Kick-Starting Africa's Carbon Markets

The potential for programmatic CDM

Information Note

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FOREWORD

The APP's role is to track progress, identify opportunities and catalyze action in support of Africa's development. Few things are more important than applying this in the context of climate change.

The carbon markets are destined to play a central role in putting the world on a path towards low carbon development. Sadly, today's international carbon markets, notably the Clean Development Mechanism, largely bypass Africa even though the continent will be hardest hit by climate change and has the least capacity to respond.

Success in increasing Africa's access to the carbon markets would have a number of benefits. First, increased financial flows and revenues would be available to governments. Such revenues are central to governments' ability to implement national growth and poverty reduction plans and to progress the Millennium Development Goals. Second, millions of families and communities across the continent lack access to energy. As the demand for energy increases, the importance of renewable energy and green technology becomes ever more important. Carbon finance has the potential to facilitate investment in this sector and provide for necessary technologies. Thirdly, success in making carbon finance accessible to Africa requires new forms of partnership between communities, the private sector, governments and international organizations, which can serve as models for renewed approaches to development.

This initiative and the resulting publication are intended to provide practical recommendations and support for the range of actors who are committed to ensuring that Africa both benefits from and contributes to climate change mitigation. The APP does not have implementation capacity, but rather convened stakeholders in order to explore practical ways in which obstacles to carbon markets in Africa can be overcome. As such, this exercise is not intended to be theoretical, but practical.

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GLOSSARY

ACM – Approved Consolidated Methodology for (large-scale) CDM projects

AMS – Approved Methodology for Small-Scale CDM projects

CCGT – Closed Cycle Gas Turbines

CDM – Clean Development Mechanism

CER – Certified Emission Reduction (equivalent to 1t CO_2e)

CPA – CDM Programme Activity

CSP – Concentrated Solar Power

CO_2e – Carbon dioxide equivalent

DNA – Designated National Authority

DOE – Designated Operational Entity

ERPA – Emission Reduction Purchase Agreement

EUA – European Union Allowances (equivalent to 1t CO_2e)

EU ETS – European Union Emissions Trading Scheme

GEF – Grid Emissions Factor

LULUCF – Land-Use, Land-Use Change and Forestry

MDGs – Millennium Development Goals

NAMA – Nationally Appropriate Mitigation Action

OCGT – Open Cycle Gas Turbines

PDD – Project Design Document

PIN – Project Identification Note

PoA – Programme of Activities

REDD – Reduced Emissions from Deforestation and Forest Degradation

UNFCCC – United Nations Framework Convention on Climate Change

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1.1. Why focus on carbon markets?

Global greenhouse gas emissions need to fall from some 52Gt CO_2e today to around 44Gt CO_2e by 2020 and 35Gt by 2030 if the climate is to be stabilized in the range deemed safe by the IPCC[1]. These emission reductions will need to occur in industrialized and advanced developing countries where governments are using a mix of policy instruments to impose a price on carbon emissions and ratchet up regulatory standards. Many details of a post-Kyoto international climate framework remain unresolved, but it seems clear that all major industrialized economies will follow the example of the European Union and institute national cap-and-trade systems. Advanced developing countries are likely to commit to some form of Nationally Appropriate Mitigation Actions (NAMAs) and/or sectoral efficiency targets.

Every national cap-and-trade system that is currently under discussion includes provisions for the use of international offsets to lower the cost of mitigating greenhouse gas emissions. Quotas for international offsets range from some 10 percent of compliance needs in the EU Emissions Trading Scheme (EU ETS) to 100 percent under the draft Australian Carbon Pollution Reduction Scheme (CPRS). Likewise, draft US legislation allows for the substantial use of international and domestic offsets. In view of the paucity of domestic offsets and strong pressure from emission-intensive industries to keep the cost of abatement low, it is widely expected that international offsets will play a prominent role in any US legislation adopted by Congress.

At current carbon prices in the EU ETS, rich countries' carbon emissions are valued at some USD500 billion per year, a sum that could increase sharply as binding emission caps take hold in an expanding list of countries. As a result, carbon is likely to become one of the most important internationally traded commodities, and the associated financial flows stemming from the use of international offsets have the potential to dwarf foreign direct investment and development assistance flowing to Africa and least developed countries.

As advanced developing countries, which already account for some 50 percent of global greenhouse gas emissions, move from lowering the carbon intensity of their growth to reducing absolute volumes of greenhouse gas emissions, they will cease to be a major source of international offsets for rich countries. Since least developed countries are widely expected to be exempt from capping their overall emissions, they will have a substantial opportunity to supply carbon offsets to rich countries. Already, demand for Certified Emission Reductions (CERs) from African countries outstrips supply, and the gap between demand and supply is unlikely to be closed in coming years. This shift towards seeking offsets from least developed countries will continue even if the overall use of international offsets by rich countries will decline as the focus moves towards reducing their per capita emissions 10-20t CO_2e at present to the 2t per capita required by 2050.

Yet, the international carbon markets are no panacea for meeting Africa's development finance needs since carbon finance is tied to the limited range of mitigation opportunities and will flow

[1] Project Catalyst: http://www.project-catalyst.info/images/publications/limiting_atmospheric.pdf

directly to the associated programs and projects. For example, carbon finance can make an important contribution towards introducing improved cook stoves or co-financing new renewable energy infrastructure, but the carbon markets will not contribute significantly towards financing countries' health systems, meeting the Education for All Goals or achieving the Millennium Development Goals on water and sanitation. Likewise, international carbon markets will not provide financing for the measures that African countries need to undertake to adapt to the consequences of climate change that have by now become unavoidable.

On the upside, as a market-based mechanism, carbon finance can be provided on predictable and legally enforceable terms. In particular, its independence from the fickle aid budgets and conditionalities that are often imposed by donors on African governments make carbon finance an attractive revenue source to complement domestic resource mobilization and other external finance.

The share of project financing that can be shouldered by carbon finance differs widely across types of programs. In the case of distributing compact fluorescent light bulbs and efficient cook stoves, carbon can finance up to 100 percent of outlays, but its share can drop to a mere couple of percent of capital expenditure in the case of solar PV. So it is important for African countries to identify clearly the areas where carbon can make a substantial financial contribution today.

Yet, if applied strategically, carbon revenues can help bring down the cost of renewable energy and other low-carbon technologies that can accelerate development across Africa. As one example, the cost of solar power technology remains very high but is coming down rapidly largely as a result of the policy incentives provided by countries in Europe, North America and Asia that are designed to increase its use. As this paper argues, similar opportunities for efficiency gains and technological progress exist that are well suited to the development needs of Africa and can be supported by the international carbon markets.

An important challenge we will return to later, concerns the effective coordination of public policy and private sector activities to mobilize carbon finance in Africa. Two critical issues need to be considered here. First, while many advanced developing countries in Asia and Latin America have been successful in attracting carbon finance from the private sector, the returns on African projects tend to be low and have a higher risk profile. Therefore public private partnerships can be an effective mechanism for kick-starting the carbon markets in Africa, particularly in the case of programmatic approaches that have high upfront fixed costs but substantially lower operating expenditures.

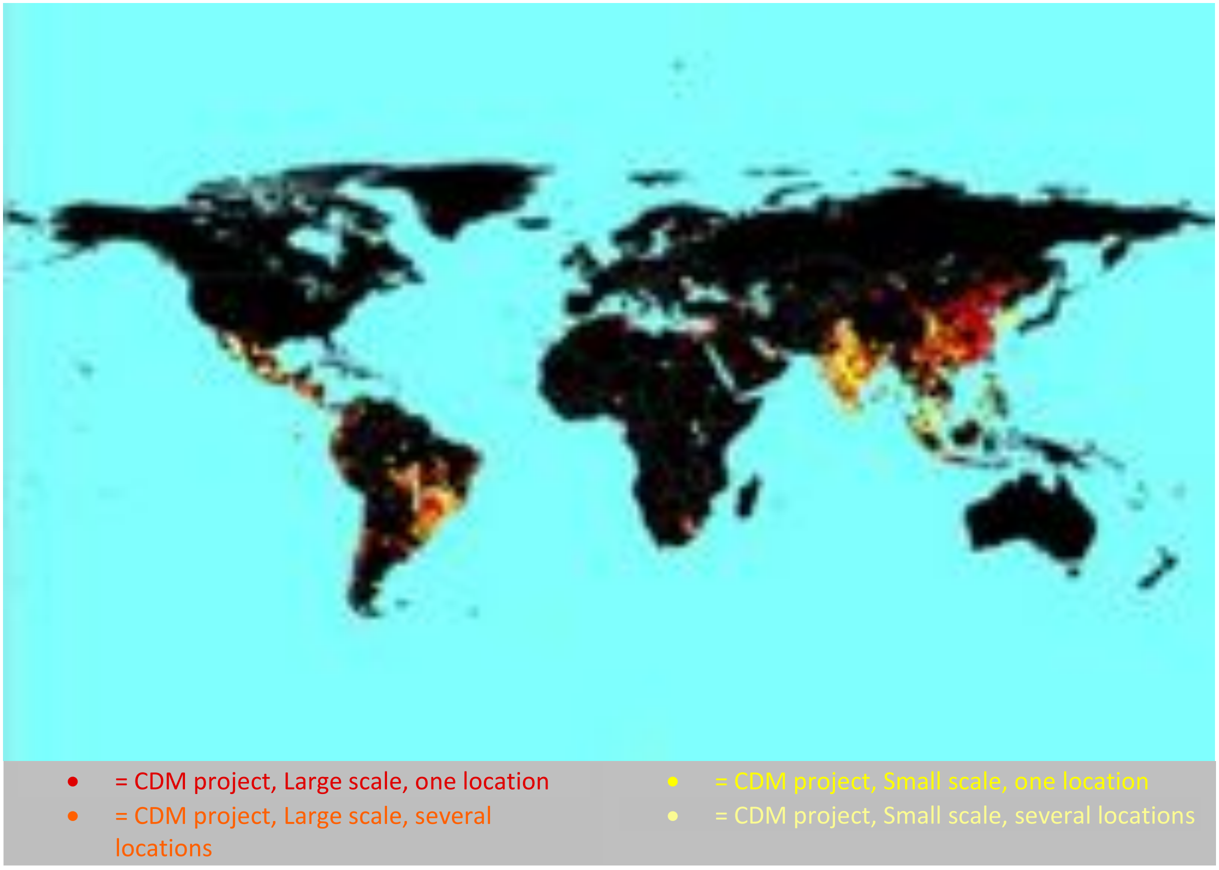
Second, renewable energy and other low-carbon technologies are central to reducing greenhouse gas emissions but can also act as drivers of economic growth. So policymakers must carefully design public policies and implementation mechanisms that leverage the expertise and resources which the private sector can mobilize. This in turn requires close coordination between the private sector and policymakers.

1.2. Status of carbon markets in Africa today

The size of the 2008 global market in UNFCCC-approved Certified Emission Rights fell some 30 percent to 389MtCO_2e (valued around $6,519 million) due to verification bottlenecks at the CDM Executive Board and smaller average project sizes. China remains the world leader in CDM supply with an 84 percent market share, followed by Brazil and India, at 4 percent market share each.

Africa is still lagging behind with just a 2 percent share of the market or a mere 112 out of 4734 CDM projects[2]. To date, some 50MtCO_2e of CDM projects have been contracted in Africa, of which more than 20MtCO_2e were transacted in 2008. Encouragingly, the supply of African CERs is growing, but Africa remains marginalized in the global carbon markets (Figure 1).

Figure 1: Geographical distribution of all CDM project activities, as of December 2009[3]



In addition to the so-called "compliance market" of UNFCCC-approved CERs, a number of voluntary carbon certification standards have emerged and have given rise to "voluntary carbon markets". Voluntary carbon markets nearly doubled in 2008, but remain small overall at some 123.4MtCO_2e.

2 Source: http://cdmpipeline.org/cdm-projects-region.htm#6, accessed on 2 December 2009.

3 Source: http://cdm.unfccc.int/Projects/MapApp/index.html, accessed on 19 November 2009. Red and orange dots denote large-scale CDM projects, and yellow and white dots denote small-scale activities.

At the lower prices paid in the voluntary markets, this volume amounted to some US$705m – sharply up from a mere US$23m in 2003.

Africa accounts for a mere 1 percent of voluntary carbon market transactions. Notably, Africa's share of the voluntary market has fallen sharply from 5.2 percent in 2006 as other countries have increased their supply of voluntary credits[4].

1.3. The CDM potential in Africa

In spite of Africa's low share of CERs, the continent has a substantial potential for generating carbon credits. A recent study commissioned by the World Bank identified the following opportunities for generating CDM credits that are available under the current rules of the CDM[5] (see also Annex II):

- **Second-cycle additions to open-cycle, gas turbine plants:** Conversion from an open cycle gas turbines (OCGT) to a closed cycle gas turbines (CCGT) presents a good CDM opportunity for countries in Africa. Currently, Africa has over 165 OCGT operational or under construction and closure of these open cycles could yield up to 200 CDM projects yielding 36 million tCO_2e per year.
- **Combined heat and power for industry:** Using combined heat and power systems to replace stand-alone generation facilities in African industries has an annual production potential of about 2.84 PJ of steam, 153.4 TWh of electricity, and 17.8 GW of additional installed power capacity.
- **Combined heat and power in sugar mills:** The potential for over 60 CDM projects exist in this field. Increased electricity production resulting from efficiency improvement is estimated at about 3,500 GWh, representing 1.23 percent of the energy generated in the countries where sugar mills operate. With a 90-percent load factor, this improvement will lead to additional power capacity of 660 MW or about 0.7 percent of installed capacity in those countries. The total emissions reduction achievable is estimated at about 2.4 million tCO_2e per year.
- **Agricultural/Biomass residue:** Biomass residue projects could total 554 if the opportunity in Africa is taken. It is estimated that these projects would generate some 41.5 GW of additional power. If implemented under the CDM, these projects would reduce emissions by about 140 million tCO_2e per year.
- **Hydroelectricity (small and large scale):** Hydroelectricity has vast potential in Africa and the implementation of programs covering small scale hydro and individual large scale hydro CDM projects could help Africa produce enough electricity to power the entire continent.
- **Flared gas recovery:** It has been shown that if flared gas is used in combined-cycle gas turbines to generate electricity in the 12 oil producing countries in Africa, about 29.5 GW of installed capacity can be put in place, representing nearly 55 percent of the installed power capacity in those countries.

[4] Source: State and Trends of The Carbon Market 2009 by The World Bank; Karan Capoor and Philippe Ambrosi.

[5] De Gouvello, C., F.B. Dayo and M. Thioye. 2008. Low-carbon Energy Projects for Development in Sub-Saharan Africa. World Bank. Washington D.C.

- **Waste gases in crude oil refinery:** This presents the opportunity for over 30 concrete projects in Africa and the recovery of over 63,600 TJ of energy whilst reducing emissions by over 5 million tCO2.
- **Improved steam system:** Over 20,000 TJ of energy would be saved in Africa if measures to improve steam energy efficiency were implemented. This savings in energy would lead to a reduction in GHG emissions estimated at 37 million tCO_2e per year.
- **Reduced clinker use in cement manufacturing:** Approximately 50 CDM projects could be developed in 24 countries using methodology ACM0005. When grouped, these projects would yield a total emission reduction of 2.9 million tCO_2 per year.

The same World Bank study has identified further opportunities for emission reductions that can be implemented as stand-alone CDM projects or Programmes of Activity (see Section 3 below):

- **Improved charcoal production:** Using the Adam Retort System for charcoal production provides the opportunity for over 60 Programs of Activities in Africa. Implementation of these facilities would reduction carbon emissions by slightly more than 25 million tCO_2e.
- **Improved biomass cookstoves:** Bio-fuelled cook stoves meet the bulk of cooking, heating and lighting needs of most rural households in Africa. Replacing these stoves with more efficient cookstove applications presents another opportunity for PoAs, regional or country specific.
- **Biodiesel from Jatropha:** Bio-diesel production from Jatropha offers robust opportunities for implementing CDM projects in countries across Sub-Saharan Africa. Degraded land can be used to cultivate Jatropha. If bio-diesel is used as a substitute for 20 percent of the diesel consumed in transport - annual emissions reduction of about 10.9 million tons of CO_2 could be achieved if these activities are implemented as CDM projects
- **Jatropha biofuels:** This presents an opportunity for PoA. A program substituting petro-diesel with biodiesel from Jatropha for power generation in countries of Africa would generate 1.5 GW of power or about 2 percent of installed power capacity and an emission reduction estimated at 8.5 million tCO_2e per year.
- **Switch to compact fluorescent lamps:** The use of over 500 million efficient lighting devices as CFLs in countries Africa will reduce power demand about 15,200 MW, representing 22.7 percent of these countries' total installed capacity. Again PoAs will provide the basis for unlocking carbon finance for this technology and it is expected that numerous PoA could be registered in each country.
- **Solar PV in isolated rural areas:** Africa has the potential to generate emission reductions of over 600,000 tCO_2 per year by implementing small scale PV projects in isolated areas. The nature of the project activity presents an opportunity for PoAs in this field. Over 200MW of electricity could be generated from this small scale source.

1.4. Emission reduction opportunities beyond the CDM

In addition to the above opportunities that can be seized under existing rules of the CDM, Africa has tremendous potential for generating land-based emission reduction certificates. Emissions from land-use change account for some 20 percent of global greenhouse gas emissions, and Africa's share is disproportionately high on a per capita basis. Nabuurs et al. (2007)[6] estimate that Africa can avoid some 1,160 million tons of CO_2e in annual greenhouse gas emissions from deforestation at a carbon price of up to $100 per ton in 2030. This amounts to 29 percent of the global total – a critical carbon sink that must be protected.

At present, though, the CDM rules governing emissions from Land Use, Land-Use Change and Forestry (LULUCF) are widely considered as impractical. The resulting carbon credits are temporary (so-called tCERs) and cannot be used for compliance purposes in most emissions trading schemes. A number of voluntary standards for forestry projects show that these technical issues around land-use change can be resolved, which would open up a large potential source of CDM revenues for African Governments. Of particular importance are Reduced Emissions resulting from Deforestation and Forest Degradation (REDD), which are part of the Bali Roadmap and need to be included in a post-Kyoto framework – either as part of the CDM or as a stand-alone mechanism.

To fully capture the LULUCF potential in Africa, the definition of afforestation and reforestation under the CDM or a REDD mechanism must be broadened to include agroforestry, assisted natural regeneration, forest rehabilitation, forest gardens, and improved forest fallow projects (Rosegrant 2007)[7]. To be viable these projects must be allowed to generate permanent CERs or equivalent REDD offsets just like all other CDM projects.

Since the focus of this paper is on carbon market opportunities that can be seized in Africa using currently available tools and rules, we will not further consider the LULUCF sector in this paper.

[6] Nabuurs, G.J., O. Masera, K. Andrasko, P. Benitez-Ponce, R. Boer, M. Dutschke, E. Elsiddig, J. Ford-Robertson, P. Frumhoff, T. Karjalainen, O. Krankina, W.A. Kurz, M. Matsumoto, W. Oyhantcabal, N.H. Ravindranath, M.J. Sanchez, and X. Zhang. 2007. "Forestry." In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, and L.A. Meyer. Cambridge, UK, and New York: Cambridge University Press

[7] Rosegrant, M.W. 2007. Pro-Poor Mitigation Strategies. Mimeo. Cited in Bryan et al. 2008.

2. WHAT IS HOLDING BACK CARBON MARKETS IN AFRICA?

In spite of a substantial potential to generate carbon credits the Clean Development Mechanism has so far failed to deliver for Africa. Only 2 percent of all CDM projects originate from Africa, and virtually no projects have been launched in tropical sub-Saharan Africa. The need to make the CDM work in Africa is frequently voiced by governments and market participants, and substantial resources have been devoted to capacity development (e.g. under the Nairobi Framework adopted under the UNFCCC). Yet, progress to date remains slow.

We see four sets of reasons for the limited uptake of CDM projects so far. First and most importantly, the cost of doing business in Africa is very high as a result of poor infrastructure, small market size, limited capacity of the private sector and government, corruption and insufficient or unclear regulatory frameworks. Projects in African countries tend to be smaller than in advanced emerging economies, but also suffer from high capital and operating costs since technical expertise and material frequently need to be imported. Yet progress is made on these fronts, as underscored by the World Bank's annual "Doing Business" survey which has identified many African countries among the fastest reformers.

Second, Africa has by far the lowest per capita emissions in the world, so the scope for reducing emissions is correspondingly lower than in countries like Brazil, China and India. The carbon markets partly penalize Africa for its low use of fossil fuels and heavy reliance on hydropower and biomass. But as the World Bank study on CDM opportunities shows, the potential for emission reductions in Africa is high even under the current scope of the CDM. Moreover, as highlighted further below, opportunities exist to increase the emission reduction potential from traditional CDM projects in Africa by careful analyses of grid factors and other key variables.

Third, as mentioned in Section 1.4, the CDM currently does not properly address forestry and land use change – the areas where Africa has substantial potential for reducing carbon emissions. Negotiations are under way to establish a new REDD mechanism and find effective ways to bring agriculture into the carbon offset market. If successful, these activities will allow Africa to drastically increase access to carbon finance.

Fourth, and this is the focus of this report, the CDM process as it is currently practiced is poorly adapted to the special needs of Africa. The process for registering CDM projects is complex and expensive; requires expert technical input that is in short supply across the continent; necessitates extensive baseline data, which is difficult to obtain in Africa; and will take a long time, up to 18 months for registration and an additional 12 months before the first credits are issued (see Section 3.1). These long delays and added uncertainty resulting from the case-by-case decision making by the CDM Executive Board currently make it difficult to use future revenues from carbon credits to co-finance the upfront investment costs associated with renewable energy and other projects that reduce greenhouse gas emissions.

The prevailing uncertainty about a post-Copenhagen climate regime further complicates investments into the CDM. However, this uncertainty poses less of a constraint for CDM activities in Africa since the European Union has already committed to admitting post-2012 CERs from least developed countries into the EU ETS. This means that most projects developed today in sub-Saharan Africa will be eligible for meeting compliance needs in Europe.

In summary, significant barriers exist that make it difficult for African countries to develop carbon credits under the CDM. Alternative voluntary standards exist, but they often suffer from similar problems, and the resulting credits command substantially lower prices.

3. HARNESSING THE PROGRAMMATIC CDM FOR AFRICA

3.1. How do CDM projects generate emission reductions?

The process for registering a standard CDM project is lengthy and involves many steps and actors (Figure 2). First, a project developer prepares a detailed scoping study or Project Identification Note (PIN) followed by a detailed Project Design Document (PDD) that describes all the technical parameters of the project and how emission reductions will be generated and monitored. Based on the PIN or PDD a host-country Designated National Authority (DNA) will issue the host country approval. Subsequently or in parallel, the project owner will contract an independent validator, a so-called Designated Operational Entity (DOE), to validate the project and refer it to the CDM Executive Board (CDM EB) at the UNFCCC for registration. At this point the project will be able to start generating Certified Emission Reductions (CERs), the carbon credits issued under the Clean Development Mechanism.

To generate the carbon credits, a project will need to carefully monitor its greenhouse gas emissions and periodically contract a DOE to independently verify the emission reductions that have occurred. Based on the monitoring and verification reports provided by the DOE to the CDM Executive Board, the latter will finally issue the CERs to the project owner or a designated representative.

Figure 2: The process for registering standard CDM projects

This complex and extremely time-consuming process needs to be repeated for every project with little efficiency gains across projects. Typically, a project developer will need to wait some 12-18 months from the completion of the PIN until the successful registration of the project. It can then take another 12 months until the first credits are issues – a full 2.5 years after the beginning of the process.

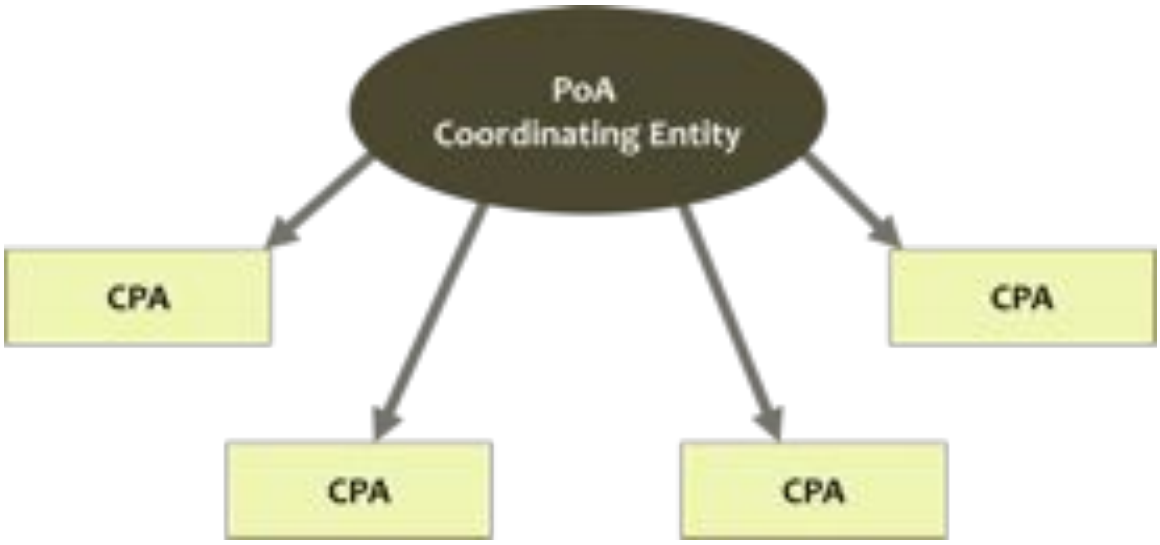
Since each of the steps involved in this process, project developers may need to spend some €70-130,000 per project on external CDM advisors and Designated Operational Entities before the project is registered. Clearly, such a cumbersome and lengthy process will not work well in a typical African country.

3.2. What is a Programme of Activities?

In an effort to reduce transaction costs in the CDM and expand the mechanism's applicability to very small project activities, the CDM Executive Board has launched the "Programme of Activities" (PoA) modality. Under this modality a PoA Coordinating Entity (government, NGO or business) [8] develops a PoA, which defines broad parameters for project activities (referred to as "CDM Programme Activities" – CPAs) that are eligible for inclusion in the PoA.

The main differences between a Programme of Activities and stand-alone CDM projects is that the latter require each project to be approved individually (or as part of a bundle) by the CDM Executive Board. Once a project has started the process towards registration it becomes difficult if not impossible to change project specifications without losing the carbon credits. Moreover, every new project needs to go through the same validation/registration process with high transaction costs and limited economies of scale. In contrast, a PoA needs to be registered only once by the CDM EB (together with its first CPA) and thereafter can include an unlimited and unspecified number of individual projects without recourse to the CDM EB (Figure 3).

Figure 3: The structure of a PoA



[8] The issue of funding for PoA Coordinating Entities is important. In the long-term, such entities should be self-sustaining with income provided through the services offered. However, in the short-term, especially for the first few to pilot the concept, external support may be required.

Figure 4 illustrates the process for registering and operating a PoA. The registration of the initial PoA and its first constituent CPA is similar to the process for a stand-alone CDM project (Figure 2). Design documents for the PoA and the CPA need to be prepared and validated by a Designated Operational Entity (DOE) before being submitted for registration by the CDM EB. This registration process will likely take a little longer compared with a stand-alone project since the validation of a PoA is more complex.

Figure 4: Registration of a PoA and inclusion of new CPAs

Once a PoA has been registered by the CDM Executive Board, new projects that meet the requirements of the PoA can be included as CPAs using an accelerated process that does not require approval by the CDM Executive Board in Bonn. Instead, a project developer only needs to fill in the CPA-specific parameters into a standardized CPA Form, which is then validated and included in the PoA by a DOE. Since many parameters for the PoA and its constituent CPAs are defined at the program level, the inclusion of new CPAs can be greatly streamlined and shortened to perhaps three months – compared with some 15-18 months for the registration of a stand-alone CDM project.

The monitoring for all CPAs is coordinated by the PoA Coordinating Entity. All CPAs included in a PoA are verified simultaneously by one DOE following a standardized process laid out in the PoA Design Document. So both monitoring and verification can be greatly streamlined to generate substantial economies of scale.

PoAs and stand-alone projects apply the same CDM principles and tools (e.g. methodologies and monitoring protocols, additionality proof, emission baselines, early CDM consideration). They generate the same types of credits and are governed by the same bodies.

3.3. Implications for the carbon markets in Africa

Programmes of Activity offer tremendous advantages over the prevailing project-based approach:

- Drastically shorter "time to market" for project operators who wish to secure CER revenues since CPAs no longer require approval from the CDM Executive Board in Bonn.
- Substantially lower transaction costs since the registration and verification processes for CPAs are greatly streamlined.
- Full scalability since, in contrast to a standard CDM project, a PoA does not need to define ex-ante the scale and location of each project activity. For example, a Government could set up a PoA for solar water heaters without defining how many heaters are deployed. Each new solar water heater can then be validated as a new CPA, thus offering the prospect of a national-scale program.
- Opportunities for the poor and small firms to benefit directly from CDM revenues to promote low-carbon technologies. For example, a family buying a solar water heater under a registered PoA program could receive a subsidy over a share of the carbon credits generated.
- Opportunities to convert future carbon revenues into upfront carbon financing by reducing the risk of non-registration. Since the time to registration and associated uncertainties are greatly reduced for CPAs compared with standard CDM projects it will become possible to provide pre-payments for future CDM revenues. This would enable the PoA Coordinating Entity to finance a part of the upfront capital costs through future carbon revenues (Box 1).
- A mechanism for regional programs. The CDM rules allow for international PoAs, so several African countries, such as members of the East-African Community or ECOWAS, could join forces to develop a regional PoA for, say, solar water heaters. Such regional programs would further reduce the transaction costs and generate economies of scale that would otherwise be impossible to achieve in smaller African countries.

Box 1: The need to move from "carbon revenues" towards "carbon finance"

A typical CDM project will begin to generate its first CERs some two years after the registration process began. The resulting "carbon revenues" are subject to major risks including but not limited to (i) non-registration by the CDM Executive Board, (ii) lower CER volumes than predicted in the design documents, and (iii) drastic swings in CER prices. As a result of the high risk and long delays, future carbon revenues cannot act as "carbon finance" that either contributes to meeting the upfront capital costs of a project or is available at the moment of financial closure. Likewise, even in the most advanced CDM markets, such as China and India, banks will typically not provide loans on the back of carbon revenues for projects that have yet to be registered or pass the validation stage.

In a nutshell, a successful CDM project will increase the internal rate of return of a project by raising operating revenues, but it will not contribute towards meeting the initial financing costs. Most importantly, it will not lower the amount of equity financing needed, which is particularly scarce in Africa. Unless these hurdles towards generating genuine "carbon finance" are overcome (e.g. by moving towards a PoA approach) the CDM can only make a marginal contribution towards increasing the number of successful projects in Africa.

In summary, PoAs can address some of the CDM-specific challenges that currently bedevil CDM projects in Africa and can create markets for generating CDM credits whereas no stand-alone projects can thrive under the CDM at present. Yet, to date, the promise of PoAs remains unfulfilled, and only one PoA has been registered[9]. In spite of the recent reforms to the PoA rules, several important issues remain:

- Unclear and potentially large liabilities for the erroneous inclusion of CPAs in a PoA;
- High upfront cost of developing a PoA (perhaps some €120-200,000 depending on the scope and complexity of the programme);
- Lack of experience in developing PoAs, which makes it impossible to predict the time it will take to register a PoA;
- Lack of clarity on how international PoAs can be set up and managed;
- Uncertainty about legal and taxation issues facing PoA Coordinating Entities that are not related to the CDM (e.g. VAT treatment, operational liabilities, restrictions on foreign ownership and applicable jurisdictions).

These issues, in conjunction with the challenges identified in Section 2, make PoAs a risky proposition for private companies, particularly in Africa. To this end, public-private partnerships are needed to launch a number of signature PoAs for each region in Africa. If successful, they will help kick-start such partnerships as well as broad-based activities to promote clean development in Africa and mobilize substantial amount of carbon finance for the continent.

3.4. Options for implementing a PoA

To successfully launch and manage a PoA, the PoA Coordinating Entity may offer (either on its own or through contractual arrangements with other parties) several sets of services:

1. **Inclusion of new projects:** A PoA Coordinating Entity can support the registration of large numbers of CPAs that may be developed by different project owners. Since this represents a major operational challenge, the Coordinating Entity must have robust project management systems in place that can effectively manage a large number of CPA registrations at minimal cost and risk.
2. **Commercialization of CERs:** The PoA Coordinating Entity can aggregate the CERs issued by a PoA and sell/auction them on a spot and/or forward basis to attract better prices than could be achieved alone by a CPA owner. As necessary, the PoA Coordinating Entity will be able to segment the portfolio and sell senior tranches at attractive forward prices.
3. **Full monitoring and verification support:** The PoA Coordinating Entity will develop and offer a monitoring platform that automates – to the extent possible – the collection of monitoring data needed for the verification process. Such a platform will greatly reduce monitoring

[9] The only PoA that has been registered by November 2009 is located in Mexico. The CUIDEMOS program distributes compact fluorescent light bulbs (CFLs) to households across the country. For more information see: http://cdm.unfccc.int/ProgrammeOfActivities/poa_db/17BH6AJX524TYQUZF8KGCWV3OIPSE9/view

costs and limit the risk of CER losses that the verification stage. The service will also support O&M activities and permit remote supervision of projects by automating the measurement of key performance variables.

4. **CER securitization and CER pre-payments:** With the political risk of non-registration by the CDM Executive Board substantially reduced, the PoA Coordinating Entity can, in cooperation with CER buyers and/or banks, offer CER pre-payments and other forms of CER securitization that will help finance the upfront capital costs of new CPAs.
5. **Structured financing solutions:** The PoA Coordinating Entity may collaborate with investors to offer standardized debt and/or equity financing solutions for CPAs on terms that will be more attractive than could be secured for stand-alone CPAs. For investors, a PoA offers an effective platform to pool the counterparty risk involved in a large number of discrete transactions.

Few organizations are able to perform all of the necessary functions required from an effective PoA Coordinating Entity, so creative solutions must be found to bring together the requisite pieces of the puzzle, including an adequate balance sheet. This is an area where innovative public-private partnerships are required to advance the state of play. Several operational models appear possible for implementing PoAs in Africa:

- **Option 1: Government-owned and operated PoA.** A government will set up and operate a PoA as a direct means to support the implementation of its policies, for example the promotion of renewable power generation or programs for the distribution of compact-fluorescent light bulbs. To be effective, governments will have to develop good solutions to addressing the operational management challenges. In contrast to the other options, this approach will be difficult to implement as part of an international PoA.
- **Option 2: Government concession.** Similar to Option 1, the government assumes the ownership of the PoA, but licenses its operation out to private operators. Again, a natural monopoly may be established that offers the benefits of scale and ease of implementation, but needs to develop effective checks and balances to ensure high-quality service and manage associated principal agent problems.
- **Option 3: Private PoA.** In this case, governments award a letter of approval to a private company or NGO who will establish and own a PoA. It then becomes possible to issue letters of approval to more than one PoA in the same space to create competition. One challenge inherent in this approach lies in identifying effective ways for coordinating public policies (including possible public co-financing for the establishment of the PoA) and the private interest in running the PoA.

Many other operational models are conceivable for operating PoAs. In reviewing concrete PoA opportunities, it is therefore important to determine which types of operational models may be most suitable for launching and operating a particular PoA. Either way, an effective Coordinating Entity is at the heart of a successful PoA. Annex III outlines the terms of reference for a typical PoA Coordinating Entity and summarizes some of the key tasks that need to be accomplished.

3.5. How might PoAs fare under a post-2012 climate framework?

It is impossible to predict at present what shape post-2012 international offset mechanisms and other mitigation programs may take, but some trends can already be identified. They all point towards a stronger role for PoAs and, ultimately, sectoral approaches for mitigating carbon emissions.[10]

- In order to reach the scale of emission reductions indicated by science and to meet rapidly growing demand for offsets from developed countries, the emphasis will shift away from registering individual projects towards programmatic or sectoral approaches.
- Increasingly, the international carbon markets will serve as a tool for governments to implement national policies (e.g. promotion of renewable energy), thus further accelerating the shift towards programmatic or sectoral mechanisms.
- It seems likely that emerging economies, which have not committed to absolute reductions in carbon emissions, will institute some form of Nationally Appropriate Mitigation Actions (NAMAs).
- To further reduce transaction costs, successful offset mechanisms will move towards benchmarks and other standardized approaches towards determining emission reductions and additionality.
- Monitoring requirements will remain strict to maintain the environmental integrity of international offsets, but monitoring protocols need to be standardized to support larger-scale activities.
- It is likely that the US and other countries may accept other offset standards in addition to the CDM. These offset standards will focus on minimizing transaction costs associated with validation, registration and verification of emission reductions.

Many of the technical and operational issues that need to be resolved in order to make PoAs work effectively will be at the core of future sectoral crediting and offset mechanisms that are likely to play a central role in mitigating greenhouse gas emissions in developing countries after 2012. These challenges include:

- Additionality and eligibility tests for broadly defined categories of projects;
- Contracting individual projects developed by different parties under a national (or regional) umbrella program;
- Monitoring and verification of greenhouse gas emissions across a large number of projects
- Effective management of emission reduction certificates and financial flows to and from the projects;
- Enforcement mechanisms for the effective implementation of the programme.

In this way, PoAs become an important precursor or stepping stone towards NAMAs and fully-fledged sectoral crediting mechanisms under a post-Kyoto framework. So while the legal basis for the latter has not been adopted PoAs provide not only a mechanism for taking the CDM to scale in

[10] This conclusion is echoed in recent statements by the chair of the CDM Executive Board who has been emphasizing the importance of programmatic approaches.

developing countries, but also a framework for thinking through how large-scale mitigation efforts can be accomplished after 2012.

4. PRACTICAL STEPS FOR LAUNCHING POAS IN AFRICA

The Africa Progress Panel has brought together experts from African governments, the private sector, non-profit organizations, international organizations, and donor agencies to review the potential of PoAs in Africa and identify practical next steps to scale up the programmatic CDM in Africa. The key findings and recommendations for actions are summarized below. These practical steps can and should be pursued right away.

4.1. Large potential for PoAs in Africa

Market demand for carbon credits in Africa is very high and exceeds available supply. As a result, it is possible to sell emission reductions from high-quality African projects at a substantial premium, particularly if the credits are registered under the CDM and supplementary quality standards, such as the Gold Standard.[11]

Programmes of Activity are well-suited to assist African governments in overcoming some of the obstacles that are currently associated with the CDM and doing business in Africa. A well-designed PoA can generate a "pull effect" for new projects that rely on carbon finance and thereby open up new markets. This will help African countries seize their untapped potential for mobilizing carbon finance to support sustainable development and the achievement of the Millennium Development Goals. In particular, regional PoAs can help African countries reduce transaction costs and achieve the economies of scale that are out of reach in the smaller countries. A central recommendation from participants in the workshop was to promote the establishment of regional PoAs. Annex I describes and assesses some of the most attractive PoA opportunities in Africa.

4.2. PoA venture funding and capacity development

Substantial progress has been made in strengthening the capacity of CDM market participants in Africa under the Nairobi Framework and other initiatives. Yet, the complexity of setting up a PoA and its Coordinating Entity (see Annex III) is not matched by the experience and expertise of market participants on the ground, thus requiring targeted capacity development.

Since awareness of CDM and its principles has already been heightened across Africa, the focus of capacity development efforts must now shift to kick-starting concrete PoAs across Africa with a strong emphasis on regional programmes. A well-designed PoA in Africa will require public-private partnerships that are implemented in conjunction with a broad range of private and public stakeholders. Thus, it offers the best prospects for promoting the "learning by doing" that is

[11] For more details about the Gold Standard see www.cdmgoldstandard.org. The Gold Standard has recently issued rules for developing PoAs under the Gold Standard label. See http://www.cdmgoldstandard.org/fileadmin/editors/files/6_GS_technical_docs/GSv2.1/Annex_F.pdf

fundamental in (i) building the capacity of the PoA Coordinating Entity, (ii) supporting governments in developing clear frameworks for mobilizing carbon finance through programmatic approaches, and (iii) broadening the awareness of how the carbon markets can support development across Africa.

However, the high upfront costs of PoAs represent a major financing challenge that is currently not being met. Participants in the workshop estimated that some €150-200,000 may be required to develop a PoA up to a point where market-based financing can become available. These upfront costs may be higher in the case of regional PoAs and thus represent a barrier that cannot be overcome through private financing alone.[12]

Workshop participants have identified an urgent need for the provision of venture finance to support the high-risk early phase of developing a PoA. A successful precedent for such facilities exists in the form of the PoA Support Center through which KfW currently supports some 20 PoAs[13]. The PoA Center demonstrates how increased grant and concessional loan financing can support the development of promising and commercially successful PoAs that would otherwise not be undertaken by the private sector alone.

More facilities along the lines of KfW's PoA Support Center are required to kick start the carbon markets in Africa and promote the much needed "learning by doing". To ensure maximum leverage and success their support could be structured along the following principles:
Prioritize funding for regional PoAs in Africa to minimize transaction costs and extend the carbon markets to small African countries that would otherwise risk being excluded.

Provide staggered financing for the key stages involved in launching a PoA. These include PIN development, establishment of PoA Coordinating Entity, PoA Design Document, and PoA validation (Figure 4).

Allocate adequate grant financing for the establishment of the PoA Coordinating Entities and ensure that their operational capacities are developed so that they can fulfill their roles effectively (see Annex III). This may involve transferring lessons learned in other regions to Africa.

Require private participants to contribute to the cost of PoA development. One option would be to require the repayment of initial grants from successful PoAs to generate revolving funds.

Publicize and share lessons with market participants in Africa and beyond.

4.3. Effective DNA support

Successful PoAs and carbon markets require close coordination with governments, particularly the Designated National Authorities (DNAs) that approve CDM projects and PoAs (see Sections 3.1 and 3.2). The CDM rules issued by the UNFCCC provide little guidance as to how PoAs should be

[12] The upfront costs for developing a PoA in Africa tend to be higher than in more developed carbon markets of Asia and Latin America. Moreover the small size of African countries and the low per capita emissions result in lower volumes of carbon revenues generated by PoAs.

[13] For more details see http://www.kfw-foerderbank.de/EN_Home/KfW_Carbon_Fund/PoA_Support_Centre_Germany/index.jsp

implemented at the national level and – appropriately – invite Governments and DNAs to develop and implement the rules and standards that should apply at the national level. As such, DNAs play a central role in ensuring that PoAs are consistent with Governments' sustainable development objectives, but they must maintain a fine balance so as to not create an unnecessary regulatory burden that will slow down or even prevent the development of new PoAs.

Therefore, African DNAs should use available DNA fora and regional workshops, as well as capacity development support under the Nairobi Framework and other initiatives to familiarize themselves with the PoA modality and how best to support effective implementation. Key upcoming meetings to advance these discussions include the regional consultations of the African Ministerial Conference on the Environment (AMCEN) scheduled for early 2010 and carbon market events such the second all-Africa Carbon Forum in Nairobi on 3-5 March 2010[14]. Moreover, international organizations that conduct capacity building, such as UNFCCC, the World Bank, UNEP and UNDP, should proactively organize and develop PoA training programmes to build capacity and increase understanding towards PoA development and implementation. Of particular importance for success will be effective support for regional PoAs, which will *inter alia* require that DNAs approve PoAs that are coordinated by entities which are not registered under the national laws of the country.[15]

4.4. Simplifying the CDM to meet Africa's special needs

The current CDM rules tend to be too demanding in terms of data and technical expertise to be readily applicable in Africa. Fortunately, the CDM Executive Board shares this assessment and has recently published recommendations on how to improve the regional distribution of CDM project activities[16]. These recommendations must be implemented promptly if PoAs are to become a viable prospect in tropical sub-Saharan Africa.

In particular, the following CDM Executive Board recommendations should be prioritized:

- standardized baseline and additionality benchmarks;
- the development of more methodologies with potential application in least developed countries;
- the creation of a positive list of project types for which the additionality test will be greatly simplified.

Africa has a huge potential for biomass and household based CDM activities, but unfortunately these types of projects require extremely complex CDM methodologies. In particular the required surveys and field studies are difficult to obtain at reasonable costs in most African countries. Workshop participants identified several ways in which biomass and household-based CDM activities can be facilitated. These include the development of

- Default baseline fuel consumption for lightning purposes

[14] See press announcement, http://unfccc.int/files/press/news_room/press_releases_and_advisories/application/pdf/20091111_pr_2nd_carbon_forum_africa.pdf

[15] For example, an East-African renewable energy PoA can be run by a PoA Coordinating Entity registered in any country in East Africa or elsewhere.

[16] http://cdm.unfccc.int/EB/050/eb50_repan54.pdf

- Default baseline wood consumption for domestic/cooking purposes
- Clear and simplified guidelines on how to assess the non-renewability fraction of biomass.
- Default non-renewability fraction values for areas with clear deforestation tendency or already deforested.
- Default equipment lifetime (e.g. for CFL PoAs)
- Authorization of regional grid emission factors

All of these modifications are consistent with the current rules of the CDM, so their implementation should be undertaken as quickly as possible. Once adopted, these changes will greatly support the development of CDM projects and PoAs in Africa and other developing regions.

4.5. Effective advocacy in support of PoAs in Africa

The development of PoAs that support sustainable development in Africa represents a major challenge. Identifying and addressing the many obstacles and operational challenges that will emerge as the concept is rolled out will also require an effective forum for advocacy and information exchange that relates to projects and programs with a high development impact. Discussions are currently underway to set up such a forum under the leadership of the Gold Standard, GTZ South South North and GTZ. Participants in the APP workshop agreed to consider joining and promoting such a forum as soon as it is launched.

ANNEX I: PROFILES OF KEY POA OPPORTUNITIES IN AFRICA

This Annex describes in detail available opportunities for developing PoAs in Africa and analyses the strengths and challenges involved with each type of technology. As outlined in the main body of the document, we focus only on PoAs that use available CDM methodologies and can be launched under the rules of the CDM as they currently stand.

Table 1 summarizes options for mobilizing carbon finance for the different PoAs described in this Annex and assesses the technical and commercial attractiveness of each PoA opportunity using a traffic-light color scheme:

- Green: promising potential and/or no significant implementation barriers
- Yellow: moderate potential and/or significant implementation challenges
- Red: low potential and/or high implementation barriers

In each thematic area PoA opportunities are ranked by decreasing order of priority. The following criteria (columns) are assessed:

- **CER potential:** How large are the PoAs in terms of generating CERs and their ability to cover operating expenses through CDM revenues?
- **Impact of carbon finance:** How important is the contribution that CERs can make towards meeting the capital and operating expenditures associated with the project activities?
- **Sustainable development benefits:** To what extent could a PoA advance the sustainable development objectives of African countries?
- **Additionality:** How can additionality be demonstrated, and will this additionality proof present a major obstacle towards developing the PoA?
- **CDM methodologies:** Which available large-scale and small-scale CDM methodologies apply, and are they suited for the PoA in question?[17]
- **Emissions baseline:** How can the emissions baselines be determined for each methodology, and are they adequate for assessing emission reductions under the PoA?
- **Monitoring:** How complex and costly are corresponding monitoring and verification requirements under this PoA?
- **Ease of implementation:** How straightforward are the design and operation (including monitoring and verification) of the PoA?

[17] Approved Consolidated Methodologies (ACM) for large-scale project activities and Approved Methodologies for Small-scale project activities (AMS) are available on http://cdm.unfccc.int/methodologies/index.html.

Table 1: Summary of key PoA opportunities in Africa

	CER potential	Impact of carbon finance	Sustainable development benefits	Additionality	CDM Methodologies	Baseline emissions	Monitoring	Ease of implementation
1. ELECTRICITY GENERATION FROM RENEWABLE POWER								
Hydro	High, but depends on countries' grid factors	Potentially high, but depends on countries' grid factors	High	Financial barriers, common practice barriers	grid-connected plants: ACM0002 (large-scale), AMS-I.D (small-scale)	Countries GEF - some countries need to compute GEF, and low GEF penalizes countries with high renewable share	Measurement of only one parameter: annual net electricity generation	Straightforward
					Off-grid plants: AMS-I.A (small scale)	Diesel and petrol generator-sets	Measurement of only one parameter: annual net electricity generation	Straightforward
Biomass	High, but depends on countries' grid factors	Potentially high, but depends on the availability of "biomass baselines" and, to a lesser extent, on countries' grid factors	High, but biomass needs to be sourced sustainably and nutrients must be returned to the soils	High capital expenditure and technological barriers ensure additionality	Grid-connected plants: ACM0002, AM0007, ACM0006, AM0027; AMS-I.D (small scale)	Countries GEF and Methane Avoidance: in anaerobic conditions biomass releases methane into the atmosphere	Annual net electricity generation and methane avoidance: baseline scenarios, waste composition and environmental conditions	Sustainable source of renewable biomass needed & monitoring is complex
					Off-grid plants: AMS-I.C; AMS-III.E	Methane Avoidance: in anaerobic conditions biomass releases methane into the atmosphere	Methane avoidance: baseline scenarios, waste composition and environmental conditions	Sustainable source of renewable biomass needed & monitoring is complex

	CER potential	Impact of carbon finance	Sustainable development benefits	Additionality	CDM Methodologies	Baseline emissions	Monitoring	Ease of implementation
Wind	High, but depends on countries' grid factors	Potentially high, but depends on countries' grid factors	High	Renewable energies are expensive in Africa and there is little experience of their use. Financial barrier	Grid-connected plants: ACM0002 (large-scale), AMS-I.D (small-scale)	Countries GEF - some countries need to compute GEF, and low GEF penalizes countries with high renewable share	Requires measurement of one parameter: annual net electricity generation	Straightforward
					Countries GEF - some countries need to compute GEF, and low GEF penalizes countries with high renewable share	Diesel and petrol generator-sets	Requires measurement of one parameter: annual net electricity generation	Straightforward
Geothermal	High, but depends on countries' grid factors	Moderate	High	High exploration and capital costs; barrier test can also be applied in many circumstances as this is a new technology for most of Africa.	Grid-connected plants: ACM0002 and AM0072	Countries GEF - some countries need to compute GEF, and low GEF penalizes countries with high renewable share	Annual net electricity generation and fugitive emissions of carbon dioxide and methane due to release of non-condensable gases from produced steam and operation of the geothermal power plant.	Exploration leads to long timeframes
					Off-grid plants: AMS-I.C	Use of coal fired and biomass fired boilers and stoves.		Exploration leads to long timeframes
Solar PV	High, but depends on countries' grid factors & commercial viability of solar PV	Low	High	Solar Power is the most expensive renewable energy.	Grid-connected plants: ACM0002 (large-scale), AMS-I.D (small-scale)	Countries GEF - some countries need to compute GEF, and low GEF penalizes countries with high renewable share	Measurement of only one parameter: annual net electricity generation	Straightforward
					Off-grid plants: AMS-I.A (small scale)	Diesel and petrol generator-sets	Measurement of only one parameter: annual net electricity generation	Straightforward

	CER potential	Impact of carbon finance	Sustainable development benefits	Additionality	CDM Methodologies	Baseline emissions	Monitoring	Ease of implementation
Concentrated Solar Power (solar thermal)	High, but depends on countries' grid factors	Low, but will increase as technology cheapens	High	Solar Power one of the most expensive renewable energy sources, so financial and technological barriers are widespread.	Grid-connected plants: ACM0002 (large-scale), AMS-I.D (small-scale)	Countries GEF - some countries need to compute GEF, and low GEF penalizes countries with high renewable share	Measurement of only one parameter: annual net electricity generation	Straightforward
					Off-grid plants: AMS-I.C (small-scale)	Diesel and petrol generator-sets	Measurement of only one parameter: annual net electricity generation	Straightforward
2. HOUSEHOLD APPLICATIONS								
Household biogas	High, but depends on baseline use of biomass	Potentially high, but depends on countries' grid factors	High	New technology for African countries and relatively expensive	AMS-III.D; AMS-I.E; AMS-I.C and AMS-III.R	Methane Avoidance: in anaerobic conditions biomass releases methane into the atmosphere	Methane avoidance: baseline scenarios, waste composition and environmental conditions	Complex baseline and monitoring issues
Solar Water Heaters	High	High	High	High upfront costs in comparison to traditional methods.	AMS-I.C	The grid emission factor of the country or use the emission factor of the specific fuel type (i.e. Diesel).	Sample of energy produced by SWH systems; number of systems in operation and their operating hours.	Installation, maintenance and monitoring of large numbers of solar water heaters is very complex
Improved cookstoves	High	High	High	Improved cookstoves face high upfront costs in comparison to traditional methods.	AMS-I.C; AMS-II.C; AMS-I.E; AMS-II.G	Fuel and stove types used before the project scenario.	Complicated: determine fossil fuel traditionally used; the use of non-renewable biomass; calculation of total biomass use before project start; efficiency of a sample of stoves introduced; broken and replaced stoves.	Complex distribution and monitoring challenges

	CER potential	Impact of carbon finance	Sustainable development benefits	Additionality	CDM Methodologies	Baseline emissions	Monitoring	Ease of implementation
Compact fluorescent light bulbs (CFLs)	High	High	High	High upfront cost of CFLs in comparison to traditional sources	AM0046	Countries grid emission factor, which places some African countries at disadvantage. Highly complex determination of baseline operating hours.	Sampling & measurement of daily lighting usage or energy use of CFLs	Complex distribution, assignment of CER ownership, and monitoring
					AMS-II.C	Countries grid emission factor, which places some African countries at disadvantage. Highly complex determination of baseline operating hours.	Sampling & measurement of daily lighting usage or energy use of CFLs	Complex distribution, assignment of CER ownership, and monitoring
					AMS-II.J	Countries grid emission factor, which places some African countries at disadvantage. Restricted to household use.	Sampling & default factors	Complex distribution, assignment of CER ownership, and monitoring
Household solar PV devices	High	High if high-emission fuels are displaced, low if baseline is grid emission factor	High	High financial barriers ensure additionality	AMS-I.A	Diesel and petrol generator-sets, kerosene for solar lamps, baseline can be difficult to establish	Measurement of one parameter: annual net electricity generation, but need for extensive surveys and sampling	Complex due to complex monitoring protocols

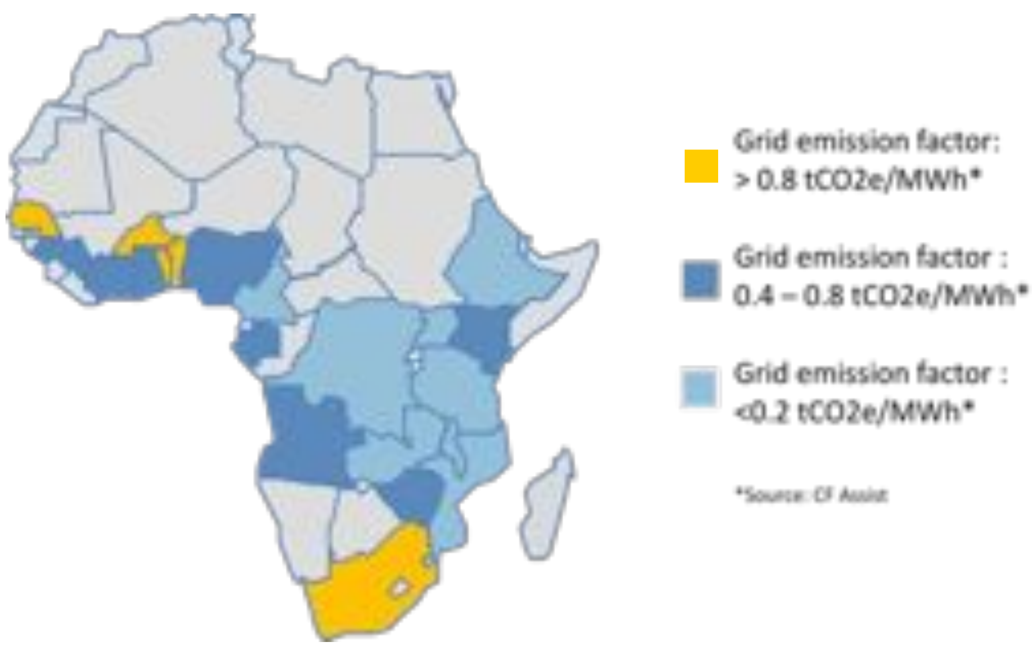
	CER potential	Impact of carbon finance	Sustainable development benefits	Additionality	CDM Methodologies	Baseline emissions	Monitoring	Ease of implementation
3. OTHER PoA OPPORTUNITIES								
Improved charcoal production	High	High	High	Negative IRRs are expected for projects without CDM revenue	AM0041 and AMS-III.K	Continuation of inefficient traditional methods	Weight of all wood used and charcoal manufactured; moisture of wood and charcoal; fugitive emissions	Complex monitoring
Jatropha biofuels	Moderate	Moderate	High if plantation covers marginal land, low if biofuel plantation competes with food production	Based on financial investment analysis, biofuels will be cost-effective only in rare cases. Therefore CER revenues will contribute significantly. The arguments of tech-nological barriers and prevailing practice barriers are applicable.	ACM0017 and AMS-III.T	Fuel type use in traditional circumstances. Typically petrol and diesel offsets are achieved.	Nitrogen based fertiliser utilisation, transport of biofuel, land use, land-use change, biofuel processing plant emissions and baseline fuel use	Complicated; requires captive fleet

1. ELECTRICITY GENERATION FROM RENEWABLE POWER

Africa faces severe power shortages together with a largely untapped potential for electricity generation from renewable power sources. With the exception of power generation from biomass, renewable energy projects are relatively easy to implement under the CDM since baselines and monitoring can often be established in a straightforward manner. Moreover, it is technically possible to combine several renewable energy technologies in one central PoA, which could substantially reduce transaction costs and expand the scope of the programme.

A central challenge for many African countries lies in the extremely low grid factors that result from a high reliance on renewable energy generation (see Section 2). As a consequence renewable energy projects in many African countries generate vastly fewer emission reductions than the same projects would obtain in countries that rely predominantly on fossil fuels. For example, a typical 10MW hydro power plant in Ethiopia may generate a mere 179 tCO2e per year compared with over 36,700 tCO2e per year for an identical plan in India.[18] Figure 2 summarizes available grid emission factors in Africa.

Figure 5: Select grid emission factors in Africa



This figure probably underplays the extent of variation across African countries. Opportunities for addressing this challenge were discussed during the workshop.

[18] Assuming a plant load factor of 60% and a grid factor of 0.0034 tCO2e/MWh for Ethiopia compared with 0.7 tCO2e/MWh for India.

Table 2: Grid emission factors for select countries in Africa and elsewhere[19]

Country	Average combined margin grid emission factor (t CO_2e/MWh)
Côte d`Ivoire	0.7291
Egypt	0.5325
Ethiopia	0.0034
Kenya	0.6545
South Africa	1.0481
For comparison:	
Brazil	0.3423
China	0.9285
India	0.8716
Mexico	0.5468

Renewable energy technologies differ markedly in their capital cost and production cost structure. Table 3 summarizes capital and operating expenditure for European power plants. Since capex and opex requirements in Africa tend to be substantially higher than in Asia and Latin America, European costs are a good approximation for the expenditures associated with a typical project in sub-Saharan Africa.

Table 3: Capex and opex requirements for renewable energy in Europe[20]

Technology	Capital expenditure (Euro per kW capacity)	Operating expenditure (Euro per kWh)[21]
Coal Fired	1,250 – 2,700	0.04 – 0.06
Gas	200 – 1000	0.06 – 0.09
Diesel	550 – 1,350	0.10 – 0.13
Nuclear	1970 – 3380	0.05 – 0.09
Wind	100 – 1370	0.08 – 0.11
Hydro Power	900 – 4800	0.04 – 0.19
Biomass	2,020 – 3220	0.08 – 0.20
Biogas	2,960 – 5,790	0.06 – 0.21
Geothermal	1,000 – 3,000	0.02 – 0.20[22]
Solar – CSP	4,000 – 6,000	0.17 – 0.25
Solar – PV	4,100 – 6,900	0.52 – 0.88

[19] Source: IGES CDM ERs Calculation Sheet: Grid Emission.

[20] Energy Sources, Production Costs and Performance of Technologies for Power Generation, Heating and Transpor by Commission of the European Communities, 2008

[21] The leveled production cost of electricity is used to compare the economic competitiveness among power generation technologies during their life time. The reported values for the production cost of electricity for each technology refer to a state-of-the-art facility. The reported range reflects variations in capital costs which depend on specific technology choices and plant location.

[22] Geothermal energy was not included in the report by the Commission of the European Communities. This data was accessed here: http://peswiki.com/index.php/Directory:Cents_Per_Kilowatt-Hour

1.1. Hydro Power

Overview

Hydropower is one of the cleanest and most reliable sources of energy. The African Continent is endowed with enormous hydropower potential (estimated at 15 percent of the world's potential), which is enough to meet all the electricity needs of the continent. However, only 7.6 percent of the economically feasible hydropower potential is currently being exploited (Table 4). Key barriers towards increasing hydropower utilization include poor but improving institutional frameworks (including feed-in tariffs), limited debt and equity financing, and the lack of technical expertise.

Table 4: Hydropower potential in Africa[23]

Gross Theoretical Hydropower Potential (GWh/year)	Technically feasible Hydropower Potential (GWh/year)	Economically feasible Hydropower Potential (GWh/year)	Installed hydro capacity (MW)	Production from hydro plants (GWh/Year)	Hydro capacity under construction (MW)	Planned hydro capacity (MW)
4,000,000	1,750,000	1,000,000	20,300	76,000	>2,403	>60000

Many African countries have been focusing on large-scale hydropower schemes, but small-scale hydro (typically < 20MW) or micro-hydro power (typically <0.1MW) plants are increasingly used as renewable energy sources, especially in remote areas where other power sources are not viable. Economically viable and proven small scale hydropower technologies are now available that have short gestation periods, low investment needs and minimal environmental impact.

Small-scale hydro power systems can be installed in small rivers or streams with little or no discernible negative environmental impact (e.g. on fish migration). In many instances, even larger run-off river hydro plants can also be designed with modest adverse environmental impact and in compliance with principles issued by the World Commission on Dams (WCD). For this reason, hydropower can play a critical role in meeting Africa's energy needs in a sustainable manner.

Countries/regions with high potential

90 percent, of the total installed capacity in Africa of 20.3GW, is concentrated in eight countries (D.R Congo, Egypt, Gabon, Ethiopia, Nigeria, Zambia, Madagascar, and Mozambique). The potential for hydro development can be broken down by region, and is summarized below (in order of potential):

1. Southern Africa: This region has exploited 60 percent of its potential, mainly through large-scale hydro projects, but small-scale potential is still largely unharnessed.
2. East Africa: East Africa has the second largest potential in Africa with about 20 percent of its capacity developed.

[23] Hydropower Resource Assessment of Africa by Water for Agriculture and Energy in Africa: http://www.sirtewaterandenergy.org/docs/2009/Sirte_2008_BAK_3.pdf

3. West Africa's contribution to installed large hydropower capacity is about 25 percent. The potential for large-scale projects in enormous in this region, but the same cannot be said for small hydro projects.

4. Central Africa: The region has enormous hydropower potential concentrated around the Congo basin

Table 5: Countries with high hydro potential in Africa

Southern Africa	East Africa	West Africa	Central Africa
Botswana	Burundi	Ghana	Angola
Lesotho	Djibouti	Nigeria	Cameroon
Madagascar	Ethiopia		Central African Republic
Namibia	Kenya		Chad
South Africa	Malawi		Congo
Swaziland	Rwanda		D.R. Congo
Zambia	Somalia		Equatorial Guinea
Zimbabwe	Tanzania		Gabon
	Uganda		

Available technologies

Several key technologies are available for hydropower:

1. Impoundment facility: This is commonly used for large hydropower plants and uses a dam to store river water in a reservoir.

2. A Diversion Facility: This is also referred to as "run-of-river" and channels a portion of a river through a canal or penstock.

3. Pumped Storage: When the demand for electricity is low, a pumped storage facility stores energy by pumping water from a lower reservoir to an upper reservoir.

A small hydro plant may be connected to a distribution grid or may provide power only to an isolated community or a single home. Small hydro projects generally do not require the protracted economic, engineering and environmental studies associated with large projects, and often can be completed much more quickly. A small hydro development may be installed along with a project for flood control, irrigation or other purposes, providing extra revenue for project costs.

Sustainable Development benefits

Hydropower offers an inexpensive, clean and reliable source of energy that can make a substantial contribution towards achieving MDG 1 on eradicating extreme poverty by offering energy services for productive activities. Moreover, hydropower projects create local employment during the construction and operation of the hydropower station. In some cases small-scale hydropower plants can also help improve the reliability of drinking water supply.

Estimated CDM revenues

Hydropower is one of the least expensive sources of renewable energy (Table 3). The volume of CDM revenues per hydro plant varies tremendously across different African countries depending on the baseline scenario and the grid emissions factor in the country the project is implemented. The table below gives an indication of how CDM revenues can have a positive financial impact on the project:

Table 6: Estimated CER revenues as a percentage of Capital Costs per MW[24]

	Euro15 / CER (% capex)	Euro30 / CER (% capex)
Ethiopia	**0.2 %**	**0.5 %**
South Africa	7.3 %	14.7 %
Uganda	3.8 %	7.5 %

The PoA opportunity

Table 7: Summary hydro PoA opportunity

CER potential	High, but depends on countries' grid factors	
Impact of carbon finance	Potentially high, but depends on countries' grid factors	
Sustainable development benefits	High	
Additionality	Financial barriers, common practice barriers	
CDM Methodologies	grid-connected plants: ACM0002 (large-scale), AMS-I.D (small-scale)	Off-grid plants: AMS-I.A (small scale)
Baseline emissions	Countries GEF - some countries need to compute GEF, and low GEF penalizes countries with high renewable share	Diesel and petrol generator-sets
Monitoring	Measurement of only one parameter: annual net electricity generation	Measurement of only one parameter: annual net electricity generation
Ease of implementation	Straightforward	Straightforward

Hydropower PoAs represent a promising opportunity in African countries where they can make a substantial contribution towards meeting capital and operating expenditure – particularly since such PoAs can also include other types of renewable electricity generation. Such PoAs and the carbon financing they can mobilize at substantially lower transaction costs have the potential to create a pull effect for new hydropower projects in Africa.

One example for a regional PoA is the Small-hydro Programme for the East Africa Region (SPEAR) that has been initiated by the Ugandan Carbon Bureau. The Coordinating entity of this PoA will be located in Uganda. SPEAR will act as a support centre for small run-of-river hydropower projects of less than 15MW each in five countries: Burundi, Kenya; Rwanda, Tanzania, and Uganda.

[24] Assumes low capital cost of Euro 900,000 per MW and 4,000h operations per year under different primary CER prices

1.2. Biomass power generation

Overview

Biomass, such as wood, agricultural residue, manure, and waste products from animal/food processing industries, can be used to generate electricity through fermentation and combustion/pyrolysis processes. On a per capita basis, Africa is the world's largest consumer of biomass for energy generation, and biomass accounts for as much as two-thirds of total African final energy consumption. The vast bulk of biomass is used for cooking (Section 2.3) and increasingly household biogas applications (Section 2.1). This section focuses on other technologies that are available to convert biomass into electricity.

A key challenge in using biomass for power generation lies in ensuring the sustainable production (and regeneration) of biomass consumed. This is a critical requirement for claiming CDM credits.

Small-scale biomass projects can be an attractive option for municipal markets and other facilities where large volumes of biomass are generated regularly. In view of the highly distributed nature of such facilities and the prohibitive cost of transporting biomass over long distances, such projects can be most effectively managed through PoAs.

Countries/regions with high potential

Biomass is abundantly available in many African countries. Arid and semi-arid countries have correspondingly lower availability of biomass.

Available technologies

A large number of technologies exist to convert biomass into electricity. The most common processes include:

- **Biomass combustion:** Sugar refineries, rice mills and other plants that generate large volumes of dry biomass often double up as power plants where the heat from biomass combustion is used to generate power. Such power plants require high volumes of secured biomass supply, which can represent a major challenge in Africa.

- **Biomass co-firing:** Traditional fossil-fuel power plants (e.g. coal-fired power plants) co-fire biomass. This approach is common across much of Asia and Latin America, but it requires (i) existing fossil fuel-based power plants, and (ii) a reliable high-volume supply of biomass – both of which are in short supply in Africa.

- **Biomass gasification:** Both liquid and solid wastes can be treated in reactors under anaerobic conditions to generate methane (biogas) that can then power electricity generators. This technology is widespread among food-processing plants in Asia and Latin America where wastewater with high organic content is converted into biogas. Similar processes for solid biomass (agricultural residue, manure) have also reached maturity.

In addition a growing number of bio-fuels are available (see Section 3.2).

Sustainable Development benefits

Biomass-based power generation can make an important but ultimately modest contribution towards meeting countries' power needs. If carefully managed to ensure the exclusive use of renewable and sustainably harvested biomass, these technologies can provide efficient clean energy that is carbon neutral. Most importantly, biomass-based applications offer an opportunity for farmers, including smallholders, to generate additional revenues from the sale of their biomass, which in turn can help meet the poverty goals.

In turn, biomass projects must avoid situations in which they contribute to nutrient mining of soils. Unless the micro- and macronutrients taken from the soil in the form of biomass are returned in some form, the long-term effect of biomass-based power generation will be a gradual leaching of the soils. This problem is most acute in the case of biomass co-firing where it is virtually impossible to return the ash the fields from which the biomass was sourced. An additional problem with high-temperature combustion of biomass lies in the fact that during the process, nitrogen-based compounds can be converted into atmospheric nitrogen, which in turn adds to the negative environmental balance of biomass-based power generation. For these reasons, it seems that small-scale power plants based on biomass gasification may offer an attractive opportunity for generating biomass-based power in a sustainable manner.

Estimated CDM revenues

Like other forms of renewable energy, biomass-based power plants remain quite expensive (except in the case of biomass co-firing), but these costs are decreasing rapidly.

Table 8: Estimated CER revenues as a percentage of Capital Costs per MW[25]

	Euro15 / CER (% capex)	Euro30 / CER (% capex)
Ethiopia	0.1 %	0.3 %
South Africa	4.9 %	9.8 %
Uganda	2.2 %	4.5 %

[25] Assumes low capital cost of Euro 2,020,000 per MW and 6,000h operations per year under different primary CER prices

The PoA opportunity

Table 9: Summary Biomass PoA opportunity

CER potential	High, but depends on countries' grid factors	
Impact of carbon finance	Potentially high, but depends on the availability of "biomass baselines" and, to a lesser extent, on countries' grid factors	
Sustainable development benefits	High, but biomass needs to be sourced sustainably and nutrients must be returned to the soils	
Additionality	high capital expenditure and technological barriers ensure additionality	
CDM Methodologies	Grid-connected plants: ACM0002, AM0007, ACM0006, AM0027; AMS-I.D (small scale)	Off-grid plants: AMS-I.C; AMS-III.E
Baseline emissions	Countries GEF and Methane Avoidance: in anaerobic conditions biomass releases methane into the atmosphere	Methane Avoidance: in anaerobic conditions biomass releases methane into the atmosphere
Monitoring	annual net electricity generation and methane avoidance: baseline scenarios, waste composition and environmental conditions	methane avoidance: baseline scenarios, waste composition and environmental conditions
Ease of implementation	sustainable source of renewable biomass needed & monitoring is complex	sustainable source of renewable biomass needed & monitoring is complex

A biogas PoA can make a significant contribution towards mobilizing financing for this emerging field of power generation in Africa. Such a PoA cannot be combined with other renewable energy PoAs (using ACM0002 or AMS-I.D) since a separate biomass baseline will need to be considered.

Currently one Biomass PoA is under validation in India. The programme involves biomass boilers and biomass heaters being used as a replacement of existing fossil fuel fired heat generating systems, i.e. it falls into the category “biomass combustion” described above.

1.3. Wind Power

Overview

Currently, Africa has installed capacity of only 567MW – a tiny share of global capacity, which reached 121.2 GW at the end of 2008. Yet the potential for wind power is substantial across the continent, as the growing number of wind maps for African countries makes clear. In comparison with hydro power, wind power requires substantial scale to be economically viable. In contrast to hydro and solar PV, small-scale wind turbines tend to have vastly lower conversion efficiencies compared with larger-scale turbines. Commercial wind parks therefore use relatively large turbines mounted on high towers and tend to have at least 50MW capacity, which in turn requires large ticket-size investments.

Electricity generated from wind power suffers from high and often unpredictable intermittency owing to variable wind speeds. As a result, sophisticated grids and alternative power sources that can supplement wind power at short notice are required to increase reliance on wind. Most countries in sub-Saharan Africa do not meet these requirements, thus reducing the potential for wind power across the continent.

Countries/regions with high potential

Much of Africa lies in the tropical equatorial zones of the globe, and therefore, many of the land-locked nations in this zone have low wind speeds. As a result the southern and northern regions of Africa pose the highest potential for wind energy.

In the South of Africa, the following countries have the largest potential: South Africa, Zimbabwe, Namibia and Angola. In the North of Africa, Morocco and Egypt have the greatest potential and have been the pioneers of wind power development in Africa. More than 90 percent of wind capacity in Africa has been installed in this region. Other countries including Burundi, Djibouti, Eritrea, Kenya and Uganda have wind power potential, but to a lesser degree.

Available technologies

Wind power is the conversion of wind energy into a useful form of energy, such as electricity, using wind turbines. Wind power can be categorized according to its size where projects below 100kw capacity are seen as small scale and projects over this limit are defined as large scale. In recent years, wind power has reached commercial maturity, and turbine technologies are now well developed across the full spectrum from small to large-scale turbines. Wind power generation prices are gradually approaching grid parity.

Sustainable Development benefits

Wind power has no substantial adverse environmental impacts, and is one of the "cleanest" technologies available. Its deployment can create jobs, though most of the value added in a wind park will be generated by the turbine manufacturers who tend to be based outside Africa.

Estimated CDM revenues

Wind power compares favorably with other sources of renewable energy, both on a capital cost and operating cost basis. CERs accruing to wind projects can have a substantial impact on a projects capital expenditure and Internal Rate of Return:

Table 10: Estimated CER revenues as a percentage of Capital Costsper MW[26]

	Euro15 / CER (% capex)	Euro30 / CER (% capex)
Ethiopia	0.2 %	0.5 %
South Africa	8.3 %	16.5 %
Uganda	3.8 %	7.5 %

For example, annual CERs accruing to the successfully registered Zafarana wind farm in Egypt have been shown to increase annual revenues by over 6 percent and increased the IRR of the project by over 2 percent.

The PoA opportunity

Table 11: Summary Wind PoA opportunity

CER potential	High, but depends on countries' grid factors	
Impact of carbon finance	Potentially high, but depends on countries' grid factors	
Sustainable development benefits	High	
Additionality	Renewable energies are expensive in Africa and there is little experience of their use. Financial barrier	
CDM Methodologies	Grid-connected plants: ACM0002 (large-scale), AMS-I.D (small-scale)	Off-grid plants: AMS-I.A (small scale)
Baseline emissions	Countries GEF - some countries need to compute GEF, and low GEF penalizes countries with high renewable share	Diesel and petrol generator-sets
Monitoring	requires measurement of one parameter: annual net electricity generation	requires measurement of one parameter: annual net electricity generation
Ease of implementation	Straightforward	Straightforward

Currently, no PoAs involving wind power are being validated in Africa. Off-grid applications (e.g. for water and oil pumping) too have no projects registered in Africa. But projects using the grid connected methodologies have been registered in Morocco and Egypt, and these methodologies pose the biggest potential for wind development in Africa.

A PoA covering wind power has the potential to significantly decrease the costs associated with obtaining carbon finance and the resulting CERs will have a significant impact on both the IRR and capital expenditure associated with these projects. A southern and northern regional African PoA could facilitate the unlocking of wind power CERs. Such a PoA would require the large-scale ACM0002 methodology and can be broadened to include all other non-biomass renewable power sources.

[26] Assumes low capital cost of Euro 500,000 per MW and 2,500h operations per year under different primary CER prices

1.4. Geothermal Power

Overview

Geothermal power is extracted from the heat stored in the earth inner crust and originates from the original formation of the planet and the radioactive decay of minerals in the earth's core. Geothermal power can be extracted by drilling wells to tap concentrations of steam at high pressures and at depths shallow enough to be economically justifiable. The steam is then led by pipes to drive electricity-generating turbines.

Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation in Africa.

Geothermal energy potential stands at 9000 MW in Africa, but only about 60 MW has been exploited in Kenya and Ethiopia. Internationally approximately 8,100 MW of geothermal power is generated, out of a global potential of 60,000 MW. So many African countries can emulate Asian countries (e.g. Indonesia and the Philippines) that have launched major initiatives to harness geothermal power on a massive scale.

Countries/regions with high potential

Table 12: Countries with high geothermal power potential

Country	Potential Generation in MW
Djibouti	< 860
Ethiopia	> 1,000
Kenya	2,000
Tanzania	650
Uganda	450

Varying levels of geothermal exploration and research has been undertaken in Djibouti, Eritrea, Uganda, Tanzania, Zambia, Malawi and Madagascar but the potential for grid connected electrification is highest in Ethiopia, Kenya, Uganda and Tanzania. Government representatives from Ethiopia, Uganda, Tanzania and Eritrea have also expressed interest in using small scale geothermal plants for rural electrification mini-grid systems.

Available technologies

Three types of power plants are used to generate power from geothermal energy:

1. **Dry steam plants** take steam out of fractures in the ground and use it to directly drive a turbine that spins a generator.

2. **Flash plants** take hot water, usually at temperatures over 200 °C, out of the ground, and allows it to boil as it rises to the surface then separates the steam phase in steam/water separators and then runs the steam through a turbine.

3. **Binary plants** allow hot water flows through heat exchangers, boiling an organic fluid that spins the turbine.

The condensed steam and remaining geothermal fluid from all three types of plants are injected back into the hot rock to pick up more heat. This technology can be used only in certain parts of the world that are geothermally unstable.

Moreover, small-scale geothermal heat pumps (GHPs) can be used for small scale projects inducing space heating. According to the Environmental Protection Agency (EPA), GHPs offer the most energy efficient, environmentally clean and cost-effective space-conditioning system available. Systems generally comprise three main components: (1) an earth connection system, (2) a heat pump system and (3) a heat distribution system. This technology can be used in many parts of Africa.

Sustainable Development benefits

Among the benefits of geothermal power are the near zero emissions and small amount of land use in comparison to other energy sources. Geothermal energy also has an advantage over other renewables in that it is independent of climatic variation: during the 2-year drought between 1998 and 2000 in Kenya, the two geothermal power plants at Olkaria offered continuous base-load power with almost 100 percent availability, unaffected by the prevailing weather conditions.

Yet, as recent accidents in Indonesia and elsewhere have shown, poorly designed and executed geothermal drillings can also lead to major environmental damage, so careful planning and sound geological and engineering studies are critical. Caution should be employed when using geothermal energy in the vicinity of high-density urban settlements.

Estimated CDM revenues

A major disadvantage of geothermal power projects are the high capital costs, made up primarily of exploration, drilling and power generation unit costs. These are partially offset by extremely low operating costs for geothermal power. From an investor’s perspective, geothermal power has a skewed risk profile as substantial capital expenditure is required for exploration wells while the productivity of a well is subject to substantial uncertainty and can only be assessed fully after the conclusion of an exploration well. In spite of recent advances in the quality of feasibility studies, these essential uncertainties remain and complicate the development of geothermal power across the world.

CDM revenues will assist in covering these costs in countries where grid emission factors are high:

Table 13: Estimated CER revenues as a percentage of Capital Costs per MW[27]

	Euro15 / CER (% capex)	Euro30 / CER (% capex)
Ethiopia	0.2 %	0.5 %
South Africa	8.8 %	17.6 %
Uganda	4.0 %	8.0 %

The PoA opportunity

Table 14: Summary Geothermal PoA opportunity

CER potential	High, but depends on countries' grid factors	
Impact of carbon finance	Moderate	
Sustainable development benefits	High	
Additionality	high exploration and capital costs; barrier test can also be applied in many circumstances as this is a new technology for most of Africa.	
CDM Methodologies	Grid-connected plants: ACM0002 and AM0072	Off-grid plants: AMS-I.C
Baseline emissions	Countries GEF - some countries need to compute GEF, and low GEF penalizes countries with high renewable share	Use of coal fired and biomass fired boilers and stoves.
Monitoring	annual net electricity generation and fugitive emissions of carbon dioxide and methane due to release of non-condensable gases from produced steam and operation of the geothermal power plant.	
Ease of implementation	Exploration leads to long timeframes	Exploration leads to long timeframes

UNEP head Achim Steiner recently stated that "Geothermal is 100 percent indigenous, environmentally-friendly and a technology that has been underutilized for too long." The opportunities for large scale roll outs in East Africa are seen as concrete and efficiently recognizable. Small-scale application for space heating presents an opportunity throughout Africa, but to this date no CDM project has yet been registered. At present two geothermal CDM projects are under validation in Kenya.

[27] Assumes low capital cost of Euro 1,500,000 per MW and 8,000h operations per year under different primary CER prices

1.5. Solar Photovoltaic (PV)

Overview

Solar PV is the application of solar cells for energy by converting solar energy directly into electricity. Due to the growing demand for renewable energy sources, the manufacture of solar cells and photovoltaic arrays has advanced dramatically in recent years. Photovoltaic production has been doubling every 2 years, increasing by an average of 48 percent each year since 2002, and then increased by 110 percent in 2008. At the end of 2008, the cumulative global PV installations reached 15,200 megawatts. Roughly 90 percent of this generating capacity consists of grid-tied electrical systems. Africa's share of the PV market is less than 5 percent of the global market and has been falling in recent years.

Net metering and financial incentives, such as preferential feed-in tariffs for solar-generated electricity, have supported solar PV installations in many countries, but the very high capital costs represent a major barrier towards the deployment of this technology. While other developing regions (e.g. India, Turkey) are now building large-scale solar PV power plants, the application in solar PV in Africa has been confined to small applications, including household devices described in Section 2.5 below.

Countries/regions with high potential

Many African countries receive, on average, 325 days per year of bright sunlight. This gives solar power the potential to bring energy to virtually any location in Africa. See also Section 0 above.

Available technologies

Solar cells produce direct current electricity from light. The first practical application of photovoltaics was to power orbiting satellites and other spacecraft, but today, the majority of photovoltaic modules are used for grid-connected power generation, and to a lesser extent, off-grid services. The cost of solar PV devices has been coming down rapidly but remains very high. Moreover, in contrast to CSP the technology cannot generate power after sunset when power demand often peaks. One advantage of solar PV is that the panels require no or minimal maintenance after deployment, so they are ideal for remote rural areas where access to technical expertise is low.

Sustainable Development benefits

Unlike fossil fuel based technologies, solar power does not lead to any harmful emissions during operation, but the production of the PV panels leads to some amount of pollution which is negligible in the long term.

Estimated CDM revenues

Solar PV is the most expensive source of renewable power in Africa. As can be seen from the table below, CDM revenues from Solar PV currently do not make a substantial contribution towards meeting project financing.

Table 12: Estimated CER revenues as a percentage of Capital Costs per MW[28]

	Euro15 / CER (% capex)	Euro30 / CER (% capex)
Ethiopia	0.0 %	0.1 %
South Africa	1.0 %	2.0 %
Uganda	0.5 %	0.9 %

The PoA opportunity

Table 15: Summary Solar PV PoA opportunity

CER potential	High, but depends on countries' grid factors & commercial viability of solar PV	
Impact of carbon finance	Low	
Sustainable development benefits	High	
Additionality	Solar Power is the most expensive renewable energy.	
CDM Methodologies	Grid-connected plants: ACM0002 (large-scale), AMS-I.D (small-scale)	Off-grid plants: AMS-I.A (small scale)
Baseline emissions	Countries GEF - some countries need to compute GEF, and low GEF penalizes countries with high renewable share	Diesel and petrol generator-sets
Monitoring	Measurement of only one parameter: annual net electricity generation	Measurement of only one parameter: annual net electricity generation
Ease of implementation	Straightforward	Straightforward

As the current costs of Solar PV is extremely high, solar PV PoAs in Africa will only make a marginal contribution towards accelerating the deployment of solar PV. This could change over time as solar PV prices decrease further.

[28] Assumes low capital cost of Euro 4,100,000 per MW and 2,500h operations per year under different primary CER prices

1.6. Solar thermal and Concentrated Solar Power (CSP)

Overview

Concentrated Solar Power (CSP) has received widespread attention through the recent announcement by the Desertec Industrial Initiative to build some 40GW of CSP in North Africa that would supply 15 percent of Europe's electricity needs[29]. If this giant initiative comes to fruition as planned, it will likely reduce the cost of CSP from some €0.12-16 per kWh towards grid parity.

Currently, though, only 600 megawatts of solar thermal power are operating worldwide and another 400 megawatts are under construction. There are also concrete plans in place for the development of an additional 14,000 megawatts worldwide. In Africa, the Sahara and to some extent the Kalahari and Namib deserts offer high solar power potential. This untapped potential has the ability to serve a large share of Europe's and all of Africa's energy needs going forward. For example, a mere 0.3 percent of the area comprising North Africa could supply all of the energy required by the European Union.

Countries/regions with high potential

Many African countries receive, on average, 325 days per year of bright sunlight and the continent has large solar energy resources. The distribution of solar resources across Africa is fairly uniform, with more than 80 percent of their landscape receiving almost 2000 kWh per square meter per year. A recent study indicates that that a solar generating facility covering just 0.3 percent of the area comprising North Africa could supply all of the energy required by the European Union.

Available technologies

Solar thermal energy (STE) is a technology for harnessing solar energy for thermal energy. Solar thermal energy plants, concentrate solar radiation with the use of mirrors and lenses to obtain high temperatures — a technique called Concentrated Solar Power (CSP), which is used for electricity generation. A wide range of CSP technologies exist, including: The parabolic trough, Dish Stirling, Concentrating Linear Fresnel Reflector, Solar chimney and Solar power tower.

Critically for Africa, the components required for CSP are becoming increasingly simple (e.g. Fresnel mirrors are replacing parabolic mirrors), so that they can be produced and maintained locally. Moreover, they are no longer subject to major technological uncertainties, as is the case with solar PV, and can instead be optimized using standard engineering processes. These advantages can make CSP more attractive for Africa than other high-tech renewable energy technologies, such as wind and solar PV.

Sustainable Development benefits

Solar Thermal power, and in particular CSP, offers a sustainable and renewable energy supply that can make a substantial contribution towards achieving the Millennium Development Goals (MDGs) by assisting in ensuring environmental sustainability. The development of CSP will allow for technology transfer into Africa and create employment opportunities as developments progress. Solutions exist to

[29] www.desertec.org

minimize the water needs for steam turbines and cooling circuits so that the technology can be deployed in the arid and semi-arid regions.

Estimated CDM revenues

One of the disadvantages of CSP are their associated costs, and to date this has limited its development worldwide:

Table 16: Estimated CER revenues as a percentage of Capital Costsper MW[30]

	Euro15 / CER (% capex)	Euro30 / CER (% capex)
Ethiopia	0.0 %	0.1 %
South Africa	1.0 %	2.1 %
Uganda	0.5 %	0.9 %

Importantly, though, the cost of CSP are expected to come down substantially in coming years owing to Desertec and other large-scale deployments in Africa and elsewhere. So the economics and the relative contributions made by carbon finance are likely to undergo a profound change over the course of the decade.

The PoA opportunity

Table 17: Summary CSP PoA opportunity

CER potential	High, but depends on countries' grid factors	
Impact of carbon finance	Low, but will increase as technology cheapens	
Sustainable development benefits	High	
Additionality	Solar Power one of the most expensive renewable energy sources, so financial and technological barriers are widespread.	
CDM Methodologies	Grid-connected plants: ACM0002 (large-scale), AMS-I.D (small-scale)	Off-grid plants: AMS-I.C (small-scale)
Baseline emissions	Countries GEF - some countries need to compute GEF, and low GEF penalizes countries with high renewable share	Diesel and petrol generator-sets
Monitoring	Measurement of only one parameter: annual net electricity generation	Measurement of only one parameter: annual net electricity generation
Ease of implementation	Straightforward	Straightforward

Large-scale solar projects currently do not present an imminent opportunity for Africa. The capital and operating costs associated with this technology are the highest of all renewable energy technologies. If

[30] Assumes low capital cost of Euro 4,000,000 per MW and 2,500h operations per year under different primary CER prices

the price of CER's and the costs of generation increase and decrease respectively in the future, then this will become an opportunity. As such stand-alone CSP PoAs will not be attractive in coming years, but it does make sense to design renewable energy PoAs in such a way that they can include CSP once the technology becomes commercially more viable.

2. HOUSEHOLD APPLICATIONS

A rapidly growing number of distributed technologies are available to reduce greenhouse gas emissions at the household or small enterprise level. PoAs targeting such applications need to be able to include and monitor vast numbers of dispersed units, so these programs represent particular implementation and monitoring challenges. For this reason, it is useful to also consider power-generating applications, such as solar PV in this category. The majority of PoAs that are currently in validation target should household applications, so there is a growing body of evidence and experience on how best to manage the associated operational challenges.

This experience shows that these programs face substantial operational and logistical challenges in deploying and monitoring vast number of devices distributed across an entire country. Incremental CDM revenues can therefore play a vital role in co-financing the operational systems and infrastructure required to mount and sustain these programs.

2.1. Household biogas

Overview

Biogas typically refers to a gas produced by the biological breakdown of organic matter in the absence of oxygen. Biogas originates from the anaerobic digestion or fermentation of biodegradable materials such as biomass, manure, sewage, municipal waste, green waste and energy crops.

Biogas technology can be a cost-effective and environmentally friendly complement to existing biomass and manure management strategies at the household or facility level. Such biogas projects reduce methane emissions and can provide clean cooking/heating fuel for households and farms, schools, hospitals, and other facilities. This makes a fuel switch from non-renewable biomass or fossil fuels to manure management through anaerobic bio-digestion interesting under the CDM.

The technical potential for domestic biogas in Africa is significant; 1 in 4 agricultural households on the continent would qualify for feasible installations, translating in a total potential of some 18.5 million installations. With the current UN Millennium Development Goals and UN Millennium Ecosystem Assessment induced-activities aiming to improve livestock holding practices, water accessibility and the environment in general, the technical potential for domestic biogas is likely to increase over the coming decade. In addition, the growing scarcity of traditional and fossil energy sources as well as the high costs of modern energy sources (electricity, LNG) in most rural areas will likely improve the economy of investment in a biogas installation over time.

For comparison, in Asia, the potential of domestic biogas is well exploited. By the end of 2004, over 15 million households in China were using biogas, the government aiming to increase this number to 27 million by 2010.

Countries/regions with high potential

In general, any African community with substantial number of livestock and/or agricultural residue can implement household biogas programs. East Africa is seen as having the highest potential for biogas production in view of the abundance of biomass and the large number of sedentary farm animals in these regions. In Southern Africa, Zimbabwe, South Africa and Lesotho have significant potential. Nigeria, Mali and Burkina Faso have the potential for larger-scale facilities in West Africa.

Available technologies

A typical biogas system consists of the following components: manure collection; anaerobic digester; effluent storage; gas handling and gas use. Different types of anaerobic digesters exist, the choice of which is driven by the existing (or planned) manure handling system at the facility targeted.[31] The gas produced can be used to generate electricity; fuel a boiler, space heater, or refrigeration equipment; and it may be directly combusted as a cooking and lighting fuel.

Sustainable Development benefits

Bio-digesters help farmers deal with their waste management problems and create organic fertilizer for the farm or facility. Biogas programs can also be implemented in schools, hospitals and other facilities that generate substantial amount of organic waste. They contribute to the mitigation of greenhouse gases through methane recovery and avoidance of firing of firewood or fossil fuel. Bio-digester programmes also have positive sustainable development effects such as, for example, alleviating the workload for women and children and easing health problems due to indoor pollution.

Estimated CDM revenues

Biogas is one of the most expensive renewable energy technologies for large scale electricity production, both in terms of capital and operating costs, and only solar power is seen as being more expensive and posing as much technology risk.

Table 18: Estimated CER revenues as a percentage of Capital Costs per MW[32]

	Euro15 / CER (% capex)	Euro30 / CER (% capex)
Ethiopia	0.1 %	0.1 %
South Africa	2.2 %	4.5 %
Uganda	1.0 %	2.0 %

[31] See http://www.cd4cdm.org/Publications/PoAManualBiogasHouseholds.pdf for a detailed description of household biogas technologies.

[32] Assumes low capital cost of Euro 2,960,000 per MW and 4,000h operations per year under different primary CER prices

CDM revenues can make a substantial impact on household Biogas applications. The Netherlands Development Organization (SNV) obtained the following results from their household Biogas programmes implemented in Nepal[33]:

Table 19: Results of Biogas plant for a household of 6 to 7 people in Nepal

Saving of Traditional cooking fuel: Firewood	2000 - 3000 kg/year
Reduction of Workload:	1.5 - 3hours per day
Reduction of greenhouse gasses	up to 5 tCO2/year
Reduction of indoor air pollution	up to 50%
Savings from use of fertilizer	up to 40%

The reduction in traditional fuel use resulted in an average saving of between 55 and 75 Euro. In addition to this the household can expect to receive 75 Euro per year in carbon revenue[34]. The cost per Biogas unit installed was Euro 365, which resulted in the following capital expenditure impacts:

Table 20: Savings and Revenue as a percentage of Capital Costs per Biogas unit (Euro 365)

	Euro15 / CER (% capex)
Savings from reduction in traditional fuel use	15.1 – 20.5 %
Revenue from CER sales	20.5 %

Biogas reactors can be locally designed and constructed, which will make them relatively affordable. Still, the dissemination of small scale biogas units is mostly hindered by the high initial cost of the digester, which ranges from EUR 200 to EUR 400. Most of the rural households in developing countries, especially middle and low income households, have difficulties in accessing financing from commercial banks. A survey of biogas CDM projects showed that the bio-digester investment is between 60 and 80% of an annual family's income. In Asia, a payback period of a digester is expected to be 2 to 3 years. A central challenge lies in the relatively low density of sedentary livestock in African communities, and the lack of stables where manure can be easily collected.

Incremental carbon revenues can therefore play an important role in tipping the balance towards the large-scale deployment of this technology.

Table 21: Estimated CER revenues per MW biogas[35]

	$15 / CER (% capex)	**$30 / CER (% capex)**
South Africa	4.8 %	8.6 %
Uganda	2.6 %	4.2 %
Ethiopia	0.0 %	0.0 %

[33] Blank, Daniel et al. 2009. Mini Biogas Plants for Households. UNEP Riso Centre

[34] Assumed price of 15 Euro per CER and 5 CERs per device per year

[35] Assuming US$1.9m per MW and 4000 operating hours per year

The PoA opportunity

Table 22: Summary Household Biogas PoA opportunity

CER potential	High, but depends on baseline use of biomass
Impact of carbon finance	Potentially high, but depends on countries' grid factors
Sustainable development benefits	High
Additionality	New technology for African countries and relatively expensive
CDM Methodologies	AMS-III.D; AMS-I.E; AMS-I.C and AMS-III.R
Baseline emissions	Methane Avoidance: in anaerobic conditions biomass releases methane into the atmosphere
Monitoring	Methane avoidance: baseline scenarios, waste composition and environmental conditions
Ease of implementation	Complex baseline and monitoring issues

The aim of biogas PoA should be to promote the dissemination of bio-digesters that utilize manure and biomass available at the household and industry level to reduce greenhouse gases. The carbon revenues should be utilized to reduce the technology's main barrier of high capital costs, this would then lead to use of biogas for heating, lighting or cooking instead of fossil fuels.

Currently, a single Biogas PoA is under validation at CDM level, this project is located in Brazil. GTZ is conducting a feasibility study for this type of project in Kenya and aims to implement 2000 biogas digesters using the PoA framework. Large biogas projects have been successfully pioneered by SNV and other organizations in several Asian countries (e.g. Nepal, Vietnam).

2.2. Solar water heaters (SWH)

Overview

Hot water plays an important role in the daily life of all societies. However, as energy prices increase steadily, so do the costs of hot water supply as the residential water heating systems – if available – that are mainly based on fossil fuels or electricity from the grid. In developing countries, hot water at the households' disposal is often a luxury good, as the initial costs for the equipment and the fuel costs are high compared with average incomes. In cases where households use electricity from the grid to heat their water, they often face unstable electricity supply and spend considerable amounts of money on electricity.

Solar water heaters (SWH) are installed on rooftops and use solar energy to directly heat water for households, hospitals, schools, and commercial facilities. SWH are widespread in China and other parts of Asia, where they contribute substantially towards lowering demand for electricity and fossil fuels. With the exception of a few small programs in South Africa and Tunisia, SWH remain rare in Africa.

Countries/regions with high potential

The distribution of solar resources across Africa is fairly uniform many African countries receive on average 325 days per year of bright sunlight. This gives SWHs the potential to bring hot water to virtually any location in Africa without the need for expensive large scale grid level infrastructural developments or fossil fuel diesel generators and oil use. Critically, SWH also work in the African highlands, where demand for warm water can be high during the cold periods. Here SWH can often replace the inefficient use of local biomass for heating and thereby reduce deforestation rates.

Available technologies

Solar heating systems are generally composed of solar thermal collectors, a fluid system to move the heat from the collector to its point of usage. SWH are broadly defined as medium-temperature collectors which use flat plates for creating hot water for residential and commercial use. There are two main categories of solar water heating systems, active systems which require a pump and passive systems which rely on convection or heat-pipes. The latter are less expensive and require less maintenance, so they offer an attractive solution for many African countries.

Prices for SWH systems have come down sharply over the last decade, and large volumes of inexpensive units can now be sourced directly from Chinese producers. Important technical innovations are still happening that will further reduce the cost of SWH units. These include replacing glass tubes with aluminum piping, which will be less expensive and fragile. Over time these innovations will facilitate the local manufacture of SWH in Africa.

Sustainable Development benefits

SWHs can assist in replacing fossil-fuel based water heating which has negative environmental impacts as it affects the indoor and outdoor air quality and contributes to global warming. SWHs also assist communities in living “off the grid” and decrease reliance on the fickle grid’s associated with Africa. Importantly, they can also contribute towards lowering indoor air pollution by reducing the need to heat water on inefficient cook stoves, which in turn will lower the incidence of acute lower respiratory infections (ARIs). So SWH are a cost-effective and environmentally friendly solution to provide hot water for households.

Estimated CDM revenues

Solar Water Heaters cost in the region of EUR 700 ranging from around EUR 200 in India and China over EUR 650 in Brazil and South Africa to EUR 1,300 in Barbados and Mexico. Operating costs are estimated at 5 Euro per year which represents one of the lowest operating costs in comparison to other small scale renewable energy technologies.

In investigating two SWH programmers undergoing validation in South Africa and Tunisia, it can be found that CERs cannot cover the upfront costs of SWH (1m^2 of SWH technology costs approximately 300 Euro) and this reiterates the need to use soft loans to roll out the SWHs. The operation and maintenance costs of SWH are estimated at Euro 5 per year and this cost is easily covered by the annual CER revenues.

Table 23: Economics of validation SWH PoAs in South Africa and Tunisia

	SWH distributed	Baseline Fuel	Annual energy output (MWh)	Emissions factor of Fuel	m2 of installed capacity per SWH	Annual CERs	Annual CERs per SWH	Annual CERs per m2
Tunisia	20000	kerosene & diesel	1.96	0.26	3.00	1000.00	0.05	0.17
South Africa	5	grid electricity	208.60	1.00	213.60	1000.00	200.00	0.94

The PoA opportunity

Table 24: Summary SWH PoA opportunity

CER potential	High
Impact of carbon finance	High
Sustainable development benefits	High
Additionality	High upfront costs in comparison to traditional methods.
CDM Methodologies	AMS-I.C
Baseline emissions	the grid emission factor of the country or use the emission factor of the specific fuel type (i.e. Diesel).
Monitoring	sample of energy produced by SWH systems; number of systems in operation and their operating hours.
Ease of implementation	Installation, maintenance and monitoring of large numbers of solar water heaters is very complex

High energy prices are the key driver for the use of SWHs. Although energy prices have risen, market penetration of SWHs is still very low, especially in developing countries. Two main barriers exist – in initial upfront cost of a SWH and social acceptance and trust of the product. In order to overcome these barriers, it is necessary to establish incentives and financing mechanisms for SWHs.

Solar Water Heating PoA's are at the validation stage in South Africa and Tunisia. These PoA's will cover the retrofitting of existing electric water heating technologies with solar based technologies and the installation of new solar water heating technologies into commercial or large scale users of hot water in health, hospitality, industrial and residential. The aim of the PoA is to provide a motivation to users through a financial incentive (e.g. soft loans) to buy residential SWH systems in order to help overcome the main barriers that prevent higher market penetration.

These PoAs underscore the main challenges that are inherent in SWH PoAs. First, installing and maintaining large numbers of SWHs represents a major operational challenge that may require large numbers of trained staff available across a country. Second, the CDM monitoring requirements for SWHs are extensive and strict, as water volumes and temperatures going into and out of the SWH unit need to be measured. This requires expensive monitoring equipment for a sample of SWH combined with sound statistical sampling approaches.

2.3. Improved Cookstoves

Overview

Almost 50 percent of the world's population still prepares their food on small stoves fired by biomass or solid fossil fuels. Nearly 500 million tons of wood are consumed in homes in sub-Saharan Africa in the form of firewood and charcoal, more wood per capita than any other region in the world.

Traditional stoves achieve low efficiencies in comparison to newly developed improved stoves. Shifting towards improved cookstoves can result in higher energy efficiency and less demand for biomass fuels.

Countries/regions with high potential

Virtually all countries in Africa consume large amounts for cooking using inefficient stoves.

Available technologies

Various improved stoves are currently available for dissemination and many more are under development. These stoves can result in efficiencies of up to 80 percent in comparison to traditional stoves where efficiencies reach a maximum level of 15 percent. According to FAO Improved Cooking Stoves can be classified into various categories:

1. **Mono-function and Multi-function stoves.** An Improved Cooking Stove can also be used for the single purpose of cooking or for multiple purposes including: water heating, room heating, meat smoking, roasting, simmering of milk, and even to electricity generation.

2. **By construction material** - Improved Cooking Stoves are mainly made of single materials: metal, clay, fired-clay or ceramics and bricks.

3. **Fixed or Portable** - Metal and ceramic Improved Cooking Stoves are normally portable in nature and can be moved indoors or outdoors while clay/brick, clay/stone Improved Cooking Stoves are generally high mass and thus are fixed.

4. **By fuel type** - Improved Cooking Stoves may be rendered practically inoperable when switching over to fuel types for which it was not constructed.

Recent experience demonstrates that successful cookstoves programs need to overcome a number of cultural and social barriers. They need to change users' behavior, which is extremely difficult to achieve. Despite their obvious benefits and advantageous economics (payback periods can be are as short as 3 months), the penetration rate of improved stoves therefore remains very low, especially in rural areas.

Sustainable Development benefits

Improved cookstoves have a number of important benefits. They lower demand for biomass and can reduce the pressure on forest and scrubland, which are frequently degraded by biomass collection. They also reduce indoor pollution (currently responsible for over five million child deaths per year) and can lead to substantial savings in fuel costs for urban households that have to buy their fuel on the market. The efficient nature of the stoves free up time for productive activities for rural households collecting fuel in forests or scrublands.

And finally, scientific evidence that has become available after the fourth assessment report of the IPCC shows that "black carbon" or the soot released by inefficient cookstoves not only acts as a major local air pollutants, but can have a powerful heat trapping effect, thus exacerbating climate change. Under the present CDM regime, it is not possible to claim emission reductions for the reduction in "black carbon" emissions, but the impact could still be substantial.

Estimated CDM revenues

The main financial requirement of a cookstove project is the procurement costs of a stove which typically range between 6 and 15 Euro per stove in Africa. This requirement is cyclical, as the useful life of stove varies between 1 and 3 years and the majority of these costs is from the large number of personal required to disseminate efficient stoves. Monitoring costs vary with sample size and include the need for various pieces of equipment which themselves come at a cost- i.e. Instruments used for the kitchen performance test (KPT) cost about EUR 900 per set.

It is estimated that improved cookstoves can save approximately between one to two tons of CO_2per year depending on the baseline scenario. To date, only one cookstove project in Africa has been successfully registered under the CDM. The project is situated in Nigeria and uses the Save 80 system, which incorporates cookstoves and heat retaining boxes, resulting in 80 percent less fuel wood use and a reduction of 2.72 tons of carbon dioxide each year. By rolling the system out to 12,500 participants, the project expects to receive an estimated 34,000 carbon credits each year.

KfW has estimated the breakeven price for these project types summarized in the table below. It shows that CDM revenues can make a substantial contribution towards meeting the cost of cookstove programs – in some instances it may even be possible to run commercially viable cookstove programs on the back of CDM revenues alone.

Table 25: Break even CER prices for cookstove projects

Annual CERs per stove	CER minimum price for break-even (Euro)	CER price for an IRR of 15% (Euro)	Number of stoves to reach break-even	Number of stoves to reach 15% IRR
2	2.3	2.4	13,500	13,900
1	4.5	4.8	34,000	36,500
0.5	9.0	9.6	145,000	180,000

The PoA opportunity

Table 26: Summary cookstove PoA opportunity

CER potential	High
Impact of carbon finance	High
Sustainable development benefits	High
Additionality	Improved cookstoves face high upfront costs in comparison to traditional methods.
CDM Methodologies	AMS-I.C; AMS-II.C; AMS-I.E; AMS-II.G
Baseline emissions	fuel and stove types used before the project scenario.
Monitoring	complicated: determine fossil fuel traditionally used; the use of non-renewable biomass; calculation of total biomass use before project start; efficiency of a sample of stoves introduced; broken and replaced stoves.
Ease of implementation	Complex distribution and monitoring challenges

Yet, cookstove programs are very complex to run under the CDM since two CDM-related challenges need to be addressed. First, it is vexingly complicated to meet the stringent CDM requirements concerning the definition of the "non-renewability of biomass used". Non-renewable biomass is defined as biomass from deforestation, forest degradation and degradation of agricultural areas. The key indicator for non-renewable nature of biomass is a decrease in the level of carbon stocks on the area where the biomass is harvested. In order to be eligible, a project has to be proven through a survey that non-renewable biomass has been used since 31 December 1989 in the baseline scenario. This requirement represents a major challenge in a typical African country.

Second, projects need to account for "suppressed demand", which is defined as a situation where access to energy services predating the CDM intervention is below actual demand due to income or infrastructure constraints. Consequently, actual demand does not reflect expressed demand for energy services by energy-poor households. A CDM project can eliminate part of the suppressed demand by decreasing the costs of energy services, but this can result in an increase of greenhouse gases, which needs to be taken into account when computing emission reductions associated with a CDM project.

Currently, one improved cookstove PoA in under validation at CDM level. The programme is situated in Bangladesh and makes use of improved wood burning stoves. Various programmes are being investigated in Africa: CARE wishes to roll out improved stoves in the northern regions of Ghana and Uganda. GTZ is investigating scaling up their already existing cookstove dissemination in Sub-Saharan countries in order to take advantage of the CDM and make this project sustainable in the long term. Both programmes are in the feasibility study phase.

In sum, cookstove projects present a real and attainable opportunity for PoA development throughout Africa. CDM risks associated with cookstove projects are currently high, but with experience and further developments should not pose a barrier to implementation.

2.4. Compact fluorescent light bulbs (CFLs)

Overview

The lighting sector in developing countries has enormous potential for energy savings and improved quality. The demand for electric lighting is increasing twice as fast in developing countries (3.6 percent) as in industrial countries (1.8 percent). Whereas lighting consumes between 5–15 percent of total energy use for households in industrial countries, in the developing world it is typically much greater – particularly among the poorest households.

Poor households without access to electricity can pay as much for kerosene used in lanterns as Europeans pay for much higher-quality electric lighting. The quality and efficiency of lighting technologies adopted in the next twenty years will have significant implications for the environment and development.

In addition to aforementioned solar PV devices (Section 2.5), many governments are considering large-scale programs for the distribution of highly efficient compact fluorescent lamps (CFLs), which can drastically reduce power consumption for lighting. These programs complement the distribution of solar PV devices since they focus on urban and peri-urban areas where households and facilities use electricity for lighting instead of kerosene lamps and other thermal applications, which can be effectively replaced by solar lanterns.

Countries/regions with high potential

African countries with high grid emissions factors should be targeted initially to ensure adequate amounts of CER's flow out of Africa. In time countries with less potential, but still the need, can be added.

Available technologies

CFLs are a type of fluorescent light. Many CFLs are designed to replace incandescent light bulbs (ILBs), and can fit into most existing light fixtures formerly used for ILBs. Compared to general service ILB giving the same amount of visible light, CFLs use less power (between 75 percent and 80 percent saving), have a longer rated life (up to 25,000 hours compared to 1,000 hours for ILBs), but have a higher purchase price.

Sustainable Development benefits

The use of CFLs instead of ILBs gives rise to various sustainable development benefits. Since fluorescent lamps use less power to supply the same amount of light as an incandescent lamp, they decrease energy consumption and the environmental effects of electric power generation. Where electricity is largely produced from burning fossil fuels, the savings reduces emission of greenhouse gases and other pollutants. CFLs programmes will also result in technology transfer and/or capacity building in greenhouse gas emission reduction technologies in Africa and will have a direct impact on demand side energy efficiency improvements.

Estimated CDM revenues

Most CFL distribution programs rely solely on CDM revenues to finance the purchase and distribution of CFLs, as well as ensuring the necessary monitoring. Assuming a (high) baseline emissions factor for electricity usage of 0.8 tCO_2e/ MWh, average daily usage of 4 hours, and an assumption that the CFL is 5 times as efficient as an ILB, the implementation of a CFL programme will result in 0.08 CERs per CFL. At €4-5 per CFL, the CDM revenues can pay back the cost of the bulbs within some 2-6 years.

The PoA opportunity

Table 27: Summary CFL PoA opportunity

CER potential	High		
Impact of carbon finance	High		
Sustainable development benefits	High		
Additionality	High upfront cost of CFLs in comparison to traditional sources		
CDM Methodologies	AM0046	AMS-II.C	AMS-II.J
Baseline emissions	Countries grid emission factor, which places some African countries at disadvantage. Highly complex determination of baseline operating hours.	Countries grid emission factor, which places some African countries at disadvantage. Highly complex determination of baseline operating hours.	Countries grid emission factor, which places some African countries at disadvantage. Restricted to household use.
Monitoring	Sampling & measurement of daily lighting usage or energy use of CFLs	Sampling & measurement of daily lighting usage or energy use of CFLs	Sampling & default factors
Ease of implementation	Complex distribution, assignment of CER ownership, and monitoring	Complex distribution, assignment of CER ownership, and monitoring	Complex distribution, assignment of CER ownership, and monitoring

Substantial experience has been built up in recent years on CDM CFL programs.[36] It demonstrates the tremendous potential for such programs, but caution is warranted since the operational and CDM-related challenges are substantial. With regards to the former, the high initial costs have been the biggest barrier to CFL dissemination. Coupled with the initial cost barrier, the poor performance of first generation CFLs created some consumer distrust in the technology. Furthermore, lack of consumer awareness of the energy savings potential and the difficulty of altering consumer habits have also contributed to the barriers to CFL dissemination. The CDM/JI could help overcome these barriers,

[36] The first registered PoA under the CDM is a CFL project where these efficient light bulbs are rolled out to households across Mexico. A further two CFL PoAs are under validation, one in India and one in Senegal.

especially the initial cost barrier, by providing additional carbon revenues that can be securitized and thus mobilize upfront financing.

From a CDM perspective, the baseline and monitoring challenges are particularly important. As the penetration of (low-quality) CFLs gradually increases outside a registered CFL PoA, the latter will find it increasingly hard to argue that the baseline for emission reductions is set by ILB. This gradual trend, which can already be observed in several Asian countries, may undermine the financial attractiveness of CFL PoAs. Even more importantly, a CFL PoA needs to ensure that every recipient of CFLs transfers the ownership of CERs to a PoA Coordinating Entity and that the emissions from a sample group of CFLs be monitored carefully. Both requirements represent major logistical and operational challenges for PoAs that aim to distribute several million CFLs. In case errors occur the resulting emission reductions may end up substantially below expectations.

Overall, CFL programs are an interesting opportunity for Africa that can be financed largely or entirely through CDM revenues. Yet interested governments must be aware of the operational challenges that such programs need to overcome.

2.5. Household solar PV devices

Overview

By converting solar energy directly to electricity, solar photovoltaics (PV) is a simple, but costly, source of power. These costs are falling though and handheld solar PV devices can make important contributions towards meeting Africa's power needs for lighting, communication and other applications that require limited power.

Africa has an abundance of solar resources and as a result PV devices have been promoted widely on the continent, with almost every sub-Saharan African country having had a major PV project. At the end of 2008, the cumulative global PV installations reached 15,200 MW. Africa though has installed capacity of only 11 MW which have been distributed fairly evenly between South, West, East and North Africa. Until now, there are few successful programs on the continent that distribute large volumes of solar PV devices to households.

Countries/regions with high potential

Many African countries receive on average 325 days per year of bright sunlight. This gives solar power the potential to bring energy to virtually any location in Africa without the need for expensive large scale grid level infrastructural developments. In any case, the power needs for small-scale solar PV devices are low enough that they can be met easily across virtually all of Africa, so there are no environmental limitations to the roll-out of these technologies.

Available technologies

PV has mainly been used to power small and medium-sized applications, from the calculator powered by a single solar cell to off-grid homes powered by a photovoltaic array. PV can also be used for desalination systems and pumping systems for water. A large number of different PV technologies and devices exist, but overall the reliability of the devices is now sufficiently high that countries can choose the right devices based on (i) required capacity, (ii) required efficiency, and (iii) price.

Sustainable Development benefits

PV has large economic and social benefits and is a renewable energy source. On a social level, PV arrays installed in off-grid rural areas will help to improve comfort and security in houses through lighting improvement. This itself has the benefits of better conditions for cooking, looking after children, and the reduction of diseases associated with kerosene lamps. Water supply and quality can be increased with PV pumping and desalination systems.

On an economic level, rural expenditure on electricity can be expected to drop by up to 50 percent with the installation of PV arrays in households. Employment opportunities are created and technology transfer takes place.

Estimated CDM revenues

The contribution that carbon finance can make towards meeting financing solar PV devices depends on the baseline that is used. If the projects displace power from the grid, then even in countries with very high grid factors will carbon finance only make a modest contribution. More likely, however, are baselines that comprise kerosene or other liquid/solid fuels used in inefficient processes. In such instances, emissions reductions are higher, and CDM revenue can make a significant contribution towards financing the proposed project activities. For example, a PoA covering this technology in Bangladesh involves the installation 2,700 PV kits, and with a baseline scenario of Kerosene, the project produces only 1,515 ER’s per annum.

The PoA opportunity

Table 28: Summary household solar PV PoA opportunity

CER potential	High
Impact of carbon finance	High if high-emission fuels are displaced, low if baseline is grid emission factor
Sustainable development benefits	High
Additionality	High financial barriers ensure additionality
CDM Methodologies	AMS-I.A
Baseline emissions	Diesel and petrol generator-sets, kerosene for solar lamps, baseline can be difficult to establish
Monitoring	Measurement of one parameter: annual net electricity generation, but need for extensive surveys and sampling
Ease of implementation	Complex due to complex monitoring protocols

The purpose of a solar PV programme should be to improve life quality standards of people in non-electrified rural areas in Africa by equipping them with individual photovoltaic kits to meet their basic energy needs and by installing photovoltaic pumping and desalination stations to satisfy drinking water needs for population and livestock. Technological, economical and social barriers present real threats to the dissemination of PV in Africa. Carbon finance can help to overcome the first two barriers with CDM revenues and technology transfer, but social acceptance will have to be achieved through education programmes.

Several reference CDM projects/PoAs exist that cover solar home appliances. One registered CDM project in Morocco distributes solar kits to poor households and generates carbon revenues using AMS-I.A. A CDM PoA is under validation for a project installing household solar PV systems in Bangladesh, and a similar one is in preparation in India. The former programme is being implemented by 15 NGOs and financial institutions jointly provide consumer financing, install the systems and ensure maintenance support.

3. OTHER POA OPPORTUNITIES

This section showcases PoA opportunities that do not fall directly into the categories of "renewable energy production" and "household applications".

3.1. Improved charcoal production

Overview

Charcoal is an important energy source in much of Africa. For example a typical Kenyan household consumes some 300 – 600 kg of charcoal every year. Yet, in addition to inefficient cookstoves that reduce the efficiency of combustion (Section 2.3), the production of charcoal is extremely wasteful. The efficiency of a typical African kiln is about 8 – 15 percent, which means that 10 kg fuel wood is required for every 1 kg charcoal. As a result, charcoal production can be a major cause of deforestation in the vicinity to high-density human settlements. Moreover, traditional methods of producing charcoal lead to high emissions of greenhouse gases, including carbon dioxide and methane.

Improved technologies exist to reduce the greenhouse gas emissions associated with charcoal production in Africa and to increase the efficiency of fuel wood conversion. PoAs present an attractive opportunity for promoting the shift towards cleaner processes across Africa.

Countries/regions with high potential

Statistics on charcoal production are difficult to locate, but charcoal use is widespread across the entire Sub-Saharan region. Most charcoal is produced locally in cottage industries that are very inefficient. For example, it is estimated that some 90 percent of charcoal made in Kenya uses inefficient traditional techniques that can be upgraded. A similar potential for improving charcoal production is likely to exist across much of Africa.

Available technologies

The traditional methods for charcoal production employ earth pits and mound kilns. In industrial countries, retort technologies are the standard method of producing charcoal, but due the high investment costs these approaches cannot be deployed widely in Africa. A more appropriate system has been developed to adapt this retort technology for rural areas. The low cost solution is called Adam Retort and can be built by two trained workers in a week for about 300 Euros and is seen as the best option for reducing greenhouse gases from charcoal making (Table 29).

Table 29: Comparison of key charcoal production technologies in Africa

	Efficiency (%)	Advantages	Disadvantages
Earth Pit	10-20	easy to build, no resources necessary, cheap	low efficiency, variable quality, emissions
Mound Kiln	8-15	easy to build, no resources necessary, cheap	low efficiency, emissions
Casamance	25-30	High efficiency	construction more complicated, material necessary, emissions
Metal Kiln	27 -35	High efficiency, moveable	investment costs, emissions
Drums	27.9	Easy to handle	small volume, emissions, drums
Half Orange	25 -30	high efficiency, large volume	skills necessary, stationary, investment costs
Adam Retort	30 - 42	less emissions, high efficiency, fast	skills necessary, stationary, investment costs

Sustainable Development benefits

Charcoal production is a prime cause of forest degradation and deforestation in many African nations, so improving its efficiency can reduce pressure and forests and shrublands. Moreover, efficient charcoal facilities will lower local air pollution and increase the productivity of kilns.

Estimated CDM revenues

In the baseline scenario, a minimum charcoal yield of 250 kg can be obtained from about 1,200 kg wood using traditional methods. The Adam's retort system yields 250 kg of charcoal from 650 kg of wood, but costs approximately Euro 90,000. At 80-percent capacity utilization, each retort has an annual production of 58.4 tons of charcoal. If a methane emissions factor of 47.5 kg CH_4 (used in registered projects) for one ton of charcoal produced is applied, this results in annual emission reductions of approximately 2000 tCO_2e per year. This represents only 20 percent of capital costs.

The PoA opportunity

Table 30: Summary Improved Charcoal PoA opportunity

CER potential	High
Impact of carbon finance	High
Sustainable development benefits	High
Additionality	Negative IRRs are expected for projects without CDM revenue
CDM Methodologies	AM0041 and AMS-III.K
Baseline emissions	Continuation of inefficient traditional methods
Monitoring	weight of all wood used and charcoal manufactured; moisture of wood and charcoal; fugitive emissions
Ease of implementation	Complex monitoring

According to the World Bank, in Sub-Saharan Africa there is potential for some 2,031 CPAs organized under 61 Programs of Activities (Annex II). A PoA covering efficient charcoal production will facilitate a reduction of the cost of obtaining carbon finance for these typically small-scale, scattered activities. Without this reduction, implementation of Adam Retort systems will not be financially viable.

Pro Natura International has implemented a green charcoal project in Senegal in association with Action Carbone of GoodPlanet. This project gives passengers of Air France the possibility to compensate their CO_2 emissions in form of carbon credits generated by this project.

Initiated in late 1986 by the Malawi Government and the World Bank, the Malawi Charcoal Project undertook research on the viability of charcoal production from wood wastes generated on government softwood forest plantations. This has resulting in the production of 9500 tons of charcoal per annum at 30 percent efficiency. These early examples show that a PoA covering efficient charcoal production represents a promising opportunity in Africa.

3.2. Biofuels from Jatropha

Overview

Biofuels – liquid fuels derived from plant materials – are becoming prominent across Africa, driven by factors such as oil price spikes and the need for increased energy security. However, many of the biofuels that are currently being supplied have been criticized for their adverse impacts on the natural environment, food security, and land use.

One of the more popular biofuels is Jatropha, which is reputed to grow on marginal and degraded land and therefore does not compete with food production.[37] A growing number of countries in Sub-Saharan Africa are using Jatropha oil as a biofuels to operate Multi-Functional Platforms and to produce biodiesel. Jatropha is also being planted in Ghana, Mali, Mozambique, Tanzania, Zambia, and other countries.

Available technologies

Biodiesel production from Jatropha begins by extracting oil from the Jatropha oilseeds that are crushed and pressed. The resulting residue cake can be used as fertilizer or animal feed, and the resulting oil can be used to make biodiesel. Raw plant oils are filtered and mixed with ethanol or methanol to initiate the esterification process, which separates fatty acid methyl esters, the basis of biodiesel, from glycerin and other byproducts. After purification, the glycerin can be used in soap production. Alternatively, the Jatropha oil can be converted into kerosenes for use in airplanes. However such conversion requires specialized and large-scale refining facilities that are currently unavailable in Africa.

Sustainable Development benefits

The substitution of petroleum fuels with biofuels produced in-country can both enhance the balance of payment in these countries and contribute to environmental sustainability. Sustainable development benefits include: security of energy supply; reduction in air pollution; and employment opportunities. While the promoters of Jatropha advertize the plant's ability to grow under semi-arid conditions and on marginal land, the verdict remains out on whether the plant competes with food production once substantial commercial demand for Jatropha-based diesel and kerosene has been built up.

Estimated CDM revenues

CERs generated through Jatropha plantations can have a significant impact on the economics of biofuel production. Under reasonable assumptions, CER revenues can contribute some 11 percent of capital costs and 25 percent of operating costs (Table).

Table 31: Economics of biofuel plantations[38]

Capital Cost of 1000 hectares	550,000 Euro
Operating Costs per tone produced	120 Euro
Production per hectare	2 tones
CERs per tone produced	3 CERs
Assumed CER price	10 Euro
CER revenue per 1000 ha project	60,000 Euro
CER revenue as a % of capital costs	11%
CER revenue as a % of operating costs	25%

[37]It remains controversial to this date whether Jatropha displaces food production. While the plant can grow in arid areas yields are substantially higher in irrigated plantations on prime agricultural land. It remains to be seen to what extent the higher Jatropha yields on such prime land will put this biofuels in competition with food production. One important variable is the extent to which Jatropha – a relatively "young" cultivation plant can be optimized to increase yields on arid and semi-arid lands.

[38] Source: S.J.A. Bakker, CDM and Biofuels, http://www.ecn.nl/docs/library/report/2006/e06033.pdf

The PoA opportunity

Table 32: Summary Biofuel from Jatropha PoA opportunity

	Jatropha biofuels
CER potential	Moderate
Impact of carbon finance	Moderate
Sustainable development benefits	High if plantation covers marginal land, low if biofuel plantation competes with food production
Additionality	based on financial investment analysis biofuels will be cost-effective only in rare cases. Therefore CER revenues will contribute significantly. The arguments of technological barriers and prevailing practice barriers are applicable.
CDM Methodologies	ACM0017 and AMS-III.T
Baseline emissions	fuel type use in traditional circumstances. Typically petrol and diesel offsets are achieved.
Monitoring	nitrogen based fertiliser utilisation, transport of biofuel, land use, land-use change, biofuel processing plant emissions and baseline fuel use
Ease of implementation	complicated; requires captive fleet

Thanks to a recently adopted new CDM methodology for biofuels, a PoA covering biofuels production in Jatropha and similar plantations can help promote the adoption of this new biofuels. However, under current methodology, the eligibility requirements for participating projects are complex and stringent, so it remains to be seen to what extents projects will be able to utilize the methodology. The insistence on captive fleets for the use of the biofuels may pose a major barrier for the implementation of these projects under a PoA modality since each participating CPA would need highly context specific project arrangements.

No PoA covering biofuels is currently registered or under validation at CDM level and very few individual project are at validation or have been registered. This is a result of methodologies surrounding biofuels only being approved recently by the EB.

ANNEX II: KEY CDM OPPORTUNITIES IN AFRICA[39]

Project type	Carbon credits	Energy capacity	Total investment required	Investment per carbon credit	Barriers to implementation identified in the World Bank report	Carbon credit potential in select countries
	mt p.a.	MW	USD bn	USD/tCO_2e		mtCO_2e p.a.
Agricultural residue	140.8	27,504	38.5	273	- Biomass costly to gather - Poor transport infrastructure - Lack of expertise for pre-use transformation - Higher investment cost than fossil fuels - Poor PPA frameworks - Possibly adverse impact on soil fertility	South Africa (35.5), Nigeria (20.6), Ethiopia (11.5), Tanzania (9.6), Kenya (6.5), DRC (5.7), Ghana (5.1), Malawi, Mozambique (4.9), Uganda (4.5), Zambia (3.4)
Flared gas recovery	91.8	44,826	n/a	n/a	- Lack of access to gas markets - Lack of infrastructure - Unreliable gas supply - Undeveloped regulatory framework - Poor fiscal and gas pricing regimes	Nigeria (24.7), Angola (15.8), Sudan (5.2), Equatorial Guinea (4.5), Congo (3.1), Gabon (3.0), Chad (2.1), Cameroon (1.1)
Combined heat and power for industry	72.9	17,844	17.8	244	- Lack of cogen technology expertise - Poor PPA frameworks - Insufficient heat generation	South Africa (58.6), Nigeria (6.0), Zimbabwe (1.1), Cote d'Ivoire, Sudan (0.8), Equatorial Guinea (0.6)
Forest residue	62.6	12,483	17.5	280	- Poor transport infrastructure - Lack of facilities for pre-use transformation of forest residues - Higher capital requirements	Ethiopia (12.5), DRC (9.6), Nigeria (9.1), Uganda (5.1), South Africa (4.3), Tanzania (3.1), Ghana, Kenya (2.9), Sudan (2.6)
Improved steam system	36.6	n/a	n/a	n/a	- Insufficient maintenance services	South Africa (29.7), Nigeria (3.0), Zimbabwe (0.6), Burkino Faso (0.5)
Second cycle addition to open-cycle gas turbine	35.1	5,931	7.1	202	- Underdeveloped financial markets to finance high upfront costs - OCGT more attractive for peaking capacity	Nigeria (24), South Africa (6.1), Cote d'Ivoire (1.5), Gabon, Ghana, Mali, Mozambique, Niger (0.8), DRC (0.7), Sudan, Tanzania (0.6)

[39] Source: De Gouvello, C., F.B. Dayo and M. Thioye. 2008. Low-carbon Energy Projects for Development in Sub-Saharan Africa. World Bank. Washington D.C.

Project type	Carbon credits	Energy capacity	Total investment required	Investment per carbon credit	Barriers to implementation identified in the World Bank report	Carbon credit potential in select countries
Hydropower	25.2	6,443	9.4	373	- High unit investment costs - Longer time for development	Incomplete: DRC (3.6), Mali (0.9), Burkino Faso (0.5), Guinea, Cote d'Ivoire (0.3)
Improved charcoal production	22.5	n/a	0.2	9	- Lack of enabling policies and frameworks - Concerns regarding sustainability biomass use	Sudan (4.8), Kenya (2.8), Cote d'Ivoire (2.0), Angola, South Africa (1.9), Nigeria (1.6), Zambia (1.2), Uganda, Tanzania (1.0)
Wood-processing residue	20.3	4,057	5.7	281	- Poor transport infrastructure - Lack of facilities for pre-use transformation of forest residues - Higher capital requirements	South Africa (5.9), Nigeria (3.5), DRC (1.4), Gabon (1.3), Uganda (1.2)
Compact Fluorescent Light (CFLs)	13.3	15,246	4.8	361	- Effective incentive/financing mechanisms - Complexity of the programs	South Africa (10.0), Nigeria (1.1), Zimbabwe (0.5)
Shift to BRT	12.4	n/a	n/a	n/a	- Lack of formal transport sector planning and data required to design BRT system	South Africa (5.0), Nigeria (3.0), Angola, Kenya (0.6), Ghana (0.5)
Jatropha biofuel	8.5	1,496	n/a	n/a	- Effective sales channels for biofuel	South Africa (2.8), Nigeria (0.9), Kenya, Angola (0.4)
Energy saving household appliances	7.4	1,412	n/a	n/a	- Effective incentive/financing mechanisms - Complexity of the programs	South Africa (6.6), Nigeria (0.3)
Waste gases in crude oil refinery	4.3	659	0.9	209	- Small capacity of region's refineries - Low capacity utilization - Limited expertise waste energy recovery	Nigeria (1.4), South Africa (1.1), Sudan (0.4)
Biodiesel from jatropha	3.2	n/a	n/a	n/a	- Lack of mechanized farming - Lack of technical knowledge in oil extraction and biodiesel production - Weak institutional frameworks - High cost of fertilizer	South Africa (3.6), Nigeria (1.1), Angola (0.5)
Reduced clinker use in cement manufacturing	2.8	n/a	0.1	36	- Consumer acceptance of blended cement - Technical and human resource capacities - Research capabilities and facilities	South Africa (0.9), Nigeria, Senegal (0.3), Ghana, Kenya (0.2)

Project type	Carbon credits	Energy capacity	Total investment required	Investment per carbon credit	Barriers to implementation identified in the World Bank report	Carbon credit potential in select countries
Coal mine methane	2.5	109	0.1	40	- Small project size - Uncertainty regarding CMM yields - Lack of interest by coal mining companies	South Africa (1.5), Zimbabwe (0.6), Botswana (0.1)
Combined heat and power in sugar mills	2.4	651	1	417	- Financial investment constraint - Poor PPA frameworks	South Africa (0.9), Kenya, Swaziland (0.2)
Non-lighting electricity for industry	1.5	740	n/a	n/a	- Lack of investment or priority	South Africa (1.1)
Grid-loss reduction	1.1	4,056	n/a	n/a	- Financial barrier	South Africa (12.9), Equatorial Guinea (2.5), Nigeria, Zimbabwe (0.7)
Landfill gas	0.9	10	0	0	- Unmanaged landfills - Lack of tipping fees - Difficulty to obtain operating licenses	Incomplete: Cote d'Ivoire (0.4), Senegal (0.3), Guinea (0.1)

ANNEX III: TORs FOR A PoA COORDINATING ENTITY

A PoA Coordinating Entity needs to undertake a broad range of tasks, some of which can be outsourced to specialized advisors. The table below outlines the most important tasks and associated competencies. It draws heavily on the PoA Blueprint Book published by KfW.[40]

Table 33: Indicative Terms of Reference for a PoA Coordinating Entity

TASK	FREQUENCY	COMPETENCIES REQUIRED	CDM REQUIREMENT	COMMERCIAL REQUIREMENT	OPTIONAL SERVICE
POA REGISTRATION					
Develop PoA idea and Project Identification Note (PIN)	Once	Knowledge of the technology and business, CDM expertise	x	x	
Prepare PoA Design Document (PoA-DD) including - monitoring plan - additionality proof - Emission baselines	Once	Programmatic CDM knowledge	x		
Develop business plan for PoA including - financial model and financing strategy - incentive scheme for inclusion of CPAs into the PoA - (as applicable) strategy for sourcing CPA	Once	Knowledge of the technology and business, financial expertise		x	
Establish PoA Coordinating Entity	Once	Legal and commercial expertise	x		
Obtain host country approval for PoA	Once	CDM knowledge	x		
Contract DOE for validation of PoA	Once	CDM knowledge & track record or balance sheet (most DOEs require a solid counterparty for the validation contract)	x		
Conduct stakeholder consultation	Once	CDM knowledge	x		
Validate PoA and first CPA	Once	CDM knowledge	x		
Register PoA with UNFCCC	Once	CDM knowledge	x		

[40] Available at http://www.kfw-foerderbank.de/EN_Home/KfW_Carbon_Fund/PoA_Support_Centre_Germany/PoA_Blueprint_Book.jsp.

TASK	FREQUENCY	COMPETENCIES REQUIRED	CDM REQUIREMENT	COMMERCIAL REQUIREMENT	OPTIONAL SERVICE
CPA INCLUSION & MANAGEMENT					
Identify and source CPAs or develop new CPAs	Continuously	Knowledge of the technology and business in the respective country		x	
Develop CPA Design Documents for new CPAs	For each new CPA	CDM knowledge	x		
Contract DOEs for inclusion of new CPAs & determine how the DOE liability for erroneous inclusion of CPAs will be handled.	For each new CPA	CDM knowledge & track record or balance sheet (most DOEs require a solid counterparty for the validation contract)	x		
Communication with DOE regarding inclusion of new CPAs	For each new CPA	CDM knowledge	x		
Sign service contract with each new CPA determining the range of services to be provided by the Coordinating Entity	For each new CPA	Knowledge of the business, CDM expertise, legal expertise	x	x	
Sign Emission Reduction Purchase Agreement (ERPA) with each new CPA	For each new CPA	Knowledge of the business, CDM expertise, legal expertise	x		
MONITORING & VERIFICATION					
Implementation of monitoring plan	Continuously	CDM knowledge	x		
Carry out monitoring for each CPA and establish effective monitoring systems	Continuously	Knowledge of the technology and monitoring requirements, CDM expertise, legal expertise			x
Contract DOE for verification of emission reductions (this DOE must be different from the DOE that validated the PoA)	For each request for issuance	CDM knowledge & track record or balance sheet (most DOEs require a solid counterparty for the validation contract)	x		
Communicate with DOE regarding verification	For each request for issuance	CDM knowledge	x		
Implement incentive scheme to ensure that CPAs conduct effective monitoring	Continuously	Knowledge of the business, CDM expertise, legal expertise		x	
Maintain and keep complete records, typically for at least two years	Continuously	CDM knowledge, effective monitoring systems	x		
SALE OF CERs					
Distribute CERs to PoA Coordinating Entity	After each issuance	Expertise in UNFCCC registry systems	x		
PoA to (i) sell CERs and distribute cash to each CPA according to incentive plan, or (ii) distribute CERs to each CPA.	After each issuance	Expertise in trading CERs, financial management systems		x	
Forward-sell CERs or obtain advance payments	Continuously	Expertise in trading CERs, financial management systems		x	x

ABOUT THE AFRICA PROGRESS PANEL

The Afica Progress Panel (APP) was formed as a vehicle to maintain a focus on the commitments to Africa made by the international community in the wake of the Gleneagles G8 Summit and of the Commission for Africa Report in 2007.Under the chairmanship of Kofi Annan, it is paying equal attention to the implementation of Africa's commitments as set out in the Constitutive Act of the African Union and landmark international agreements. In 2008, a secretariat was established in Geneva.

The Panel's members continually assess new opportunities and threats to Africa's development, including how far previous commitments of Africa are being met. They use their judgment and experience to highlight pressing concerns, inspire honest debate amongst leaders and civil society, help mobilise resources and prompt effective action.

The Panel is composed of the following members:

- Mr. Kofi Annan (Chair)
- Mr. Tony Blair
- Mr. Michel Camdessus
- Mr. Peter Eigen
- Sir Bob Geldof
- Mrs. Graça Machel
- Mrs. Linah Mohohlo
- General Olusegun Obasanjo
- Mr. Robert Rubin
- Mr. Tidjane Thiam
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