis more efficient countries.

The UNFCCC launched the AIJ pilot phase in 1995 – prior to the proposed implementation of the Kyoto Protocol – in order to learn more about the possible operation of projects under international flexibility mechanisms. The Swedish AIJ programme in the Baltic states is the only AIJ programme that has consistent reported transaction costs in four categories (technical assistance, follow-up, reporting and administration) over time (Michaelowa and Jotzo, 2005).

Michaelowa and Jotzo (2005) analysed the Swedish data in regard to:

- the impacts of project categories – the transaction costs of renewable-energy projects might be expected to be lower than those of energy-efficiency projects because the latter have greater situation-specific planning needs and a higher number of participants;
- the impacts of start date within the same project categories – learning effects should reduce transaction costs of projects that start later;
- economies of scale within the same project categories;
- host-country specifics within the same project categories.

In the Swedish programme, however, no costs for external validation and certification accrued. The average cost of technical assistance and administration was 20.5 percent of total project cost for energy-efficiency projects and only 14.4 percent for renewable-energy projects. There was a declining trend in transaction costs over time, as expected. Economies of scale were important but there were negligible differences in costs between project types of the same size (Michaelowa and Jotzo, 2005).

Certification costs are mainly fixed, as reported by certifiers (e.g. SGS, KPMG, DNV, PricewaterhouseCoopers and EcoSecurities) engaged in validating, monitoring and certifying greenhouse gas abatement projects. SGS, for example, clearly stated that verification and certification costs are relatively independent of project size; it estimated a cost of €17 000 for the first verification and €8 500 for each additional round. KPMG stated that "whereas there will be some correlation between the cost of validation and verification and the size of the project the relationship will not be linear", and DNV suggested that the credibility of certifiers would be jeopardized if their fee was proportional to the quantity of emission reductions verified (Michaelowa and Jotzo, 2005).

For the four Prototype Carbon Fund projects for which there are complete data, there is a close, although not perfect, correlation between the size of project and the transaction costs per tonne of CO_2 reduced. Due to the large size of the projects, the unit cost is much lower than in the Swedish AIJ cases (Michaelowa and Jotzo, 2005).

EcoSecurities examined a 150 MW gas plant with 0.35 million CERs per year and a 2 MW biomass plant generating 35 000 tCERs (temporary CERs) per year. Total transaction costs were €0.3 to €0.7 per tonne for the larger project and €0.4 to €1.1 per tonne for the smaller project. The relatively high costs associated with the larger project were due to the assumption that certification and enforcement costs would be proportional to the quantity of CERs generated (Michaelowa and Jotzo, 2005).

The costs of the operation of the CDM Executive Board are to be borne by project proponents in the form of a fee. This fee is above €0.1 per tonne CO_2eq if a project has an annual reduction of less than 2 000 CERs, assuming a 21-year lifetime. For larger projects, the fee becomes negligible per unit cost of CO_2eq (Michaelowa and Jotzo, 2005).

Empirical evidence suggests, therefore, that economies of scale are the most important factor determining the share of total cost made up by transaction costs because fixed costs form a significant part of transaction costs. Nevertheless, this needs to be confirmed by further research (Michaelowa and Jotzo, 2005).

Evidence from AIJ and emerging CDM projects shows that transaction costs can account for a significant share of the total cost of CDM projects, especially in a market characterized by low permit prices. Transaction costs tend to be higher in project categories with higher implementation costs, and smaller projects are at a disadvantage because fixed costs become a major factor (Michaelowa and Jotzo, 2005).

CDM transaction costs are not easy to define. Chadwick (2006) suggested that they are components in the price of CERs that cannot be attributed to either the physical process of removing greenhouse gases from the atmosphere or the level (or changes in the level) of demand for CERs.

Small-scale renewable-energy and energy-efficiency projects are helping to meet the needs of rural people in developing countries, alleviate poverty and foster sustainable development. However, the low emission reductions per installation are making it difficult for such projects to derive value from participating in the CDM. Negotiators of the Marrakech Accords (November 2001) as well as the CDM Executive Board recognized this problem and adopted simplified CDM modalities and procedures for qualifying small-scale projects. Such projects were defined as renewable-energy project activities with a maximum output capacity equivalent to up to 15 MW; energy-efficiency improvement project activities that reduce energy consumption by an amount equivalent to up to 60 gigawatt hours per year; or other project activities whose emission reductions are less than 60 kilotonnes of CO_2 per year (Purohit, 2009).

The thresholds for the latter two categories were increased by a decision of the 12th Conference of Parties to the UNFCCC in November 2006. Even with the simplified rules, however, the current design of the CDM still means high transaction costs for individual small-scale projects. Costs can be reduced by bundling similar small projects into a single project that is still eligible for the simplified procedures. The 'gold rush' atmosphere of 2005 has also mobilized small-scale project developers (Purohit, 2009).

In a study by Purohit (2009) on biomass gasifier-based projects under the CDM in India, one of the possible barriers to the large-scale dissemination of biomass power was the high upfront cost of these systems. Other barriers included technical barriers, financial drawbacks, a poor institutional framework, short-sighted electric utility policies, and low environmental concern. In the Indian context, wood from natural forests and eucalypt plantations, and agricultural residues, are normally used as fuel and raw material.

The consumption of biomass per unit of electricity generated in the dual-fuel mode of operation of a biomass gasifier-based system depends on factors such as the type of biomass, its moisture content and calorific value, the operating load of the system, and the diesel replacement factor; it is estimated to be in the range of 1.0 to 1.4 kg per kWh at the system's rated capacity. The actual consumption of woodfuel at the 5 to 100 kW biomass gasification projects installed in Gosaba Island, Sundarbans, and West Bengal has been reported to be 0.822 kg per kWh (Purohit, 2009).

MEASUREMENT, REPORTING AND VERIFICATION

The CDM has a registration and issuance approval process; in each country, approval is granted by the designated national authority. Public funding for CDM project activities must not result in the diversion of official development assistance (UNFCCC, 2010).

The VCS has a different system, as described below.

Registration and verification

The VCS Registry System enables the tracking of all VCUs, from issuance to retirement, and is a key part of the VCS programme, ensuring that all VCUs are real, measurable, additional, permanent, independently verified, unique and traceable. Three international companies – APX Inc., Caisse des Dépôts and Markit – are contracted to act as registries that issue, hold, transfer and retire VCUs and interact directly with the VCS project database to upload project documentation and obtain unique serial numbers for each VCU.

The following steps are required to register a project and issue VCUs under the VCS Registry System. First, an accredited validation and verification body must validate the project and verify its greenhouse gas emission reductions or removals. Second, the project is presented to a VCS registry for registration. Third, the VCS registry administrator reviews the project and VCU issuance claim. Fourth, the project is registered and the initial VCUs are issued on the VCS project database. VCUs may also be issued subsequent to the initial issuance of VCUs to the project.

The last step – project maintenance – implies that the project proponent can update project details (VCS, 2010). Microprojects (i.e. <5 000 tCO_2eq savings per year) may be validated and verified by microproject validators and verifiers, who must comply with certain requirements (VCS, 2008).

Methodologies: measurement, monitoring and reporting

VCS methodology elements provide the framework for the development of projects and the quantification of greenhouse gas emission reductions or removals. These elements describe methodologies and methodology revisions, additionality performance tests and tools/modules. The methodology elements of the VCS, the CDM and the Climate Action Reserve are approved under the VCS programme and can be found at www.v-c-s.org.

All methodologies applying for approval under the VCS programme must undergo a double-approval process. They must include applicability criteria that defines the area of project eligibility, a process that determines whether the project is additional or not, determination criteria for the most likely baseline scenario and all necessary monitoring aspects related to monitoring and reporting of accurate and reliable greenhouse gas emission reductions or removals (VCS, 2008).

FINANCE OF CARBON SAVING

Financial information on wood-based projects is not readily available for analysis; often, financial data are not disclosed by companies. The data used in the analysis below (summarized in Table 42) were derived from two main sources: CDM project design documents; and projects funded by the Global Environment Facility (GEF).

CDM wood-based projects

Two examples are described.

- ***Empee Distilleries in India:*** Investment costs, including pre-operational expenses and the total capital investment, were estimated to be US$9.8 million. Average annual operational and maintenance costs, including fuel, administrative

TABLE 42
Emission reductions and costs of various wood-based projects

Project/country	Emission reductions (*$MtCO_2eq$*)			Costs (*US$ million*)		
	Baseline scenario	Alternative scenario	Incremental reductions	Baseline scenario	Alternative scenario	Incremental cost[a]
CDM (India)	0.37	0.18	0.19	n.a.	13.20	n.a.
CDM (Malaysia)	0.0005	0.1045	0.102[b]	0	7.10	7.10
GEF (Belarus)	n.a.	n.a.	n.a.	5.50	7.51	1.08
GEF (Poland)	n.a.	n.a.	n.a.	0.47	2.60	2.13
GEF (Slovakia)	0.07	0.66	0.59	6.18	8.34	2.16

[a] Difference between the alternative scenario and baseline scenario costs.
[b] Taking leakage into account.
n.a. = Data unavailable.

expenses, salaries and utilities, were estimated to be US$3.4 million. Carbon project development costs were estimated at US$50 000 and monitoring and verification costs at US$10 000 per year. Thus, final costs were an estimated US$13.26 million.

- ***4 MW biomass power plants using waste woodchips and sawdust in Central Java Province, Indonesia*:** The estimated capital investment required to achieve emission reductions of 0.102 Mt of CO_2eq during the seven crediting years (2008–2015) was US$7.1 million.

GEF wood-based projects

GEF projects have the following characteristics, which differ from CDM or VCS projects:

- the objectives normally include the enhancement of energy security through increased energy efficiency and the deployment of renewable energy types;
- projects include institutional capacity building, awareness raising and other similar activities;
- the introduction of new facilities or the upgrading of existing facilities to allow the use of woody biomass would usually be a part of a larger project and would play a demonstration role. The costs associated with this demonstration component are used here for the analysis.

The goal of the project Biomass Energy for Heating and Hot Water Supply (Belarus) was to address the reduction of greenhouse gas emissions in Belarus by increasing the capacity of the government to support biomass energy projects and the capacity of customers to finance and implement them. The baseline scenario was described as "present level of adoption of biomass energy systems continues, with simple, inefficient and unsustainable conversion techniques. Upgrades of boilers at the sites, if they occur at all, are equivalent to gas or oil systems". The related costs totalled US$5.50 million (US$1.59 million – site owners, in kind; US$1.78 million – site owners, cash; US$2.13 million – government, cash). The project's technical component involved the conversion of five boilers to enable the use of biomass feedstock in the form of forestry residues and woody waste from woodworking enterprises at a total cost of US$7.51 million (the incremental cost – the difference between the alternative scenario cost and baseline scenario cost – therefore, was US$2.01 million). Direct CO_2eq emission reductions over the 15-year period were estimated to be approximately 1.08 Mt (UNDP, undated).

The objective of the project Integrated Approach to Wood Waste Combustion for Heat Production in Poland was to reduce greenhouse gas emissions by removing barriers to the creation of a viable wood-waste market offering clean energy. Specifically it involved the substitution of 4 MW of heat production capacity using hard coal by 4 000 tonnes of biomass (wood waste) per year, equivalent to about 1 300 tonnes per year of hard coal (less than 10 percent of the identified coal substitution potential of 14 500 tonnes per year). The incremental cost of the project was US$2.136 million.

Under the project Reducing Greenhouse Gas Emissions Through the Use of Biomass Energy in Northwest Slovakia, the baseline scenario – substitution of 44 coal/coke-fired boilers with 22 more efficient coal boilers and 22 natural-gas-fired boilers – produced total emission reductions of 0.068 $MtCO_2eq$ (assuming a project lifetime of ten years) at a cost of US$6.184 million. In the alternative GEF scenario (assuming a project lifetime of ten years) pellet-fired boilers consuming 0.012 Mt of pellets per year would lead to emission reductions of 0.201 $MtCO_2eq$ and a central processing unit that allowed treatment of wood waste with minimal methane emissions would reduce emissions by 0.454 $MtCO_2eq$. The cost of this alternative scenario was estimated at US$8.34 million. Thus, the incremental cost of US2.159 million would produce incremental emission reductions of 0.587 $MtCO_2eq$.


FAO/FO-6998/H.B. GÜNSEN