

PoA BLUEPRINT BOOK

Guidebook for PoA coordinators under CDM/JI



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Preface

It is with pleasure that we present this blueprint book on programmatic CDM to the interested audience of future programme coordinators, developers, public and private organisations and professionals in the field of the Clean Development Mechanism (CDM) and Joint Implementation (JI). The further development of the CDM and JI is one of the strategic objectives of the CDM/JI Initiative of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

The programmatic approach is the window of opportunity for overcoming the barriers of the dominant single project-oriented regulations of the CDM. Among others, high transaction costs and oftentimes the need for complex organisational performance structures of GHG emission reduction projects have until now been stumbling blocks for the successful mobilisation of smaller project activities in many areas where emission reduction potential appears to be both economically reasonable and feasible.

Against this background, at its first session the CMP decided to introduce the “Programmes of Activities” (PoA) as a variation of the CDM. Since 2007, when the CDM Executive Board operationalised PoA at its 32nd and 33rd meetings, only a few CDM PoA activities listed in the UNEP/Risoe statistics have been prepared. These PoAs, which are taking place in Bangladesh, Brazil, Honduras, Mexico, Senegal, Uganda and South Africa, focus on biogas flaring, composting, efficient light bulbs, run-of-river hydro power, solar home systems and solar water heating. Today these activities are still in the validation stage, and registration has not yet been requested for any of them.

Given the significant incremental barriers and costs the PoAs are facing, the BMU decided in 2008 to establish a “PoA Support Centre” to encourage project developers to elaborate feasible PoA ideas and to escort and facilitate the activities at least throughout the entire PoA project cycle. During the first few months KfW's Carbon Fund, which is implementing the PoA Support Centre, identified a broad range of potential new Programmes of Activities. A first set of six PoAs in India, Israel, Poland and South Africa which address CO₂ reduction in different sectors (such as boiler refurbishment, energy efficiency measures in households and solar water heating) have reached the PDD development stage.

The blueprint book shows us, on the basis of early experience with PoA development and valuable contributions by international experts, the prospects of the programmatic approach in different sectors. It captures the spirit of this emerging field by citing numerous examples which highlight further PoA activities in the described sectors (CFL, household stoves, domestic biogas, solar water heating, industrial boilers and building refurbishment) and could also, given the general remarks and recommendations it contains, serve as blueprints and model cases for other sectors as well. It illustrates important organisational and economic aspects of PoAs and may provide helpful input for identifying and developing the potential in the new and emerging area of programmatic CDM.



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PoA Support Centre Germany

KfW, on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), supports the development of a portfolio of eligible Programmes of Activities (PoA), for which it is soliciting programme proposals.

An experienced partner for your projects, KfW offers advisory, structuring and assessment services for your programme proposals as well as financing and grants to cover the preparation of programme concepts, project design documents (PDDs) and monitoring plans. In addition, it offers its know-how to help with programme implementation and can assist with marketing expected carbon credits. Please contact the PoA Support Centre via our webpage www.kfw.de/carbonfund or email (carbonfund@kfw.de).

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List of abbreviations

ADB	Agricultural Development Bank of Nepal
ACM	Approved consolidated methodology
AM	Approved methodology
AMS	Approved methodology for small-scale CDM project activities
BAT	Best available techniques
BAU	Business as usual
BSP	Biogas Support Programme
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
CNISP	Chinese National Improved Cook Stove Programme
CFL	Compact fluorescent lamp
CH ₄	Methane
CHP	Combined heat and power
CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
CPA	CDM Programme Activity
CPA-DD	CDM Programme Activity Design Document
DEHSt	Deutsche Emissionshandelsstelle (Designated National Authority of Germany)
DNA	Designated National Authority
DOE	Designated Operational Entity
EB	CDM Executive Board
ESCO	Energy service company
GEF	Global Environment Facility
GHG	Greenhouse gas
ILB	Incandescent light bulbs
GTZ	German Technical Cooperation
GWh	Gigawatt-hours
HVAC	Energy efficient heating, ventilation and air conditioning
IRR	Internal rate of return
JI	Joint Implementation
JPA	JI Programme Activity
JV	Joint venture
KPT	Kitchen performance test
M&V	Measurement and verification
MW	Megawatt
MWh	Megawatt-hours
MW _{th}	Megawatt thermal
NGO	Non-governmental organisation

NTG	Net-to-gross
PDD	Project Design Document
PoA	Programme of Activity
PoA-DD	Programme of Activity Design Document
PWh	Petawatt-hours
SSC	Small-scale
SNV	Netherlands Development Organisation
SWH	Solar water heating
Tph	Tonnes of steam per hour
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
VITA	Volunteers in Technical Assistance

1. Introduction

The impacts of climate change on human development have been widely recognised and discussed in the past years, especially since the publication in 2007 of the fourth report of the Inter-Governmental Panel on Climate Change (IPCC). Experts, national leaders and the public are aware of the impact which greenhouse gases (GHG) concentrated in the atmosphere have on global climate change and global warming and the related consequences, such as draughts, flooding, changes in vegetation and loss of biodiversity. To fight climate change, many industrialised countries have committed themselves to reducing GHG emissions.

The market-based mechanisms under the Kyoto Protocol Clean Development Mechanism (CDM) and Joint Implementation (JI) allow developers of greenhouse gas (GHG) emission reduction projects in developing countries (in the case of CDM) and in industrialised countries (JI) to generate emission reduction credits. In the case of CDM these credits are called Certified Emission Reductions (CERs), and in the case of JI, Emission Reduction Units (ERUs). They are tradable and can be used for compliance with the emissions commitments of the industrialised countries specified in the Kyoto Protocol and therefore can generate revenues in hard currency. So far, the CDM has mobilised thousands of projects and billions of euros have been budgeted for the acquisition of CERs. It can thus be seen as one of the most successful elements of the global climate policy regime. Nevertheless it has to be pointed out that up to now CDM/JI has been limited to larger stand-alone activities like hydropower stations or landfill projects.



A Solar Home System generating electricity for a rural family in Morocco. Source: KfW photo archives, photographer: G.J. Lopata

New opportunities

In 2007 this project-based approach was enlarged to allow Programmes of Activities (PoAs) to be registered as CDM or JI projects. A PoA is a programme that can comprise multiple and combined emission reduction activities or projects. By aggregating the combined emission reductions of the different participants in the programme, it gives small and dispersed activities and projects that would be too small for the traditional stand-alone approach a chance to participate and profit from CER or ERU revenues.

PoAs constitute a new instrument and a great opportunity for different actors, such as utilities, banks, municipalities and other private or public entities, to tap a

low-cost GHG reduction and certification potential by doing their core business - reaching out to micro and small activities in private households, agriculture, small enterprises and transport.

The additional revenue which can be generated by the PoA is one of the main incentives but not the only one. Synergies evolve from bringing together different actors to develop new creative programmes that go hand in hand with their core business strategy and the goal of reducing greenhouse gas emissions. Opening up new client bases and penetrating different market segments might be an incentive to banks and microfinance institutions, saving electricity an incentive to utilities in power-strapped countries. Other non-pecuniary benefits accrue for the different actors by developing PoAs.

At the same time, there are various challenges in developing Programmes of Activities. The nature of the CDM/JI project cycle, the complexity of the rules and the related transaction costs as well as the task of designing ambitious programmes leading to policy implementation and GHG reduction for multiple actors is not an easy mission. So far the experience with PoAs is relatively limited. By the end of December 2008, 11 PoAs had been listed on the UNFCCC website (eight under the CDM and three under JI). The PoAs under the CDM are hosted by Bangladesh, Brazil, Honduras, Mexico, Senegal, South Africa, Tunisia and Uganda. They apply distributed renewable energy (solar home systems; solar water heating, small hydro), energy-efficiency measures at the household level (distribution of efficient light bulbs), biogas flaring (methane capture from animal waste), and the installation of a waste management system (municipal waste composting). The three PoAs under the JI in Germany comprise energy efficiency at the industry level (replacement and refurbishment of low-efficiency heating boilers) and at the household level (introduction of heat pumps). They include relevant deviations from CDM regulation/guidance due to the JI procedures.

By offering PoA blueprints for selected types of programmes, this guidebook aims to help the developer and implementer of a PoA to understand the way a PoA is generally structured as well as the specifics of the chosen project types. The blueprintbook provides insights for interested private or public entities such as power utilities, development agencies or financial institutions on the rationale of different types of programmes. Consequently, it shows ways to structure a PoA upscaling experiences of the day-to-day business with carbon credit revenues.

In the following chapters, the guidebook provides information to help PoA coordinators to understand the specific logic and challenges in designing a PoA under the CDM/JI. They are organised as follows:

Chapter II gives a general orientation on programmatic CDM/PoAs by answering the following questions: why develop a Programme of Activities, what is a PoA (basic definitions and methods), who are the actors (roles, incentives and responsibilities), how to design and implement the programme, who owns the CERs and what are the related costs of developing a PoA.

Chapters III to VIII show case studies which are structured identically to allow the comparison of different subchapters and to allow the interested reader to navigate directly to the type of programme he or she is interested in. Each chapter introduces the background of the concerned technology and analyses key methodological issues that affect the programme design.

The following types of programmes are discussed: replacement of **incandescent light bulbs** through **CFLs** (Chapter III), improvement or replacement of **household stoves** (Chapter IV), **domestic biogas** (Chapter V), **solar water heating** (Chapter VI), **industrial boilers** (Chapter VII) and **energy efficiency in buildings** (building refurbishment, Chapter VIII).

Based on the experiences from existing programmes, this guidebook analyses expected carbon revenues and financial requirements¹ of a “model” project under a PoA. For each technology it provides an overview of fixed and variable costs of a model programme which serves as a basis for the analysis of thresholds, in terms of carbon credit price and project size, for making the project financially attractive. Additionally, a PoA business model is proposed on the basis of lessons learnt in the relevant existing programmes.

It should be kept in mind that each programme is specific and needs to be shaped according to the local conditions. Therefore the analyses provided in the guidebook – in particular, the financial parameters – must be understood as examples and models. Although the blueprints cannot be copied one to one in reality, the models offer a concrete basis for understanding the key steps for the PoA design and implementation.

Chapter IX outlines the lessons learnt from the development of PoAs under CDM and JI and the perspectives in the development of a market for PoA activities.

The different sectors were selected to show examples of household-based types of programmes and programmes which can be adapted to small and medium enterprises. Furthermore the case studies aim at presenting different instruments which in general show a good financial attractiveness.

¹ The financial sections are developed from the perspective of a PoA coordinator, but not from that of households or end-users. Therefore, energy savings for the end-users are not considered in the calculations.

2. Programmatic CDM/JI - an overview

This PoA blueprint book provides an orientation in the young and complex field of programmatic CDM/JI, so called Programmes of Activities (PoAs) under the flexible Clean Development Mechanism (CDM) and Joint Implementation (JI). These mechanisms allow developers of greenhouse gas (GHG) emission reduction projects in developing countries (in the case of CDM) and in industrialised countries (JI) to generate emission reduction credits.

In the case of CDM these credits are called Certified Emission Reductions (CERs), and in the case of JI, Emission Reduction Units (ERUs). Per tonne of CO₂e. emission reduction, one Certified Emission Reduction (CER) or one Emission Reduction Unit (ERU) will be issued. Carbon revenues refer to the monetary value of the expected emission reductions under the PoA.

CERs and ERUs are tradable and can be used for compliance with the emissions commitments of the industrialised countries specified in the Kyoto Protocol. In the case of the CDM, the sustainable development of host countries is an important policy target that led to the requirement of approval of CDM projects by a Designated National Authority (DNA) of the host country. To avoid the creation of fictitious credits, a complex system of rules has been introduced for the CDM, which is developed and managed by the CDM Executive Board (EB). Independent auditors, known as Designated Operational Entities (DOEs) are used to check whether the projects or programmes conform to the rules.²

So far, the 'traditional' CDM approach has mobilised thousands of projects and billions of euros have been budgeted for the acquisition of CERs. It can thus be seen as one of the most successful elements of the global climate policy regime. However, these emission reductions so far arise from single project activities in single locations in limited and very specific sectors.

Why pCDM?

The potential of programmatic CDM lies in large numbers of small and homogeneous low-cost greenhouse gas abatement activities. Of particular importance is demand-side energy efficiency (efficient lighting; appliances; industrial equipment like boilers, motors, pumps; fuel-efficient vehicles). Small-scale fuel switch measures in residential heating or in SMEs are another interesting area. A considerable potential also exists for small-scale waste management activities and renewable energies.

² In order to ease the presentation in the following, reference is made only to CDM. JI will only be treated explicitly in case of more substantial differences to CDM procedures. In general, the guiding principles for programmatic JI are very much the same as those for programmatic CDM.

Opportunities exist for institutions that have an interest in and the capacity to tap into this potential. Actual experience shows that the developers of PoAs must not be involved in carbon finance yet but must have experience in setting up programmes for a wide range of participants. Examples include but are not limited to banks with environmental finance experience, including promotional banks and microfinance institutions; utilities experienced in demand side management programmes and public sector entities like energy agencies or public authorities in the areas of environmental protection, energy, transport or housing.

Another argument for programmatic CDM is the nature of the CDM project cycle as well as the increasing complexity of the rules, which leads to high transaction costs for project activities. CDM-related transaction costs occur both before and during a project's implementation. These transaction costs constitute a barrier to the development of CDM projects, especially for small and dispersed projects which have low volumes of emission reductions if submitted as separate CDM projects. The pCDM is therefore an option to achieve economies of scale and at the same time to reach wider groups of stakeholders and types of activities that are too small to be developed as stand-alone CDM projects. The programmatic CDM has therefore the potential to open sectors that have so far been almost untouched by the CDM.

In this spirit PoAs can be regarded as a climate policy instrument with a high potential to promote environmentally friendly development. Additionally, programmatic CDM is in a far better position to support and accelerate national and local climate policy implementation and to help fast developing countries to embark on a climate-friendly and sustainable development and growth path and simultaneously promote the market introduction of climate-friendly technologies.

PoAs will find their natural niches in the field of small to medium-sized projects which are geographically and/or temporally dispersed and have a large number of project owners unknown before the start of the PoA. Reflecting the current regulatory situation and the aim of PoAs, this guidebook for PoA coordinators focuses on the following technologies that fit within these natural niches and are regarded as highly suitable for PoAs:

- (1) Compact fluorescent lamps
- (2) Household stoves
- (3) Domestic biogas
- (4) Solar water heating
- (5) Industrial boilers
- (6) Building refurbishment

This list is of course not complete and constitutes only a small fraction of PoA opportunities. The above technologies were selected because of available first CDM experiences with these types of activities and because of the broad range of different program designs they allow to discuss.

What is a Programme of Activities (PoA)?

The PoA originates from a decision of the 2005 Conference of the Parties serving as the Meeting of the Parties (CMP) of the United Nations Framework Convention on Climate Change (UNFCCC). In general the CDM programmes, known as Programmes of Activities (PoAs), are measures that are coordinated and implemented voluntarily by private or public entities that implement policies or measures leading to real GHG emission reductions.

... *Decides* that project activities under a programme of activities can be registered as a single Clean Development Mechanism project activity provided that approved baseline and monitoring methodologies are used that, inter alia, define the appropriate boundary, avoid double-counting and account for leakage, ensuring that the emission reductions are real, measurable and verifiable, and additional to any that would occur in the absence of the project activity (7/CMP.1, paragraph 20).

The PoA consists of several **CDM Programme Activities (CPAs)**. A CPA is a single, or a set of interrelated, measure(s), to reduce GHG emissions or result in net anthropogenic greenhouse gas removals by sinks, applied within a designated area defined in the baseline methodology³. That means that a CPA can be the activity in one facility (such as a fuel switch in an enterprise or the installation of a biogas digester in one agricultural household) or can be grouped together reasonably because of the amount of activities (such as the replacement of incandescent light bulbs in a group or the installation of solar water heaters in households or buildings). Other criteria for grouping activities could be – inter alia - geographic, chronological or according to CER amount. By definition, the overall size of a PoA is unknown at the start of the PoA implementation. Numerous CPAs can be included under a POA either at the time of registration or during the implementation of the PoA. The private or public entity that coordinates the PoA is referred to as a PoA coordinator. A PoA has a **duration** of up to 28 years (up to 60 years in the forestry sector).

Baseline and monitoring

The **baseline** of a CDM project (including a programme) is the most plausible alternative scenario to the implementation of the project (the business-as-usual scenario). A CDM methodology determines how the baseline of a particular type of project needs to be established and how the baseline emissions shall be

³ (EB 32, Annex 38, page 1).

calculated. It also defines the modalities of determination of emissions under the project scenario. The difference between baseline emissions and project emissions constitutes the emissions reductions that can be claimed under CDM (reduced by potential leakage, i.e. emissions outside the boundary of the project). Both baseline and project emissions need to be monitored. The required monitoring procedures are also part of a CDM methodology. Just as in regular CDM projects, the **crediting period** for CPAs can be either a) a 7-year crediting period (forestry sector: 20-year crediting period), renewable twice; or b) a single 10-year crediting period (forestry sector: 30-year crediting period). A PoA can use any approved baseline and monitoring methodology, large or small-scale.⁴ An important advantage of PoAs is that the baseline for the whole programme is determined at the beginning in the **project design document** (PDD) for the Programme of Activities. The baseline stays consistent for each crediting period of the CPA unless the baseline is revised within a major methodology revision by the EB.

The choice of methodological approaches has important implications for the programme design, especially for **monitoring**. Of particular importance are the following two approaches for the quantification of GHG reductions:

- (i) deemed savings approach and
- (ii) measurement & verification (M&V) approach.

With the deemed savings approach, gross energy savings are estimated on the basis of stipulated values, which come from historical savings values of typical projects. The savings determined for a sample of projects are applied to all the projects in the programme. However, with the use of deemed savings there are no or very limited measurement activities and only the installation and operation of measures is verified. On the other hand, the M&V approach selects a representative sample of projects in the programme and the savings from those selected projects are determined and applied to the entire population of projects, that is, the programme. The M&V approach has been a typical approach employed in the existing CDMJI methodologies, while the deemed savings approach is rather new, currently it is only available for one methodology that addresses CFLs (AMS-II.J, see Chapter 3).

An important advantage of PoAs is the fact that small-scale methodologies can be applied without any limit to the size of the PoA. Although some large-scale methodologies are being developed specifically for use with PoAs, it is most likely that PoAs will use small-scale methodologies, applying these to the CPAs. Small-scale methodologies can be used by CPAs in the PoA, as long as each CPA is kept under the small-scale threshold. Since small-scale methodologies are much simpler and more standardised, small-scale PoAs (SSC-PoA) have a comparative advantage over large-scale PoAs.

⁴ Nevertheless, PoA-specific versions of the small-scale methodologies have to be used. The PoA-specific regulation accounts for leakage. The leakage rules basically require independent monitoring of scrapping of replaced equipment, which in some project categories can substantially increase transaction costs. In the case of fuel switch, upstream emissions have to be considered whereas regarding biomass, the leakage rules from the respective large-scale methodologies apply.

Documentation

A general description of the PoA, the application of the used methodology and detailed information of the GHG reduction potential and definition of a CPA have to be presented in the CDM project cycle to the UNFCCC Executive Board (EB) for registration. Furthermore, information on the additionality of the programme has to be given. The term **additionality** refers to the demonstration that both the PoA itself and each CPA would not have been implemented, or implemented to the same extent, without counting on the registration under the CDM.

The document in which the information is presented to the EB is the **project design document (PDD)** for the Programme of Activities, the **CDM-PoA-DD**. The second important document to be presented in the CDM project cycle is a project design document for one already existing real CDM programme activity CDM-CPA-DD. Furthermore a generic CDM-PoA-DD is requested (basically a form that is used for the submission of further CPAs). Independent auditors, **Designated Operational Entities (DOEs)** are used to check whether documentation conforms to the rules. A DOE is either a domestic legal entity or an international organisation accredited and designated, on a provisional basis until confirmed, by the Executive Board (EB) and later by the CMP. The DOE has two key functions: it validates and subsequently requests registration of a proposed CDM project activity and it verifies emissions reductions of a registered CDM project activity that it certifies as appropriate and requests the Board to issue Certified Emission Reductions accordingly.

Not formally required by the EB but generally developed in the preparation phase of a project or programme is a **Programme Idea Note (PIN)**, which contains the identification of a promising PoA, a feasibility assessment and the eligibility under the CDM or JI. In order to prepare and structure the promising programme idea carefully and to circumvent unwanted surprises it is recommendable to invest time and resources in this initial assessment. PINs, PDDs and - if necessary - feasibility studies are essential documents to present to possible carbon buyers for their appraisal and subsequent purchasing agreements⁵.

The following formal steps have to be undertaken to develop a new PoA:

⁵ For more information please refer to the website of the UNFCCC, <http://cdm.unfccc.int/ProgrammeOfActivities/index.html>; the CDM Rulebook (<http://cdmrulebook.org>), ESMAP Technical Paper 120/07, Figueres, C. and Philips, M.: Scaling up Demand-Side Energy Efficiency Improvements through Programmatic CDM (2007).

Task	Frequency	Competence required
Preparation Phase		
1. Development of the PoA idea and a PIN	Once. Initial activity	Concept development Economic/financial competence Competence to contract necessary supplementary pCDM knowledge
2. Development of PoA Design Document and CPA Design Document, including the monitoring plan.	Once. Initial activity	Concept development Economic/financial competence (p)CDM knowledge or competence to contract necessary supplementary CDM knowledge
3. Approval by designated national authority (DNA)	Once. Initial activity	Understanding of CPA-DD content
4. Validation of the CDM-PoA-DD and CDM-CPA-DD through a Designated Operational Entity (DOE)	Once. Initial activity	Understanding of CPA-DD content
5. Registration with the EB of the UNFCCC.	Once. Initial activity	Understanding of CPA-DD content
Inclusion / Implementation Phase		
6. Check whether submitted CPAs fulfil the eligibility criteria Submission of CPA Design Documents (CPA-DDs) to DOE	Continuously to include the CPAs, when CPA-DD is finalised.	Understanding of CPA-DD content
7. Operation of record keeping system for each CPA	Continuously	Organisational / programme implementation and reporting experience.
8. Implementation of monitoring with each CPA according to the monitoring methodology	Continuously	Experience to hire engineering knowledge regarding measurement equipment used; understanding of the baseline and monitoring methodology.
9. Communication with DOE regarding monitoring reports	After each request for issuance.	See above
10. Distribution of CERs to PoA Coordinator / CPA coordinator or CPA directly, depending on incentive system	After each issuance of CER.	Knowledge of the performance of each CPA and the contractual arrangements between coordinator and CPA coordinators

Table 1: Steps in PoA development

PoA versus a bundled activity

Under the CDM procedures for traditional projects the opportunity to bundle several project activities exists. Bundling is defined as bringing together several CDM project activities to form a single CDM project activity.

The advantage of bundling is that bundled projects can obtain a single validation report and a single certification report for the entire bundle, which streamlines these processes for project participants. Furthermore, depending on the underlying CDM methodology, a bundle can use sampling procedures for monitoring. Bundling therefore reduces transaction costs.

The limits of a bundle are that (i) it is a pre-defined, fixed structure (no activities can be added to ex ante defined bundle), that (ii) each participant in a bundle is a CDM project participant, that (iii) size limits for simplified methodologies for small scale CDM projects apply on the level of bundle and not only on the level of an individual activity. These restrictions do not apply to PoAs.

The key difference between a PoA and a bundle is therefore that the number and timing of projects developed under the PoA are completely flexible. Basically, bundling was designed for individual project sponsors that deal with a limited number of known similar activities (e.g. retrofitting of 10 boilers within one company) whereas PoAs were made for programmes incentivising a large number of different entities to undertake a certain type of activity (e.g. a country-wide boiler modernisation programme run by a public agency).

The PoA coordinator and other actors

In designing a PoA, the PoA coordinator plays a decisive role. The coordinator must be able to define the programme concept, including the implementation arrangements. It is important that the coordinator is clear on the possible target group(s), the service or activity to implement, organisational issues involved in the start of implementation and that he has an idea on how to organise the monitoring. Generally the PoA coordinator will be responsible for the structure and business model of the PoA, the underlying organisation of contracts and agreements with programme partners or CPAs and the marketing of the carbon certificates (Certified Emission Reductions – CER). The PoA coordinator is also responsible for designing the incentive system that attracts possible programme participants (households or SME) to undertake the proposed measures and to manage the financial flows within a programme and in relation to the carbon buyers.

An understanding of CDM/JI-related topics is helpful but not central as this knowledge can be contracted on the international or national consulting market. Nevertheless, it is essential that the PoA coordinator has an outstanding local network, credibility and a good understanding of the barriers and difficulties the

target group (enterprises or households) is facing in introducing or implementing the relevant activities (e.g. energy efficiency or renewable energy measures). Another crucial capability is to be able to organise a high-quality monitoring system which is indispensable for being able to claim the achieved emissions reductions as Certified Emission Reductions (CERs) under CDM.

The starting point of PoA development is typically the determination of the required type and level of incentive a programme needs to offer in order to be attractive for its target group. Which type and level of incentive are most appropriate depends on the special circumstances of programme implementation but also on some more generic features, like the type of activity the programme intends to stimulate (e.g. retrofitting/rehabilitation of existing equipment, accelerated replacement of devices or new investment in equipment or purchases of appliances). Possible types of incentives include price discounts, grants, loans at favourable rates or simply payments-on-delivery for achieved emission reductions. Besides economic incentives, policy incentives can also be chosen if the programme consists in implementing policy or regulation. In case of loans, up-front grants or price discounts, a financial transformation is needed, that is in this case, to transform future income of CER into today's financing need.

Natural PoA coordinators are larger organisations with the required institutional capacity to run a PoA. However PoAs might also offer opportunities for newcomers like smaller private companies interested to venture into a new business area. Running a PoA can become particularly interesting if it has strong links to and synergies with the core business activities and interests of the PoA coordinator.

Typical PoA coordinators can be **banks** which engage more and more in the fast growing markets for climate friendly technology. In this context programmatic CDM can become an interesting opportunity to design attractive financial products or to support traditional lending in low-carbon projects using the revenues to subsidise interest rates etc.

Energy supply companies are often main drivers of demand-side energy efficiency measures in order to reduce peaks in energy demand and to contribute to an optimisation of power generation over time. Furthermore, for many utilities, energy saving and, also, generation of clean energy is part of their corporate responsibility strategy. Programmatic CDM can support utilities in achieving energy savings and cleaner energy generation. In this context, programmatic CDM/JI could become an interesting instrument for utilities. **Public agencies** will benefit from introducing PoAs revenues, promoting policy implementation and

generating revenues to secure the operating costs of the necessary managing units of the sector policy or strategy.

In all these examples, PoA operators not only have strong links to their core business activities but also major synergy potentials. An example is monitoring procedures that can be well integrated into loan approval and monitoring processes of banks and, in particular, microfinance institutions. Utilities can build on existing customer data bases and public institutions on established institutional structures and outreach. However, PoAs also offer opportunities for smaller companies in opening a new business area for private sector activities that are primarily the domain of the public sector and of governments.

The target group or CPA has different incentives to take part in a programme. **Agricultural enterprises**, for example, might benefit from clean, safe and healthier energy by switching from coal or wood to biogas for cooking or lighting given the risk connected with firing for cooking or lighting. Biogas digesters can provide farmers with organic fertiliser. In the case of energy efficiency measures, **households and small enterprises** may benefit from new and more efficient devices and technologies, a reduced energy bill or better access to credit, which could spur the economics of their businesses. The business model for a new PoA should be structured in a way that gives incentives and at the same time counts on the core competencies of all participants.

Seed funding

An important point which has to be analysed carefully by the programme developer and the PoA coordinator is the necessity of seed funding. Seed funding **does not** include the preparation costs or investment costs of a programme (such as costs for the CDM documentation or for a biogas plant or a boiler). Seed funding is the amount of funds which is needed to prefinance the incentive. The necessity for seed funding mainly depends on the structure of the programme.

In **payment-on-delivery** programmes there is no need for seed funding. The revenues of sold certificates will be handed over to programme participants at the time of accrual, which is after the successful verification of the CPA. That means that programme participants will take the delivery risk of the CERs. This type of programme will become relevant if, for example, the barrier for participants to implement a measure does not lie in high upfront costs or missing upfront awareness-raising but, for example, in the burden of ongoing costs (such as electricity or maintenance costs). With a payment-on-delivery-approach the participants in the programme receive an ex-post payment in proportion to the achieved emission reductions.

Other types of programmes such as **grant programmes**, **loan programmes** or **supply programmes** would generally need some amount of seed funding to prefinance the incentive for the participants. This incentive could be a

- **grant** where the implementing agent offers fixed upfront grant payments to the programme participants on the condition that they undertake the targeted activities. In return for the provided grants the implementing agent will typically request the ownership of the emission reductions which it can sell in order to finance the grant programme. The delivery risk for the emission reduction will then lie with the implementing agent rather than with the programme participants.
Purchases of efficient household appliances (cooking stoves, refrigerators, air conditioners) are examples of activities where a grant programme could become most appropriate.
- **subsidised loan** where the carbon revenues of the programme are used to soften loan conditions in particular to bring down interest rates. Then the lender would take the carbon delivery risk and offer uniform loan conditions to each participant in the programme.

A **Supply programme** is similar to a grant programme. Carbon revenues are used to pay for price discounts or free distribution for energy efficient devices. The PoA coordinator takes the delivery risk of CERs and provides the price discount for ownership of achieved emission reductions. Supply programmes are most relevant for micro activities where the seed funding risk can be reduced to technical default, allowing a statistical approach to risk assessment such as CFL programmes.

The required **seed funding** accrues out of the need for financial transformation of carbon revenues (sold CER) into some kind of incentive payments offered to the participants of the programme. Even if these incentive payments can be financed entirely out of carbon revenues there is a need for some seed funding in the starting phase of the programme before the first generation of activities generates enough carbon revenues to pay for the incentives to be provided to the next generation. This seed funding can be provided by the PoA coordinator himself, by programme participants, by public funds, private funds (banks or other financiers), carbon buyers or international donors.

An Example

A prototype Residential Solar Water Heating Programme is going to save fossil fuels which would have been used to heat water. The annual saving per unit is 2 t CO₂e. At a price of carbon of 10 EUR/t this corresponds to EUR 20 p.a. per unit. Households participating in the programme shall receive a subsidy of 10% of the investment costs (which are EUR 1,000 per unit) upfront. Over 4 years 5,000 units are installed each year. Administration costs are EUR 3 per unit and year. The programme therefore costs EUR 2 million in subsidies and EUR 0.8 million in administration costs. After 15 years total carbon revenues stand at EUR 5,2 million. However, break-even will only be reached in year 8. The seed funding required stands at EUR 1.4 million.

Obstacles in PoA development

Transaction costs

Transaction costs⁶ under CDM comprise costs that arise during the project cycle, e.g. development of the concept and the proper project documentation and/or new methodologies, hiring external auditors, and payment of registration and administration fees under the UNFCCC.

For a Programme of Activities the transaction costs (not including operational costs of the programme itself) result, inter alia, from fixed costs for PoA development (e.g. concept development, sector studies, PDDs, monitoring plans etc.), and running monitoring costs and verification costs.

For traditional stand-alone projects, estimates for the different transaction costs incurred prior to project implementation (up-front transaction costs) lead up to almost EUR 200,000 (Ellis et al. 2004)⁷. Post-registration transaction costs add to the upfront transaction costs.

For the preparation of the different steps, the following costs are estimated. These costs can vary significantly due to programme complexity, the need for international consultant knowledge etc.

The figures in Table 2 therefore represent estimates for a PoA and are based on first experiences in PoA development.

⁶ For references on transaction cost elements, see Michaelowa and Jotzo (2005) as well as Cames et al. (2007)

⁷ 1 USD = 0.73 EUR on October 10th 2008 (<http://www.oanda.com/convert/classic>).

Activity	Estimated Costs ⁸	Comments
Preparation phase		
1. Development of PoA idea and a PIN	Between EUR 8,000 and EUR 15,000 plus travel expenses Up to 15 days	Without feasibility studies / field visits / baseline surveys etc. Upfront
Development of PoA Design Document and CPA Design Document, including the monitoring plan.	Between EUR 50,000 and EUR 150,000, including the monitoring plan	Using a small-scale methodology which is likely in the case of PoAs Upfront
Validation of the CDM-PoA-DD /CDM-CPA-DD through a DOE	Up to EUR 50,000 upfront, yearly verification EUR 30,000	Upfront and yearly verification
Implementation concept.	Up to EUR 100,000	Includes record keeping system for each CPA, adaptation of internal procedures and documentation etc.
Registration fee, UNFCCC ⁹ .	Registration costs of a PoA are determined by the first CPA.	Calculation of the amount to be paid and the procedures for payment will follow the existing rules for the payment of a registration fee (annex 35 to EB 23 Report).
Operational phase		
Monitoring reports. Installation of monitoring equipment and establishment of a database for recording monitoring parameters.	EUR 30,000 – EUR 100,000	Upfront and yearly expenses
Ongoing verification	EUR 10,000 – EUR 30,000	
Issuance fee, UNFCCC	USD 0.10 for the first 15,000 t CO ₂ e; USD 0.20 for any amount in excess of 15,000 t CO ₂ e in a given calendar year	

Table 2. Estimated costs of the development of a PoA.

⁸ We expect that international consulting knowledge is needed in the majority of the cases.

⁹ No registration fee and share of proceeds at issuance have to be paid for CDM project activities hosted in least developed countries.

Each of the following PoA blueprint chapters classifies project costs into fixed and variable cost components based on the estimated costs in table 2.¹⁰

Regulatory barriers

Potential PoA developers should be aware of current **regulatory barriers**. These rules are subject to review by the CDM Executive Board and might be modified. Currently (as of April 2009) those barriers include:

- There are extended and challenging liability rules for DOEs in case of erroneous inclusion of CPAs.
- The decisions on PoA state that the starting date of a CPA can only be after the registration of the PoA. This is a difference to regular CDM projects where credits can be obtained retroactively, and therefore represents a shortcoming, especially because of the insecurities connected with the time-consuming registration process itself.
- PoAs can use only one baseline and monitoring methodology but not a combination of more than one.

Timeframe of the PoA development and starting date

Experience so far has shown that the validation and registration process is time-consuming. In standard CDM projects it could take up to two years from the first idea to the registration of the project. For PoAs this period might become even longer, mainly because of the still existing uncertainty for project developers, DOEs and the EB in this new field. Once the first PoA is registered we expect the procedural time to shorten. Nevertheless it is important to plan around 1-2 years at least for the development until the registration of the PoA.

Who owns the certified emission reductions?

The ownership of the CERs is obviously an important issue for the investors in carbon markets. It is not determined in the rules and procedures of the Kyoto Protocol and is in principle open to national rules and regulations in the CDM market. One might argue that the approval of a CDM project by a DNA implicitly involves an allocation of property rights. In order to be on safe ground most CDM participants and, in particular, a PoA coordinator will insist on legally binding private agreements between the different stakeholders in a CDM project or the participants in a PoA, as the case may be.

¹⁰ The financial sections are developed from the perspective of a PoA coordinator, but not from that of households or end-users. Therefore, energy savings for the end-users are not considered in the calculations.

From an economic point of view it is apparent that the different participants in a PoA need to benefit from the revenues (for example through a price discount, a grant, a subsidized loan etc.) in order to have an incentive to reduce their emissions or to participate in the programme. On the other hand, it also seems evident that, in general, the PoA coordinator should possess the ownership of the credits as he would typically be the one selling the credits to the market and generating the carbon revenues out of which the incentives the programme provides and the operational costs of the programmes are paid.

In any case this topic is subject to negotiations between the parties within the framework of the relevant legislation.

Experiences with JI PoA in Germany – a project developer's perspective

There are different ways to implement JI projects either under the Track 1 procedure or Track 2.

JI 2nd Track is comparable to the procedure under the CDM mechanism. In this case the involvement of the JI Supervisory Committee (JISC) is necessary. The development and implementation of JI projects under **JI 1st Track** needs to be in accordance with national regulations of the JI host and investor country.

At present there is a lack of JI-specific regulation. It is only since the COP 14 that the JISC has been mandated to develop guidelines and procedures for projects under PoA. With this mandate it is possible to enable PoAs in all JI countries. However, regulations or guidelines on programmatic approaches under JI 1st Track emerge from national legislation. This is the case in Germany, for example, where the German national authority (DEHSt) supports Track 1 procedure.

Currently, three PoAs under the JI mechanism have been successfully implemented in Germany. In this respect other project plans can benefit from experiences gathered so far. In general all PoAs implemented in Germany are to be in accordance with the decisions of Annex 38/39 for PoAs under the CDM. This means that project documentation, for example, should be in accordance with formal requirements for CDM (documents: PoA-DD, JPA-DD).

Nevertheless, the DEHSt alleviates some procedures. These alleviations represent deviations from the official CDM guidance documents and refer to the following aspects: a) inclusion, b) verification and c) methodology.

a) Inclusion - consistency check is done in the course of verification

The process of inclusion of a JI programme activity under a registered Programme of Activities (PoA) has been simplified. Thus, consistency checking by a DOE when including a new project activity in a registered Programme of Activities (PoA) is not essential, as this can be done in the course of verification.

In this respect the coordinator for PoA decides about the inclusion of additional project participants without involving the DOE and the DOE checks the consistency of new participants during the verification process. This helps to reduce transaction costs as the process of consistency check is expected to be a very costly and time-consuming approach which could render the whole PoA unfeasible.

b) Verification – *one verification turn per year*

The applicability of an approved baseline and monitoring methodology must be assured for all project activities. But it would be appropriate to keep the complexity of the process at reasonable levels with regard to the verification procedure. Considering the requirements related to verification, certification and request for issuance, project activities may be expensive in terms of effort and costs. According to this, the required minimum frequency is lowered to one verification turn per year and to a sample of 10%.

c) Methodology - *combination of several measures*

In German JI-PoAs, several methodologies can be combined. This is done, for example, in a German boiler modernisation programme combining an energy efficiency methodology with a fuel-switching one.

The experience with the implementation of several JI PoA projects in Germany has shown that these alleviations are helpful and that they do not prevent the conservativeness of the overall approach.

3. Compact fluorescent lamps

3.1 Background

Electricity consumes massive amounts of energy worldwide. The residential sector contributes to the electricity consumption to a large extent and the part which lighting consumption plays is estimated to reach up to 28% (Mills 2002). Huge energy savings and CO₂ reductions could be achieved by introducing energy efficient lighting. The most popular example of energy-efficient lighting is compact fluorescent lamps (CFLs).

CFLs consume only 20% to 25% of the energy used by incandescent light bulbs (ILBs), the conventional lighting technology, with the remaining 75% to 80% wasted as heat. In contrast, a CFL uses all of its electricity input to produce light. CFLs also have much longer lifetimes with rated life spans of 5,000 to 25,000 hours compared with 1,000 hours on average for ILBs. Although CFLs have much higher initial costs than ILBs (about 20 times higher), they are far more economical on a life cycle basis due to their longer lifetimes and energy savings potential. The total lighting costs for 10,000 hours use are estimated to be ca. EUR 18 for CFLs and EUR 58 for ILBs (IEA 2006). Therefore, replacing ILBs with CFLs is a win-win-win solution with benefits from a climate, economic, and – by reducing system load and/or

the consumption of primary fuels exposed to international market risks - energy security perspective (Lefèvre et al. 2006).

However, the penetration rate of CFLs (especially high quality) is still very low, especially in the residential sector. The high initial costs have been the biggest barrier to CFL dissemination, particularly for poorer sections of the community. Coupled with the initial cost barrier, the poor performance of first generation CFLs (e.g. cooler light colors, a tendency to flicker, and a higher rate of failure before the end of rated lifetimes) created some consumer distrust in the technology. Furthermore, lack of consumer awareness of the energy savings potential and the difficulty of altering consumer habits also contributed to the barriers to CFL dissemination (Lefèvre et al. 2007). Lastly, but not the least, the



Incandescent light bulb.

Source: KfW photo archives, photographer: Thomas Klewar

split-incentives problem¹¹ is also an important barrier to the energy-efficient lighting technology.

The CDM/JI could help overcome these barriers, especially the initial cost barrier, by providing additional carbon revenues that can be securitised and thus mobilise upfront financing. The following sections discuss methodological and financial requirements for a CFL programme, and develop a model for CFL programme implementation building on the lessons learnt from existing CFL programmes.

3.2 Methodological requirements

In order to claim for CERs from a CFL programme, the energy savings from the programme have to be calculated first. Key parameters for the energy savings calculation, depending on the chosen methodology, include - *inter alia* – the number of CFLs installed and replaced ILBs, power rating of the CFLs and ILBs, and daily lighting usage. Alternatively, they include the number of distributed CFLs and replaced ILBs and the energy use of the CFLs and ILBs.¹²

The energy savings are multiplied by the grid emission factor to calculate the emission reductions by the programme. In determining the energy savings, there are two broad categories of methodological approaches: (i) M&V approach and (ii) deemed savings approach. The key difference between the two approaches is the degree of monitoring requirements (the former involves greater monitoring efforts since a sample of CFLs has to be monitored to estimate the average daily lighting usage).

As of March 2009, the following three approved methodologies are available for CFL distribution programmes: AM0046 (version 01),¹³ AMS-II.C (version 11)¹⁴ and AMS-II.J (version 02)¹⁵. Due to the complexity in its methodological approach AM0046 is not a relevant choice for a PoA development.

Methodological differences between AMS-II.C and AMS-II.J

By using **AMS-II.J**, CERs can be earned only for the rated lifetime of CFLs (i.e. rated life to 50% failures). Daily lighting hours have a default value of 3.5 hours or lower. Only if a continuous measurement of usage hours of the baseline lamps takes place (on a sample basis over a limited period of time) can a different value

¹¹ Also known as “principal-agent” barriers, in which one party makes decisions regarding the energy efficiency of a building or energy-consuming device as an “agent” on behalf of the “principal”, the party that pays the end-use energy bill. This problem might appear in new home and commercial building markets where the builders’ motivation is to minimise first(not long-term) energy costs, and in landlord-tenant relationships for residential and commercial space (ASHRAE 2007).

¹² Depending on the methodology applied to the programme, additional parameters need to be considered.

¹³ AM0046 (version 01): Distribution of efficient light bulbs to households.

¹⁴ AMS-II.C (version 11): Demand-side energy efficiency activities for specific technologies

¹⁵ AMS-II.J (version 02): Demand-side activities for efficient lighting technologies.

be used¹⁶. Another important implication for the programme design is that AMS-II.J requires at least one of the following measures:

- (i) either a minimal price charged for CFLs,
- (ii) a direct installation of CFLs or
- (iii) a limitation of CFLs per household.

The latter criterion is probably relatively easy to meet. The most significant difference is the extent of ex-post monitoring. AMS-II.J is based on the deemed savings approach, AMS-II.C is based on the Monitoring and Verification (M&V) approach.

AMS-II.J assumes the daily lighting usage to continue with a pre-determined value (using default values), hence does not involve ex-post monitoring of this parameter and reduces the associated risks of ex-post monitoring.

AMS-II.C requires continuous measurement of daily lighting usage or energy use of CFLs in a project sample group which is selected randomly at the beginning of the project implementation and will be fixed for the entire crediting period.

Regardless of the methodology applied, however, the project needs to inspect a sample of households annually to check whether the distributed CFLs are still in operation. This project cross check group has to be randomly selected every year.

Both methodologies may not readily be applicable to “cold” regions/countries as these methodologies require leakage calculation if a PoA leads to increased heating load (“cross effects”) if more than four CFLs are distributed per household. Details of such leakage calculation are not yet provided in the current version of the methodologies and are likely to be difficult. Therefore the implementation of a PoA in cold regions should be restricted to the distribution of four CFLs.

In sum, the methodological differences imply that AMS-II.C is more suitable for a programme which aims at higher risks and higher returns and which has the possibility to implement a more sophisticated monitoring system (e.g. using remote sensing technologies). AMS-II.J has a lower return but might be more secure in its returns as the monitoring requirements do not require an ex-post monitoring of daily lighting usage. The gain from the simpler monitoring requirement for daily lighting usage should be carefully compared against the possible loss in the amount of CERs.

¹⁶ Compare Paragraph 12 of AMS-II.J:<http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html>

PoA Coordinators have to keep this in mind and should check the key variables carefully at the beginning of the PoA development. They should determine the possibilities to set up a sophisticated monitoring system and compare the costs and risks with the revenues they would obtain with the more secure and easier system. A decision will also depend on the amount of planned CFLs to be distributed. On those results the decision on the methodology can be taken.

Category	Key methodological differences for application to a PoA
Ex-ante survey & implementation planning	AMS-II.C: ILB usage pattern; ¹⁷ CFL penetration rate. AMS-II.J: ILB usage pattern; CFL penetration rate; Net-to-Gross (NTG) ratio. ¹⁸
CFL distribution & ILB replacement	AMS-II.C: Direct installation and/or distribution at dedicated distribution points; no formal requirement on CFL prices or replacement of defective CFLs. AMS-II.J: Direct installation, minimal price charge for the CFLs (i.e. no give-away) or restriction of CFL distributed per household; mandatory replacement of defective CFLs.
Monitoring	AMS-II.C: Sample-group monitoring for daily lighting usage; ex-post CFL functionality check. AMS-II.J: Deemed value for daily lighting usage; ex-post sample group monitoring for CFL functionality check.
Scrapping	AMS-II.C and AMS-II.J: Disposal of ILB to be documented and independently verified. The number of destroyed ILB to match number of distributed CFLs.

Table 3: Key methodological characteristics between AMS-II.C and AMS-II.J

3.3 Programme design

3.3.1 Lessons from existing CFL programmes

Based on the survey of 26 CFL programmes implemented in 14 countries around the world, du Pont (2007) found that the most popular CFL programme type was public awareness programmes, followed by give-away, discounted sale, testing & certification, and labelling. CFL programmes are most commonly implemented by utilities or governments, supported by manufacturers/suppliers, utilities (if they are not the implementing agency), and retailers (du Pont 2007). These programmes have been conducted before the programmatic CDM was introduced by the UNFCCC.

¹⁷ Option 1: Daily lighting usage and power rating of ILB, or Option 2: Energy use of ILB. AMS-II.J only allows Option 2.

¹⁸ A NTG ratio represents a share of "free-rider" households that would have installed CFLs anyway. A default factor for an NTG ratio (95%) can be used.

Du Pont (2007) summarises the following key success factors for CFL programme implementation:

- (i) promotion & marketing,
- (ii) partnership with suppliers/retailers,
- (iii) testing & labelling, and
- (iv) subsidy/discount.

Regarding promotion & marketing, lack of consumer awareness is a limiting factor. In order to overcome the barrier, information and education need to be central to any promotional programme. In the context of partnerships with suppliers/retailers, retail delivery channels seem to be superior to direct mails due to higher installed rates and groundwork laid to promote adoption (Skumatz and Howlett 2006). The quality of CFLs is a key to successful programme implementation. Testing & labelling can help alleviate consumer distrust in CFLs due to the poor performance of early generation CFLs.

The biggest barrier of high initial costs can be overcome by providing a subsidy/discount. However, it should be kept in mind that too much subsidy/discount could devalue the product and might lower the effectiveness of a programme. Charging a certain amount of fee will tend to increase the adoption of distributed CFLs for actual usage and will curb resale.

It is also important to note that successful CFL programmes combined several measures to address multiple barriers (Lefèvre et al. 2006). For example, the effectiveness of subsidy and give-away programmes (initial cost barrier) can be increased by parallel efforts to raise public awareness (information/behaviour barrier) and to ensure the product quality by testing & certification (technological barrier).

3.3.2 Business model and institutional requirements

Building on the lessons learnt from the CFL programmes described above, a CFL PoA business model is conceptualised in Figure 1. This business model is only one possibility to structure the Programme as other options regarding the different actors and their roles and responsibilities are possible. The PoA coordinator could as well be a CFL supplier, a public energy agency, a large ESCO or other. The structure of the business model should be oriented towards the core competencies of the different actors, especially the core interests and strengths of the PoA coordinator. The figure summarises the key actors and their responsibilities.

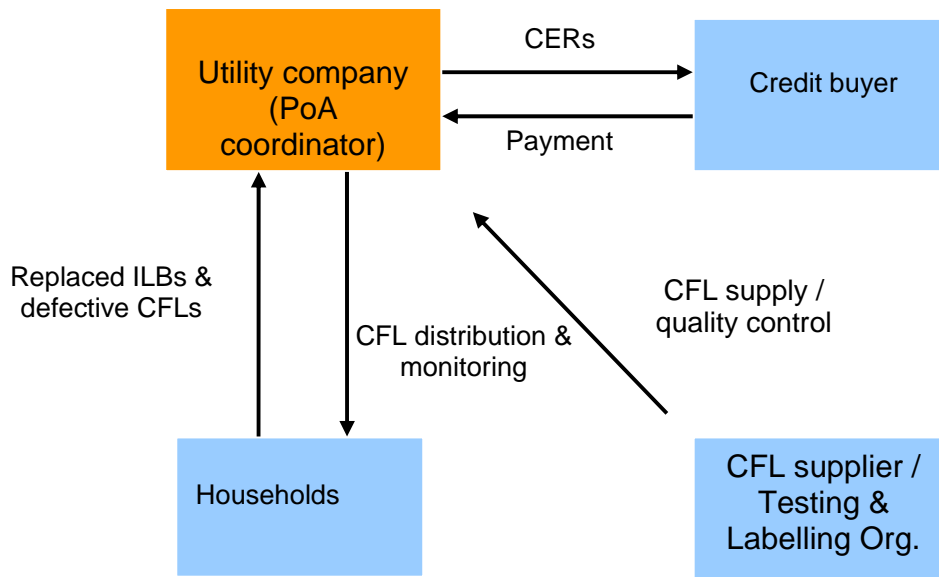


Figure 1: CFL programme business model example

The model strives to address the barriers to CFL penetration in the following manner:

- Initial cost barrier: CFL distribution for free or at discounted prices¹⁹. The CFLs are procured at production cost.
- Technological barrier: CFL testing & labelling to ascertain the quality of CFLs; free replacement of defective CFLs (e.g. one-year guarantee)
- Information/behaviour barrier: Awareness raising by a utility company, CFL supplier, and retailer

Aim of the PoA: The aim of the PoA is to enhance the penetration of CFLs by bringing down the price of CFLs, which has been the biggest barrier to the technology penetration. The carbon revenues are utilised to recover the balance of costs. This would lead to reduced energy costs for households and longer durability of CFL compared with ILB.

Target group: The CFLs are distributed to grid-connected households, which currently use ILBs.

Managing entity: The PoA coordinator is a utility company with a very strong logistical capability and excellent local network to enable an effective monitoring. CFLs come from local production or are imported.

¹⁹ The difference to the stove programmes described below is that the target households are not really concerned about lighting costs, while the fuel costs for stove users are a very high proportion of the expenses of the households and thus awareness is not a problem.

As the PoA coordinator, the utility takes care of the CFL distribution and replacement of ILBs, free replacement of defective CFLs within a year, safe disposal of used CFLs, and awareness raising of the CFL programme. In case of use of remote sensing equipment, it develops the technical specifications for the monitoring equipment used and administers sample selection, installation of meters and data collection. The utility customer database is an asset for establishing a database for household random sampling required for the monitoring (the utility customers fulfil the eligibility requirement for household participation, i.e. grid-connected households). In case of remote sensing monitoring, data collection should be done centrally by the PoA coordinator. If this is not the case, the utility company performs the monitoring of daily lighting usage and CFL functionality check as they regularly have to go to each customer household to meter its electricity consumption.

Actors involved: Besides the power utility and the households, the business model involves one or more CFL suppliers, either local or international, to secure the timely provision of a large amount of high-quality CFLs. In addition, the involvement of a testing & labelling organisation helps to assure the quality of the distributed CFLs and overcome the customer distrust that the first-generation CFLs created. Furthermore, retailers can support the CFL distribution process. The retailers are often well-equipped for promotional and awareness raising activities, which is central to any CFL programme. Also, the use of barcodes can significantly simplify the distribution process for retailers (Skumatz, Howlett 2006). These actors could receive an incentive out of the CER revenues if necessary to change business habits or promotional activities. The subsequent contractual structure needs to be coordinated by the PoA coordinator.



Different compact fluorescent lamps to save energy.
Source: KfW photo archives, photographer: Thomas Klewar

Programme implementation:

- The PoA coordinator shall prepare all necessary contractual arrangements with the CFL suppliers, the testing & labelling organisation, and the retailers. The PoA Coordinator organises awareness raising activities for the CFL programme. The testing & labelling organisation should set the minimum quality standard of the CFLs. If appropriate, the retailers can help distribute the CFLs and organise the awareness raising activities. In case of remote sensing monitoring, the PoA coordinator would issue the tender for the equipment, define the sample, install the equipment in the sample households and collect the data. In case of monitoring through physical checks in the sample households, the utility should be responsible for the monitoring of daily lighting usage and functionality of the distributed CFLs.
- The PoA coordinator needs to conduct an ex-ante survey in the project area. The key issues for investigation are: ILB usage pattern, CFL penetration rate, and NTG ratio²⁰ in the area. The ex-ante survey shall be based on randomly sampled households in the area, so the utility customer database needs to be provided by the utility company. According to the results of the survey, a detailed project implementation plan has to be established. The key issues are the number, power rating, and lumen output of CFLs to be distributed / ILBs to be replaced. As the energy savings of a SSC-CPA project under the PoA is capped by the 60 GWh/year threshold, careful consideration of these items is indispensable. The logistics for the CFL distribution is also key to the implementation plan.
- The CFLs have to be distributed either door-to-door or through centralised distribution channels. A door-to-door distribution is labour-intensive and requires substantial time and costs. Therefore, it is important for the project viability to streamline the distribution process and reduce the associated costs. One possibility for the cost reduction is to ask local NGOs to distribute the CFLs because they are often well informed about the local geography and CFLs are not very complicated technology even for non-technicians to deal with. Another possibility is to involve local retailers and utilise the existing business relationship with the CFL supplier. How to organise the process depends strongly on the actual working procedures of the utility. If customers are visited at home regularly it would be the easiest to exchange the CFLs then and take care of the requirement to collect all the ILB and take responsibility for their destruction, verified by a third party.

²⁰ Only if AMS-II.J is applied. If the default ratio of 95% is used, there is no need for ex-ante survey on this item.

- Monitoring should be conducted by the PoA coordinator. The daily lighting usage is to be monitored at sample households which are chosen from the utility customer database. Along with their customer visit for metering the electricity consumption, they can also read the daily lighting usage meters and check if the distributed CFLs are still in operation or not. The monitoring procedures require physical inspection at respective sample households,²¹ so these procedures have to be integrated into the utility's existing business procedure.

3.4 Carbon revenues and financial requirements

3.4.1 Carbon revenues

Taking one of the most advanced CDM projects on CFL distribution in India as a case study, Table 4 summarises key parameters for CER estimation of the programme.

Number of households	Number of CFLs to be distributed	CFL penetration factor	Average daily lighting usage	Weighted average power rating [W]	Grid emission factor [tCO ₂ e/MWh]	Annual amount of CERs	Annual amount of CERs per CFL
400,000	530,000	19%	4.0 hours	ILB: 98 CFL: 19.9	0.81	41,500	0.08

Table 4: CER estimation of a model CFL programme²².

The CER potential largely depends on the programme design and the location. It would be highly recommendable to conduct an ex-ante survey at the location where a programme is planned. It would help the programme developer find out which lamp types exist and the potential number of lamps that can be replaced. This can vary extremely between countries, states and even villages. For PoAs where the CFL penetration factor needs to be considered according to AMS-II.C and AMS-II.J, it would be essential to know this factor for the planned programme area as the emission reductions will be deducted by the CFL penetration factor. In the Indian CFL programmes currently in the CDM programme pipeline, this factor varies between 5% and 30%.

One of the most distinctive features of the financial requirement of CFL programmes is that this programme type in general only allows for one main revenue stream coming from the sale of CERs. Otherwise, the additionality would be difficult to demonstrate due to the low life-cycle cost of CFLs.

²¹ If remote sensing monitoring equipment is used for the daily lighting usage monitoring, the physical inspection at households in the sample group(s) is not necessary.

²² Note: The project is based on AMS-II.C (version 09). As opposed to AMS-II.C (version 10), it does not take transmission & distribution loss into account for the emission reduction calculation. Hence, the transmission & distribution loss is not included in the table.

Depending on the programme design, additional minor revenue streams might occur (e.g. when distributing the CFLs for a minimal fee)²³.

3.4.2 Financial requirements

According to the Indian CFL programmes, the total costs for CFL procurement are EUR 3.3 – 5.8/CFL, including CFL production and ordering costs of EUR 3.0 – 5.0/CFL and other programme costs (transport, tax & duty) of EUR 0.3 – 0.8/CFL. It should be kept in mind that these programmes are using the highest quality CFLs with an average lifetime of at least 15,000 hours. Depending on the quality standards of the CFL technology used, the specific investment costs per CFL vary. It is recommended to use high quality CFLs to ensure the life-cycle of the device.

If door-to-door distribution is used and cannot be accomplished during the usual business activities of the power utility as PoA coordinator, it might easily sum up to be the biggest cost component in the development of CFL PoAs as this process tends to be labour-intensive and requires a large number of people for the distribution.

The cost of the distribution can be very low if, for example, a local NGO is willing to assist voluntarily or normal procedures of the utility personnel can be used. Other options to distribute CFLs include, for example, central distribution by inviting the households to pick up the devices on a special CFL date at a central point or by distributing CFLs during the regular visits of the power utility etc. The way this is implemented depends on local networks and local possibilities of the PoA Coordinator. The way the CFLs are distributed is not determined in the methodologies. Traceability of the installation of every single CFL and the safe disposal of the light bulbs has to be ensured by the PoA coordinator, for example by using the utilities' data and/or consumer awareness processes.

Once the distribution of CFLs is completed, the operational costs are minor, except for the costs for conducting the monitoring.

Some additional revenues might be generated depending on the programme design (e.g. a minimal fee charge for CFLs). But as these revenues and the revenues of the selling of the CERs will only accrue at a later stage the pre-financing or seed funding issue is often a barrier to programme implementation. Even if a small-scale methodology is applied, programmes involve greater complexity in design and implementation than most other CDM programme types. By nature, these programmes involve a high number of appliances in numerous locations (e.g. households) in a geographically dispersed area, which

²³ The Indian project aims to distribute CFLs for free or for a minimal fee. In case a fee is charged, it will not be higher than 15 Indian Rupees (INR), which is comparable to the price of an ILB (e.g. INR 15 is around EUR 0.26)

requires a highly sophisticated organisational structure. In particular, costs for the logistical efforts (e.g. CFL distribution, ILB replacement and safe, certified disposal, necessary training for distribution and monitoring teams) should not be underestimated. Possible providers of seed funding can be (at least partly) the buyer of the CERs, international and local financial institutions, international CFL producers or public funding, either international or national.

The cost overview of a model CFL CDM programme is summarised in Table 5, assuming distribution of 530,000 CFLs, a CFL lifetime of 10 years, and a monitoring sample size of 200 households. It is estimated for a model CFL programme based on AMS-II.C. For the model CFL programme the estimate assumes advanced remote sensing monitoring equipment for the daily lighting usage. If conventional equipment is used, the upfront cost becomes lower and the annual cost higher (as physical inspection of the sample households will be necessary). In addition, although not a mandatory requirement of the CDM/JI, safe disposal of CFLs is recommended to increase public acceptability of a CFL programme.

Like all other fluorescent lamps, CFLs contain a small amount of mercury. Experiences with CFL safe disposal have been concentrated in industrialised countries, so authentic cost estimates of such an exercise in developing countries are not publicly available and need to be assessed in the preparation of the Programme. Therefore, the cost overview below does not account for safe disposal of CFLs.

Cost components		Upfront (EUR)	Annual (EUR p.a.)
Fixed costs	Programme design and CDM documentation	200,000	30,000
	Monitoring	70,000	3,000
	CDM fees	50,000	30,000
Variable costs	CFL procurement	4.50 per CFL	-
	CFL distribution and ILB replacement ²⁴	0.51 per CFL	-
	Other costs	-	< 0.01 per CFL

Table 5: Overview of the estimated fixed and variable costs of the model CFL programme (nominal)²⁵

For this specific example with 530,000 distributed CFLs, the nominal costs per CFL would thus reach EUR 5.6 upfront plus EUR 0.1 annually.

²⁴ Assumed person-month required: 7 months for experts, 100 months for local skilled staff, and 1,000 months for ground-work staff.

²⁵ Note: Distribution of 530,000 CFLs; CFL lifetime of 10 years; Monitoring sample size of 200 households. The CDM methodologies require the monitoring only in the sample households. It is assumed in this report that the sample size is 200 households, so the monitoring costs are considered fixed.

This generates the following attractiveness table, assuming no significant revenues are earned from the CFL distribution. The annual CER per CFL are calculated using the methodological requirements. The determinants are, inter alia, the operating hours per day, baseline penetration, grid emissions factor etc. For details please refer to chapter 3.2 on methodological issues.

Annual CERs per CFL	CER minimum price for break-even (EUR)	CER price for IRR of 15% (EUR)
0.16	6.5	7.8
0.08	13.0	15.5
0.04	25.9	31.0

Table 6: Indicative level of CER prices and CERs per CFL required for break-even and IRR of 15%²⁶

Furthermore, the financial information of the model programme allows for the calculation of the critical programme size to achieve financial viability. The following CER revenue levels are considered for the analysis, assuming a CER price of EUR 12 and annual CER generation per CFL of 0.04, 0.08 (as in the Indian case) and 0.16. Based on the three scenarios for the CER revenue per CFL, the critical programme sizes for the break-even and IRR of 15% are summarised in Table 7.

Annual CERs per CFL	Critical size (number of CFLs)	
	Break- even	IRR of 15%
0.16	105,000	139,000
0.08	830,000	Unlikely to achieve
0.04	Unlikely to achieve	Unlikely to achieve

Table 7: Critical size of a CFL programme for reaching break-even and IRR of 15%²⁷

The analysis shows that CFL programmes in countries with high baseline emission factors, low CFL baseline penetration factors and high lamp utilisation rates are financially more attractive. Nevertheless the programmes make sense everywhere. Choosing lamps with a lifetime that allows full utilisation of a 10-year crediting period is also important. The overall size of the PoA should reach at least 1 million unless it is possible for the coordinator to procure CFLs at lower costs than those achieved in current CFL programmes.

²⁶ Note: Calculated using AMS-II.C (v.09). Discount rate of 10% for the calculation of the break-even. (For simplification the calculation of the break-even applies a discount rate of 10% for the NPV in each blueprint.)

²⁷ Note: Calculated using AMS-II.C (v.09). Discount rate of 10% for the calculation of the break-even.

Key points and challenges

1. The exchange of compact fluorescent lamps for incandescent light bulbs in residential lighting has great potential to reduce electricity consumption and thereby contribute to the reduction of GHG. CFLs only consume 20% to 25% of the energy used by ILB.
2. Barriers to introducing and disseminating these ILB lie in the high initial cost, technical problems in the first generations of CFLs and in customers' scepticism and lack of awareness.
3. The programmatic CDM could help overcome these barriers by providing additional revenues from the sale of CERs to finance a price discount or the complete subsidisation of the devices.
4. Successful programmes combine a mixture of promotion and marketing measures with high-quality CFLs. Free distribution should be avoided as it devalues the product and might diminish the effectiveness of the programme.
5. The costs per CFL vary, in the case study they are EUR 5.6. The CER revenue per CFL vary between 0.4 and 0.16 t CO₂/a, depending on the baseline emissions and other factors.
6. Challenge I: In most cases the PoA developer will need seed-funding to (pre-)finance the CFLs. Seed-funding can be provided by carbon credit buyers, private investors (CFL suppliers, banks etc.) national public funds or international donors. Nevertheless this might result in a key challenge for the programme.
7. Challenge II: The decision on the monitoring needs to be based on a feasible and cost-efficient way to organise the monitoring. At the beginning of the PoA an accurate assessment of the use of the deemed savings approach or the measurement and verification approach is necessary.

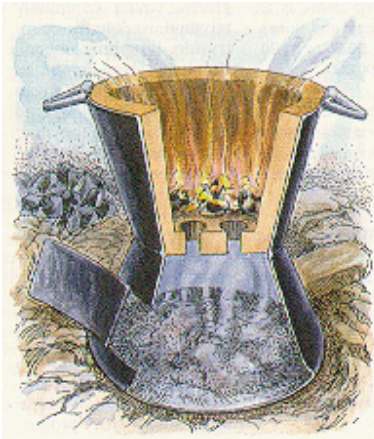
4. Household stoves

4.1 Background

Despite all efforts to extend the reach of modern forms of energy, almost 50% of the world's population still prepares their food on small stoves fired by biomass or solid fossil fuels (Kammen 2007). Often, these stoves are very primitive and have an extremely low efficiency. They also lead to severe pollution of the indoor air, which causes respiratory diseases. According to Kammen (2007), these diseases kill four to five million children worldwide every year and are the leading health hazard in developing countries.

The traditional three-stone cooking device (Figure 2 c)) has an efficiency of less than 10%. Metal stoves (Figure 2 b)) achieve 10-15%. Improved stoves, such as the “Jiko” (Figure 2 a)) developed for a large-scale stove distribution programme in Kenya, reach an efficiency of 25–40%. For a detailed description of all common stove types, see GTZ (2008).

a) improved



b) traditional



c) three-stone fire



Figure 2: Improved compared to traditional stove and three-stone fire
Source: Kammen (2007)

Improved cookstoves contribute to the reduction of pressure on native forest and scrubland, which are frequently degraded by biomass collection. They reduce indoor pollution and can lead to substantial savings in fuel costs for urban households that have to buy their fuel on the market. They free up time for productive activity for rural households collecting fuel in forests or scrubland. The replacement of biomass/fossil fuel stoves by renewable energy-operated stoves such as solar cookers can reduce biomass use even further, but it has encountered cultural barriers (cooking is done before sunrise or after sunset, unwillingness to cook outdoors). The stoves in Figure 4 show an example of devices that could be used in a PoA. Of course there are other technical options

which might serve the specific local needs of a PoA better, such as stoves built into houses.

No solar cooker programme has been able to achieve penetration rates comparable to efficient biomass cookstove programmes. We thus do not discuss such programmes in this section. We also do not address cooking devices using biogas, as biogas will be covered in a subsequent section.

Despite their undeniable benefits, and although formal payback periods are as short as 3 months (GTZ 2008), the penetration rate of improved stoves is still very low, especially in rural areas. The initial costs of EUR 6-15 per stove have been the single biggest barrier to efficient stove dissemination, particularly for poorer sections of the community. Coupled with the initial cost barrier, the poor performance of first-generation improved stoves (e.g. cracking of ceramic components, tendency to fall over, overheating of pots) created user distrust in the technology. Trust can only be built by introducing (semi-) industrial manufacturing of stoves, which would also bring costs down due to scale effects. Furthermore, lack of consumer awareness of the energy savings potential and the difficulty of altering cooking habits also contributed to the barriers to efficient stove dissemination.

The programmatic CDM²⁸ could help overcome these barriers, especially the initial cost barrier, by providing additional revenues from the sale of CERs to finance efficient manufacturing equipment. The following sections discuss methodological and financial requirements for an efficient stove programme, and develop a model for efficient stove programme implementation building on the lessons learnt from existing efficient stove programmes.

4.2 Methodological requirements

In order to claim CERs from an efficient stove programme, the fuel savings from the programme have to be calculated first. Fuel use in the baseline situation depends on the efficiency of baseline stoves, the number of distributed efficient stoves and their capacity rating as well as daily stove usage. Fuel use in the project situation is determined by the efficiency of stoves distributed by the project, the number of distributed efficient stoves and their capacity rating as well as daily stove usage. The fuel savings are multiplied by the carbon content of the fuel used to calculate the emission reductions achieved by the programme; this requires knowledge of the fuel types. As in the case of CFL programmes, two broad categories of methodological approaches could in principle be used to determine fuel savings: (i) M&V approach, and (ii) deemed savings approach.²⁹ The salient difference between the two approaches is the degree of monitoring

²⁸ JI is not relevant for this technology, as biomass stoves are not widely used in industrialised countries.

²⁹ See Ch.2.2 for short descriptions of the approaches.

requirements. However, to date, no deemed savings methodology has been approved for stove programmes.

There is no approved methodology for large-scale stove projects. For SSC projects achieving a renewable biomass firing capacity of up to 45 MW_{th} (approximately 50,000 stoves³⁰) or an annual biomass savings capacity of up to 180 GWh_{th} (about 35,000 improved stoves³¹), several methodologies are available. For greenfield renewable biomass stoves replacing fossil fuelled stoves, the methodology “Thermal energy for the user with or without electricity” (AMS-I.C) is available. Improvement of fossil fuelled stoves is addressed by the methodology “Demand-side energy efficiency activities for specific technologies” (AMS-II.C). Both methodologies have been available since 2003 but have only been used by developers of solar cooker projects.

AMS-I.C is only applicable for new, **renewable energy stoves** that replace fossil fuel ones. This is a rare condition but might exist in China. It requires measurement of the efficiency of baseline fossil fuel stoves or at least two manufacturers’ specifications. Alternatively, a 100 % baseline efficiency can be assumed. While M&V is not required for technologies that reduce less than 5 tCO_{2e} per year per application, this is not the case for biomass appliances such as stoves, where the amount of biomass used needs to be monitored.

AMS-II.C addresses improvement of **fossil fuel stoves**. The baseline is fossil fuel use of the existing stoves, discounted by the degree of penetration of improved stoves. A representative sample of existing stoves needs to be checked by a validator with regard to their capacity. For a sample of stoves installed through the programme, usage hours have to be monitored.

A key question that stifled stove programmes for a considerable time was the treatment of non-renewable biomass use under the CDM. 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. For over two years, projects reducing use of non-renewable biomass were not eligible. Only in December 2007, two non-renewable biomass methodologies were approved: (i) switch from non-renewable biomass for thermal application by the user (AMS-I.E), and (ii) energy efficiency measures in thermal applications of non-renewable biomass (AMS-II.G).

³⁰ This assumes an average power of 1 kW per stove, which might be an overestimate for the small portable stoves generally used.

³¹ According to Bailis et al. (2007a), the average savings per stove is about 50 MJ/stove and day, i.e. about 5 MWh_{th} per year. Then the threshold of 180 GWh_{th} is reached at around 36,000 stoves. The level can vary widely depending on the actual efficiency improvement per stove and stove usage intensity.

For the **non-renewable biomass methodologies** (AMS-I.E and II.G), it has to be proven through a survey that non-renewable biomass has been used since 31 December 1989. This will impact on PoA preparation costs. AMS-II.G is the only methodology applicable to the typical improved cook stove programmes where improved biomass stoves are distributed to substitute inefficient ones. The baseline is based on the assumption that in the absence of the CDM project, the fossil fuel (kerosene, LPG or coal) most typically used for cooking applications in the region/host country would have been used. The CO₂ emissions factor of that fuel is multiplied by the energy content of the non-renewable biomass used before the project start and the total use of non-renewable biomass by the project.

Thus, a PoA has to determine which fossil fuel is normally used for cooking in the host country. To determine the use of non-renewable biomass, its share in total biomass used before project start has to be determined by survey methods or through historical data. For calculation of total biomass use before project start, the number of pre-project stoves has to be multiplied by the estimated average annual consumption of biomass per stove. The difference in efficiencies between baseline stove and project stove is a key parameter, which is to be determined using representative sampling methods or referenced literature values. The latter is probably easier for PoA developers, but might not be available everywhere. If the saving of non-renewable biomass leads to the replacement of renewable biomass elsewhere by non-renewable biomass, this needs to be deducted from the emissions reductions. This can lead to complicated analyses of indirect effects of the PoA.

The efficiency of a sample of stoves introduced by the programme has to be checked annually. Programme stoves that are broken and have been replaced also need to be monitored. Data on the amount of biomass saved by the programme that is used by non-project households/users have to be monitored as well. These three monitoring requirements have an important impact on PoA design. To date, AMS-II.G has not yet been applied due to its complexity.

AMS-I.E is applicable for new renewable biomass technologies, i.e. only for new stoves exclusively fired by renewable biomass. This is unlikely to be the case in any project as in almost all situations where biomass is used in developing country contexts for cooking and heating, some biomass will be non-renewable. It uses a similar approach for baseline determination and monitoring as AMS-II.G.

For all the methodologies, it is advantageous to include the scrapping of replaced stoves to avoid loss of CERs due to the need to calculate emissions from utilisation of the replaced stoves elsewhere.

Table 8 shows the differences between the methodologies theoretically applicable for stove programmes.

Category	Key methodological differences
Applicability	AMS-II.G: Stove improvement using (partly) non-renewable biomass. AMS-I.E: New stoves using exclusively renewable biomass. AMS-II.C: Stove improvement using exclusively fossil fuels. AMS-I.C: Replacement of (exclusively) fossil-fuelled stoves by biomass stoves.
Biomass source	AMS-II.G and AMS-I.E require a survey or historical data to prove that non-renewable biomass has been used since 31 December 1989. AMS-II.C and AMS-I.C do not require such data.
Monitoring	AMS-II.G and AMS-I.E: Share of non-renewable biomass in total biomass used by stoves before project start. Check of efficiency of all appliances or a representative sample of baseline stoves as well as programme stoves (annually) to ensure that they are still working at the spec. efficiency or replaced. Non-renewable biomass leaked to non-project participants. AMS-II.C: Usage hours and capacity of a stove sample. AMS-I.C: Total biomass use.

Table 8: Key methodological differences between AMS-II.G, I.E, I.C and II.C

Monitoring of stove efficiency is based on international standards initially developed at a Volunteers-in Technical-Assistance (VITA) Conference in 1982, involving donors and other institutions. Several procedures were established (Smith et al. 2007). However, Bailis et al. (2007a) show that monitoring efficiency under laboratory conditions (“water boiling test”, WBT, see Bailis et al. 2007b) gives strongly differing results from monitoring under kitchen conditions (“kitchen performance tests”, KPT). The former sometimes gives lower energy efficiency for improved stoves compared with traditional ones, while kitchen-based tests showed a clear reduction of fuel use through the introduction of efficient stoves, albeit with a wide range (see Bailis et al. 2007a). Programme developers should therefore be extremely careful in the choice of stove model and do testing with a small group of users. Otherwise, negative surprises regarding CER volume are possible.

4.3 Programme design

4.3.1 Lessons from existing efficient stove programmes

Since the 1970s, international donors and aid organisations have tried to disseminate improved stoves through several hundred projects spread throughout dozens of countries. These efforts range from national initiatives that have introduced more than 180 million stoves for rural Chinese households (Ergeneman 2003) to village training programmes in East Africa in which small groups of women learn to build and maintain their own stoves (for links to a few of the programmes see REPP 2007). It has to be kept in mind that the programmes presented hereafter were designed without using the CDM mechanisms.

Mixed experiences

History shows that successful stove programmes are rare and require good preparation and cultural understanding. The development of the Kenya ceramic *Jiko* programme, which distributed over one million stoves, is a good case study. The first improved stoves began to appear in the early 1980s and were designed by aid groups such as UNICEF and CARE Kenya. The response from stove users was mixed at best. The designers, mainly natives of the U.S. and Europe, had not done sufficient field testing. In one of the first models, the stove's opening did not match the size of most pots. Key design improvements were achieved by user groups and small-scale stove manufacturers. Schools, churches and businesses started to buy the stoves, setting an example for individual households. Penetration of the *Jiko* is over 50% in urban areas but much lower in rural areas. This shows that even at prices of EUR 2-5 per stove, the financing barrier for people with low opportunity costs of time and the ability to collect fuel "for free" is prohibitive. Therefore, a "light" version of the *Jiko* was developed costing just EUR 0.8; its design was strongly influenced by women's groups (Kammen 2007).

The large stove programme in India suffered from low utilisation rates due to an emphasis on distributing large numbers of stoves for free without raising the awareness of the rural population regarding benefits of the improved stoves (Ergeneman 2003). Moreover, the programme had a complicated structure with unclear roles for the different government agencies involved.

Based on the survey of efficient stove programmes implemented in India, China, Eritrea, and Ethiopia, Ergeneman (2003) found that programmes should include incentives for stove utilisation, ramp up quickly to utilise scale effects and encourage competition between stove suppliers. He sees an annual increase of

dissemination by 5% as the maximum long-term expansion rate of a stove programme.

The Chinese success story

The most successful programme was implemented in China (Smith et al. 1993), where now 70% of rural households operate an improved stove. The Chinese National Improved Stove Programme (CNISP) started in 1980 under the leadership of the Department of Environmental Protection and Energy within the Ministry of Agriculture. The CNISP promoted the use of approximately 10 different types suitable for users in different regions of China, mostly made of prefabricated cast iron, ceramic, or concrete slabs. Besides conducting stove research, the government confined itself to clearing away bureaucratic hurdles, giving local energy offices the responsibility for technical training, and setting standards for manufacturing production. Direct government subsidies paid to the stove suppliers cover 10% of the cost of the average stove, and including government wages and foregone taxes increase to 15%. Most households had to pay most or all of the costs of stove purchases and installation. Nevertheless, direct subsidies to households did feature in the CNISP. Subsidies mostly ranged from 10% to 40% of the cost of biomass stove purchases and installation (Sinton et al. 2004). The organisation bypassed the provinces by addressing 1,500 Rural Energy Offices on the county level, which competed for a limited number of support contracts with dissemination target levels. These offices decided on the types of stoves that should be disseminated. The Rural Energy Offices at the provincial level monitored the awarded contracts through standardised inspections of a specified subset of households. Stoves in at least 30 homes were randomly sampled and 90% had to achieve a minimum of 18% thermal efficiency. Only then could a county obtain its final payments from the national central government (Smith 2007, Bailis et al. 2007).

Lessons learnt

The lesson from the stove programmes is that giving stoves away for free is unlikely to be effective. Programmes that focused on support to stove suppliers to expand production and utilise scale effects coupled with quality control of stove production have been the most effective ones. This generates a challenge for CDM, as PoAs that support the scale-up of production and sell stoves at a price that is lower than the current market price might face challenges in additionality determination, given that improved stoves are financially attractive already at current market prices.

4.3.2 Business model and institutional requirements

Building on the lessons learnt from the efficient stove programmes described above, an example of an efficient stove PoA business model is conceptualised in Figure 3. The figure summarises the key actors and their responsibilities. It has to be kept in mind that other options (e.g. private company / NGO specialised in commercialising cook stoves, etc.) regarding the different actors and their roles and responsibilities are possible. The development of the business model should be oriented towards the core competencies of the different actors, especially the core interests and strengths of the PoA coordinator.

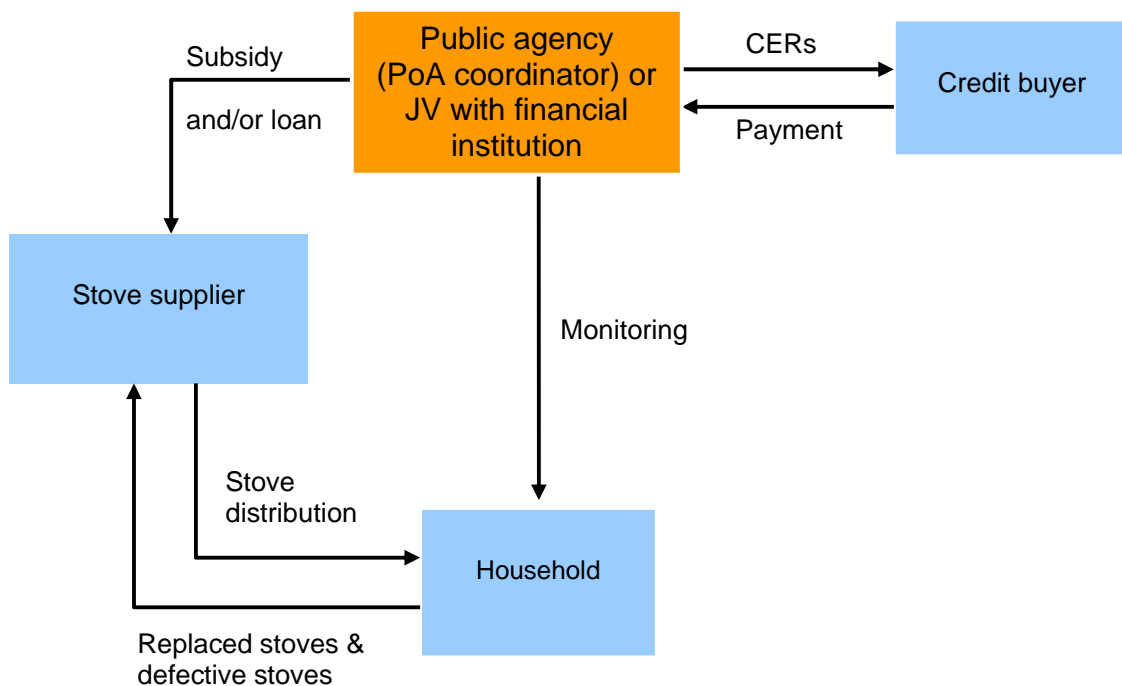


Figure 3: Efficient stove programme business model example

The model strives to address the barriers to efficient stove penetration in the following manner:

- Initial cost barrier: efficient stove distribution at reduced prices due to increased scale of production and some additional discount. Free distribution is ineffective as utilisation rates will be low in that case (see the Indian example compared with the Chinese success). Obviously the degree of discount should be commensurate with the purchasing power of the target population.

- Technological barrier: support of producers to switch from artisanal to factory-level stove production. Efficient stove labelling is required to ascertain the quality of efficient stoves; replacement of defective stoves at nominal cost within one year.
- Information/behaviour barrier: awareness raising through NGOs

Aim of the PoA: The aim of the PoA is to enhance the penetration of efficient cookstoves by making stoves more affordable through subsidisation of effective production processes. This allows offering the products at reduced prices. The carbon revenues are utilised to recover the balance of costs. In addition to the reduction of greenhouse gas this would lead to reduced indoor air pollution and better health conditions mainly for persons living below or close to the poverty line. The time for collection of biomass as fuel would be saved.

Target group: The efficient cook stoves are distributed to households, which currently use cook stoves of low efficiency. Most probably the target group comprises mainly women.

Managing entity: The PoA coordinator is a public agency with a very strong logistical capability and excellent local network in areas that are normally not conducive to business activities. These qualifications are indispensable to lead the complex programme implementation steps such as stove production support, distribution and monitoring. The PoA coordinator is responsible for the financial transformation (e.g. providing a subsidy to stove suppliers and/or buyers or introducing a soft loan) and takes a lead in monitoring. To increase sales, a joint venture with a financial institution could be envisaged to enable a micro-credit facility for stove buyers.

Actors involved: Besides the public agency, the financial institution and the households, the business model involves stove suppliers. They are responsible for efficient stove distribution to households, scrapping of replaced stoves, and free replacement of efficient stoves failing in the first year.

In addition, the involvement of a testing & labelling organisation helps assure the quality of the efficient cook stoves. Also, local NGOs or rural energy centres (if available) could assist in the stove distribution and monitoring as well as raising awareness of the efficient stove programme.

Programme implementation: First of all, the PoA coordinator is to prepare necessary contractual arrangements with the stove suppliers, the testing & labelling organisation, and the local NGOs or rural energy centres. The PoA coordinators should pay the stove suppliers a lump sum per stove produced sufficient to cover the price discount and to allow expansion of high-quality

production. A substantial amount of pre-financing should be provided to enable early up-scaling of production capacity. Stove suppliers should also receive a CER share because this provides an incentive to produce long-lasting stoves and to market them to the right target group.

Secondly, the PoA coordinator needs to conduct an ex-ante survey of randomly selected households in the project area. The key issues for investigation are: stove usage pattern, efficient stove penetration rate, and non-renewable biomass usage in the area. According to the results of the survey, a detailed project implementation plan has to be established. The key issues are the minimum quality standard for efficient stoves, the number and efficiency of the efficient stoves, and logistics for distribution of the efficient stoves. As the energy savings of a SSC CPA under the PoA are capped by thresholds which are determined by the different methodologies, careful consideration of these items is indispensable.

Thirdly, the efficient cook stoves have to be distributed either door-to-door or through centralised distribution channels. As is the case with CFL distribution, the process is labour-intensive and requires substantial time and costs. Possibilities for cost reductions include, but are not limited to: assistance by local NGOs, a rural energy centre, and/or retailers.

If a micro-credit facility is part of the PoA, monitoring can be linked to the payment of instalments, where bank agents perform the KPT when they collect payments. The introduction of a MFI would require the training of bank employees in the application of the KPT. Furthermore the role of a financial institution might be strengthened further if it is used to determining the flow of funds, or handing over financial incentives to the end users or stove suppliers, e.g. if soft loans are included. Programmatic CDM/JI can become an interesting opportunity for a MFI to design attractive financial products or to support traditional lending in this type of project.

If there is no micro-credit facility, the PoA coordinator can hire a rural energy centre or local NGO to implement the monitoring. It is important to build up on existing networks the PoA coordinator or other institutions have to arrange the monitoring as efficient and effective as possible at the lowest possible cost.

4.4 Carbon revenues and financial requirements

4.4.1 Carbon revenues

Taking one of the few programmes on efficient stove distribution evaluated under CDM aspects as a case study³², Table 9 summarises key parameters for CER estimation.

Number of efficient stoves to be distributed	Share of non-renewable biomass	Annual biomass usage (t/stove) in baseline	Stove efficiency (%)	Energy use (GJ/stove)	Fossil fuel emission factor (tCO ₂ /GJ)	Annual amount of CERs	Annual amount of CERs per stove
785,000	98%	1.2 wood 2.5 charcoal	Baseline: 16 Project: 25	Baseline: 93 Project: 60	0.06	1,550,000	1.97

Table 9: CER estimation of a model efficient stove programme (based on AMS-II.G v. 01)
Source: Data provided by GTZ (2006), own calculations. The baseline fossil fuel would be LPG.

The CER potential depends on several key factors. A project implemented in an area with a low share of non-renewable biomass will have a low CER generation rate. Likewise, the baseline biomass utilisation can vary widely. Stove efficiencies can vary widely, even among stoves of the same design. The emissions factor of the baseline fossil fuel is another important parameter. Altogether, the CER potential can vary by more than an order of magnitude. The parameters of the Senegalese PoA are all on the optimistic side; they would allow the generation of 2 CERs per stove and year³³. Normally, non-renewable biomass would make up a much lower share – around 25% to 50%. At 25%, annual CER volume per stove would reach 0.5 CERs, at 50% 1 CER.

As in the case of other demand-side energy efficiency activities, efficient stove distribution allows for one main revenue stream coming from the sale of CERs. If there are more income options (e.g. through governmental support) the additionality needs to be argued carefully and oriented to the different barriers the PoA would encounter. The additionality argumentation could include, for example (depending on the local situation), the barriers caused by large transport, access or awareness costs, especially when the programme serves

³² The data have been provided by the GTZ - Programme to Promote Rural Electrification and a Sustainable Supply of Domestic Fuel in Senegal, which is currently elaborating PoA documentation for its component FASEN ("Foyers améliorés Sénégal"). For detailed information see www.peracod.sn.

³³ Van Buskirk (2004) reports 2.3 VERs per stove for a project in Eritrea, but uses a much less conservative methodology.

remote and poor communities.

Free distribution of stoves might lead to careless handling and low utilisation rates, as shown in past stove dissemination programmes. The design of the programme will also determine the amount of seed funding required. This is especially the case if the programme is not a pure payment-on-delivery but needs a financial transformation to cover up-front grants or soft loans. However, efficient stoves lead to substantial fuel cost savings and, due to the resulting short payback period, can be seen as a financially attractive option.

4.4.2 Financial requirements

Due to the short lifetime of new cookstoves disseminated by a CDM project (between 1 and 3 years), the project costs have a cyclical aspect. After initial distribution, costs fall for 2 years to increase again once the first major replacement is required. Depending on the organisational structure this might be complicated, as old stoves have to be recovered and disposed. So, even if only a 10-year crediting period is aimed at, a good organisation for replacement has to be in place. In particular, costs for the logistical efforts (e.g. efficient stove distribution and necessary training for distribution and monitoring teams) have to be calculated carefully.

The efficient stove procurement costs range from EUR 1 to EUR 30 per stove. In the large stove dissemination programmes in China and India, stove costs reached around EUR 15 (Engeneman 2003), in African programmes around EUR 6. The distribution of efficient stoves is likely to take the lion's share mainly because of the need for hiring a large number of people for the distribution team (e.g. if a person is able to distribute 10 stoves per day, dissemination of 100,000 stoves requires about 50 person-years)³⁴. We have to point out that the way to distribute the stoves or organise the replacement depends on the possibilities the participating actors see in developing the programme. It might well be possible to sub-contract a local microfinance institution (MFI) or a local NGO depending on the network that exists in the geographical boundary of the programme.

Monitoring costs are sensitive to the sample size and the spatial dispersion of sample households. Instruments used for the kitchen performance test (KPT) cost about EUR 900 per set. Labour costs vary widely across different developing regions – particularly for technically skilled personnel, which in Africa have wage levels half of those paid in Latin America.

³⁴ If distribution efficiency can be improved, this will have a crucial impact on project costs.

In terms of labour time for each pair of stoves tested, a KPT could take anywhere from 10 person-days for a small sample of tightly clustered households to 40-50 person-days for a rigorous and statistically significant large sample of widely dispersed households (Bailis 2008). The water boiling test can take 1-2 person-days for each stove pair tested.

Transport costs should also be considered and would be highly sensitive to the area and sample design; Bailis (2008) sees them at EUR 15 per person-day spent testing. Hulscher et al. (1999) give a rough estimate for staff requirements of different phases of a stove dissemination programme. Combined with the values provided by Bailis (2008), they present the calculations in Table 10. The analysis assumes distribution of 1 million stoves, stove lifetime of two years, and a monitoring sample size of 200 households.

Cost components		Upfront (EUR)	Annual (EUR p.a.)
Fixed costs	Project design and CDM documentation	200,000	30,000
	Monitoring ³⁵	3,000	36,000
	CDM fees	50,000	30,000
Variable costs	Efficient stove procurement	6.00 per stove	-
	Efficient stove distribution and baseline stove replacement ³⁶	1.30 per stove	-
	Other costs	-	0.02 per stove

Table 10: Overview of the fixed and variable costs of the model stove programme (nominal)³⁷

³⁵ Assumed costs for purchase & installation of monitoring equipment (flow meter, instruments used for the kitchen performance test) at 200 households (sample group) and set up of database are EUR 3,000 upfront. Annual costs of EUR 36,000 comprise the required physical inspection and meter reading at the stove (assumed person-months required for the annual monitoring: 2 months for experts, 40 months for local skilled staff, and 50 months for ground-work staff).

³⁶ Assumed person-month required: 6 months for experts, 44 months for local skilled staff, and 6,300 months for ground-work staff.

³⁷ Note: Distribution of 1 million stoves; stove lifetime of 2 years; monitoring sample size of 200 households.

In the African context, nominal costs per stove would reach EUR 7.80 upfront plus EUR 0.10 per year. This generates the following attractiveness table for annual CER volumes of 0.5, 1 and 2, respectively, assuming no significant revenues are earned from the stove distribution.

Annual CERs per stove	CER minimum price for break-even (EUR)	CER price for IRR of 15 % (EUR)
2	2.3	2.4
1	4.5	4.8
0.5	9.0	9.6

Table 11: Indicative level of CER prices and CERs per stove for 1 million stove programme required for break-even and IRR of 15 %.³⁸

The financial information of the model project allows for the calculation of the critical project size to achieve financial viability.

The following CER revenue levels are considered for the analysis, assuming a CER price of EUR 12. Based on the three scenarios for the CER revenue per stove, the critical project sizes for the break-even and IRR of 15% are summarised in Table 12.

Annual CERs per stove	Critical size (number of stoves)	
	Break-even	IRR of 15 %
2	13,500	13,900
1	34,000	36,500
0.5	145,000	180,000

Table 12: Critical size of a stove programme for the break-even and IRR of 15%³⁹

Stove programmes are quite attractive once the challenge of determining the share of non-renewable biomass is overcome. In a situation with a share of non-renewable biomass of more than 50%, already the distribution of 50,000 stoves makes commercial sense. However, programme design has to set incentives for high stove utilisation rates.

³⁸Note: Discount rate of 10% for the calculation of the break-even.

³⁹Note: Discount rate of 10% for the calculation of the break-even.

Key points and challenges

- 1.** Almost 50% of the world's population prepares their food on small stoves fired by biomass or solid fossil fuels that generally have a low efficiency and high consumption of non-renewable biomass or fossil fuels.
- 2.** Barriers in introducing and disseminating more efficient stoves include high initial costs of the devices, high transaction costs, low product quality and a lack of consumer awareness of the energy savings potential.
- 3.** The programmatic CDM could help overcome these barriers by providing additional revenues from the sale of CERs to finance efficient manufacturing equipment.
- 4.** Programmes that focused on support to stove suppliers to expand production and utilise scale effects coupled with quality control of stove production have been the most effective ones.
- 5.** The first key challenge is a careful investigation of the baseline of the programme, especially if households that use mainly dung, waste or other renewable energy for firing the baseline reductions are too small to legitimate the development of a PoA.
- 6.** The second key challenge is the design of an appropriate structure of the business model working together with actors that possess the necessary local network to organise the logistics of distribution and monitoring.

5. Domestic biogas

5.1 Background

Greenhousegas emissions from firing firewood and destroying forests as well as methane emissions from manure contribute to a very high extent to the global warming process. This makes fuel switch from non-renewable biomass or fossil fuels or manure management through anaerobic biodigestion interesting for CDM/JI. Livestock breeding takes place not only in large scales in animal production farms, but also in smaller scales in rural areas at the individual level.

On the individual level, biogas plants are much less prevalent but could ideally be implemented with small-scale fixed domes with a capacity of just a few cubic meters. In this chapter **small-scale farming** activities with only little livestock are focused. Methane recovery plays therefore a smaller role and fuel switch is the most important measure to implement.

Besides preventing methane emissions, the biogas can be used at households where normally fossil fuel or firewood is combusted e.g. for heating, lighting or cooking, generating emission reductions through the fuel switch. The average lifetime of a biodigester is above 20 years (van Nes 2007).



Nepalese cattle farmer feeding manure to his biogas plant.

Source: KfW Entwicklungsbank, Biogas Support Programme - Nepal

As discussed in the stove chapter, such fuel switch will reduce indoor pollution and reduce drudgery related to fuelwood collection. The availability of at least 20 kg dung per day allows running of a small biodigester (SNV 2005), two cows or seven pigs provide enough fuel to meet the daily cooking needs of a rural family (Teune 2007). At the end the slurry residue out of the digester is no waste but a valuable fertiliser.

Even though the above benefits seem to be obvious, small biodigesters are in practice not the commonly used technology at the household level. The dissemination 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 biodigester investment is between 60 and 80% of an annual family's income (UNFCCC 2008). In Asia a payback period of a digester is expected to be 2 to 3 years (Teune 2007).

Furthermore, the digester is a very sensitive technology that needs surveillance of trained staff. In rural areas, this kind of knowledge is not common. Also aggravating is that the handling of dung and excrements is a taboo in some cultures. Thus, an awareness raising campaign should not only inform potential users about the technology and benefits, but also aim at overcoming the reservation about the use of animal waste.

A few projects already tried to disseminate domestic biodigesters. The biggest and most widely known are the Biogas Support Programmes (BSPs) in Nepal and Vietnam, which were implemented by the Netherlands Development Organization (SNV) jointly with other partners such as KfW Development Bank. They aimed at dissemination of nearly 200,000 biogas plants in different phases. Other ones were implemented in China, India and Africa. The programmes were mostly dependent on external investors and ODA.

The outcome of the early programmes was that the financial attractiveness would highly depend on the size of the biodigester (Karnel 1999). Smaller biodigesters scattered across remote areas are less financially attractive than installations in smaller farms with a higher density of animals. Due to the larger number of animals, farmers can use bigger biodigester types. In addition, the increasing management effort for dispersed activities can easily eat up the revenue from biogas projects at the household level.

To overcome these barriers the programmatic CDM approach is necessary to increase the income of the domestic biogas programmes.

5.2 Methodological requirements

The first step for a domestic biogas project is the identification of an area where large quantities of manure exist and/or there is the potential for fuel switch. As of March 2009, two small scale (SSC) methodologies exist for the mitigation of methane emissions of manure management. These are: AMS-III.D "Methane recovery in animal manure management systems" (version 13), and AMS-III.R "Methane recovery in agricultural activities at household/small farm level" (version 1). For the energetic use of the recovered methane, the following methodologies are currently available: AMS-I.C "Thermal energy for the user with or without electricity" (version 13), and AMS-I.E "Switch from non-renewable biomass for thermal applications by the user" (version 1).

As a PoA benefits from the application of a SSC methodology without being limited to the SSC threshold (that is 60 kt CO₂e), the following analysis focuses on SSC methodologies. Therefore, ACM0010, a large-scale methodology for this technology category, is out of the scope. AMS-III.R can only be used in combination with AMS-I.C so that in this case the two methodologies play a role, this is because the production of biogas (methane recovery) needs to be

deconstructed by the end use in for cooking, heating, electricity or other thermal energy uses.

Methane emission avoidance: The two methodologies focus on different target groups for manure handling. AMS-III.D is applicable in livestock production units, whereas AMS-III.R aims at rural households which have just a couple of animals for their livelihood. Therefore, the most suitable methodology for domestic biogas projects is AMS-III.R.

In the application of AMS-III.R, annual emission reductions at each household are limited to 5 t CO₂e. The amount of anaerobically decayed manure has to be determined by an ex-ante survey. The projects in the pipeline using AMS-III.R show that one could generate nearly 3.5 t CO₂ reductions per year with 2 to 3 cattle. Also, capturing methane from manure of 4 to 5 pigs reduces emissions between 0.5 and 0.8 t CO₂e per year. On one hand, the emission reduction range points out that the AMS-III.R threshold of 5 tCO₂e/a is sufficiently high to accommodate normal domestic biogas programmes. On the other hand, it shows that a PoA must involve a large number of households to generate a significant amount of CERs. The project size ranges from 10,000 to over 30,000 involved households (UNFCCC 2008). Due to reasons of conservatism the methodology applies a default factor for the physical leakage rate of the biodigester of 10 %.

The monitoring of biodigesters is conducted with a sample group. This sampling approach implicates that not all the biodigesters have to be equipped with monitoring devices, but just a small number of randomly chosen biodigesters.

Use of biogas methane as energy source: AMS-III.R only covers the anaerobic decay of manure. For the energetic use of the recovered biogas, it refers to AMS-I.C. AMS-I.C is designed for renewable thermal energy for users who previously generated heat with fossil fuels. It allows for the use of simplified monitoring for projects that reduces emissions less than 5 t CO₂e/year per biodigester (for more details, see Chapter 6 “Solar water heating”). In the past, AMS-I.C used to cover the switch from non-renewable to renewable biomass, but the current version excludes the option (see Chapter 3 “Household stoves”). The applicable methodology for the switch from non-renewable biomass is now AMS-I.E (also see Chapter 4 “Household stoves”). Table 13 summarises the key methodological differences of the methodologies potentially applicable to domestic biogas programmes.

Category	Key methodological differences
Applicability	AMS-III.R: Mitigation of manure methane emissions (annual emission reductions per biodigester is limited to 5 tCO ₂ e/a. AMS-I.C: Biogas use replaces fossil fuels. AMS-I.E: Biogas use replaces non-renewable biomass.
Biomass source	AMS-I.E requires a survey to prove that non-renewable biomass has been used since 31 December 1989. AMS-III.R and AMS-I.C do not require such survey.
Monitoring	AMS-III.R: Survey of operating systems, average operation hours, animal population, waste generated and fed into digester and the proper soil application of the digester. AMS-I.C: Survey of operating systems, average operating hours and total biomass use. Simplified monitoring procedures are available if the annual emission reductions per biodigester is less than 5 tCO ₂ e/a. AMS-I.E: Share of non-renewable biomass in total biomass used before project start. Efficiency of a sample of baseline equipment as well as project equipment (annually). Efficiency of equipment broken and replaced. Non-renewable biomass leaked to non-project participants.

Table 13: Key methodological requirements of AMS-III.R, I.C and I.E

After all, the decision on which emission reduction options the PoA should aim at, i.e. methane reductions or the fuel switch, depends on the potential of each option in the concerned area. Generally no substantial amounts of methane are produced if manure is spread on the fields or piled in small stocks, the only source of emission reduction for this cases is then the replacement of fossil fuels or the use of non-renewable biomass.

An important restriction appears for a PoA business model due to the methodological requirement. The two methodologies favourable for PoAs, i.e. AMS-I.C and AMS-III.R, offer the simplified monitoring procedure for small projects (< 5 t CO₂e/year per biodigester). Although domestic biogas programmes are normally below this threshold, PoAs shall carefully investigate the issue to be able to use the simplified procedure.

5.3 Programme design

5.3.1 Lessons from existing domestic biogas programs

Mendis and van Nes (2001) summarise the key success factors of the BSP Nepal as follows:

- Identifying the most appropriate and cost-effective design for the product before launching a wide-scale dissemination programme;
- Establishing and enforcing solid design, quality and service criteria that will ensure the reliable and cost-effective operation of installed plants;
- Identifying the key institutional players and assisting in strengthening the capacity of these players to effectively carry out their respective roles;
- Securing the commitment and support of financial institutions to work in close partnership for the dissemination and financing of the product;
- Designing and applying financial incentives needed to stimulate the market and attract buyers in a manner that is uniform, transparent, and easy to administer.
- Ensuring that financial incentives reach the target groups to bring down prices of the biogas plants.
- Providing technical and management support to all key players;
- Instituting coordinating committees to ensure the cooperation and partnership of stakeholders, and
- Sufficient resources for product support and market development.

The successful biogas programme model shows the need for a multi-facet approach for programme implementation.

5.3.2 Business model and institutional requirements

Building on the lessons learnt from the CFL programmes described above, a domestic biogas PoA business model is conceptualised in Figure 4. It has to be kept in mind that other options (e.g. public agency or cooperation with various biodigester suppliers etc.) regarding the different actors and their roles and responsibilities are possible. The development of the business model should be oriented towards the core competencies of the different actors, especially the core interests and strengths' of the PoA coordinator. The figure summarises the key actors and their responsibilities.

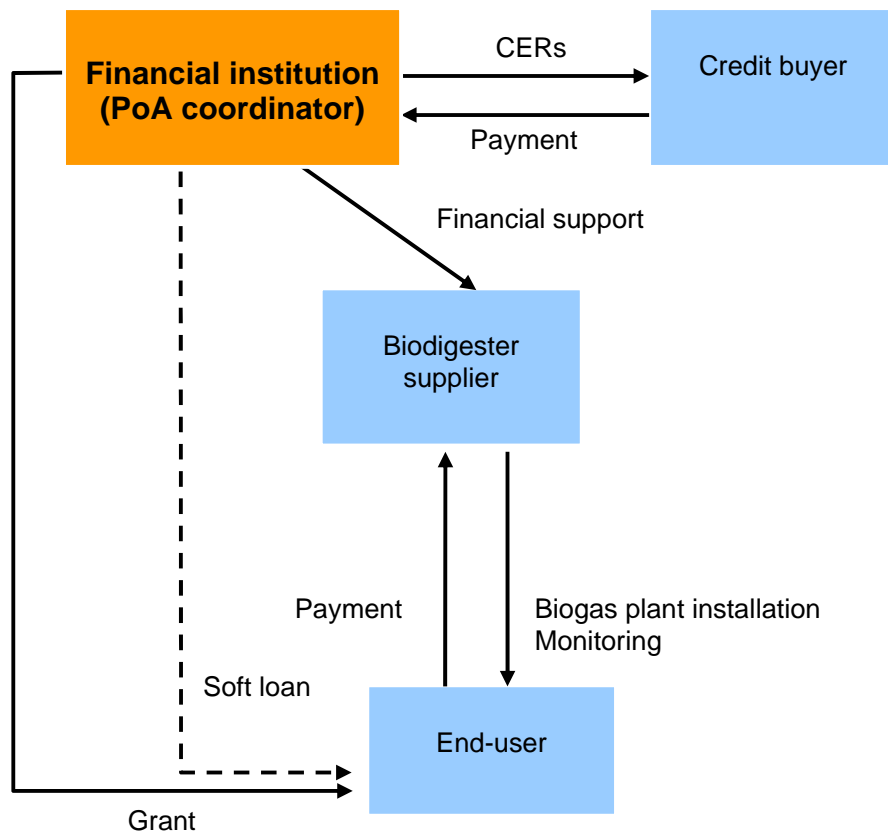


Figure 4: Domestic biogas programme business model example.

The business model is developed in regard to overcome the barriers that prevent a stronger market penetration of domestic biodigesters as follows:

- Initial cost barrier: Provision of grant to biodigester buyers to lower the initial costs to a more attractive level. In addition, for poorer people this measure can be combined with a measure to ensure the access to the required financing (availability of microcredit).
- Technological barrier: Ensuring high quality of equipment by adjusting the design of the biodigester to the need of the applicants and implementing a quality standard for the digester production. Furthermore, users should receive information how to operate the biodigester in an easy-to-understand format.
- Information/behaviour barrier: Awareness raising and promoting by the PoA coordinator.

Investment subsidies and microcredit facilities for buyers of biodigesters are a necessary, but not sufficient condition for accelerated dissemination of biogas plants. This requires the involvement of a rural development bank right from the

start of the programme. Soft loans could use projected carbon revenues as collateral.

Quality and design standards for biodigesters are important to generate trust in the technology; they have to be developed in close cooperation with biodigester component manufacturers. The quality standard also assures a high level of leak-tightness of the biodigester to avoid a gas pass-off into the atmosphere. Users have to be trained and an after-sales service is important to keep digesters operational during the crediting period. Customer satisfaction with the product leads to a programme reputation, which eventually works as the best promotion strategy. In the case of operating problems of the plant the owner is thankful for a contact person and for fast and experienced help. The first phase of the BSP Nepal program showed that for the contracted private company especially the after-sales service was not profitable, which led to non-compliance with the maintenance contracts for periodical inspection and emergency help. The consequence is also to train local staff to achieve a better availability of competent people and make sure that dissemination is only done in areas with a sufficient availability of maintenance staff. This would best be achieved by having several servicing companies, each covering a relatively small area.

The PoA coordinator should be integrated in existing networks which reach the local population as well as decision makers at regional or state level. Ideally, it would be a development organisation or an association of small and medium enterprises. Given the importance of local knowledge, an organisation with a number of local branches would be best suited for the purpose. A good standing of the organisation can help to dispel doubts about the functioning of the technology and its benefits for the users.



Nepalese family using biogas from their biogas plant for cooking.
Source: KfW Entwicklungsbank/ Biogas Support Programme - Nepal

Aim of the PoA: The aim of the PoA is to promote the dissemination of biodigesters that utilise animal manure at household's level to reduce the utilisation of non-renewable biogas or the methane production and thereby reduce greenhouse gases. The carbon revenues are utilised to reduce the technology's main barrier: the initial costs through a subsidy paid to buyers of the biodigesters. This would then lead to use of biogas for heating, lighting or cooking instead of fossil fuel.

Target group: The biodigesters are introduced to rural, animal keeping households. Currently the manure decays anaerobically and the household use cooking or heating techniques of a low efficiency.

Managing entity: The PoA coordinator is a financial institution that possesses very strong logistical capability and excellent local network. The financial institution provides partial grants to the end-users coupled with a micro-credit facility for poor households. Moreover, it supports small and medium-sized companies to set up a biodigester production line conforming to the standards for biodigester quality set by the programme. The starting point should be companies that already have experience with such technologies. Loans for setting up biodigester production lines can be collateralised by carbon revenues from biodigesters sold by the company. If AMS-I.C is applied, the regular repayment of the micro loan can serve as a proof of real, actual use of the digester. For this the database of the bank is integrated into the monitoring process. The PoA coordinator has the responsibility to run the awareness raising campaign of the biodigester programme.

Actors involved: Once the biodigester producers have set up their production lines, they start their sales programmes, coupled with training programmes for target households. This training should ensure that households are able to operate the plant under normal circumstances and tackle smaller problems themselves. To minimize systems failures, dedicated biogas service facilities should be set up. They can either be affiliated to a digester manufacturer or operate independently. At each biodigester sale, a maintenance contract has to be signed with clear responsibilities. Contracts should include annual maintenance visits used for the collection of monitoring data. It is also possible to work with other actors, that depends on the local circumstances.

Programme implementation: Under the assumption that no biodigester producer exists, the financial institution first has to tender grants for biodigester production line. The grants should be linked to strict technical standards for the biodigesters. These standards have to take into account prior experience with biodigesters in the host country. If no experience exists, a field testing has to be done to identify an appropriate design.

Parallel to the development or improvement of the biodigester production lines, a survey should be conducted to identify households with animals. If AMS-III.R is applied, this survey should also investigate the common practice of the animal keeping and manure management and in case of using AMS-I.E a survey to verify the use of non-renewable biomass in the past needs to be carried out.

Once the production lines are operational, the roll-out of biodigester sales should be started. This has to be linked with an awareness raising campaign implemented by a the producer, a local NGO and/or a biodigester company association. Through the campaign, the identified end-users should get information about the technology, connected requirements and a realistic outlook of the benefits. The financial institution offers grants and micro-credits.

The construction of biodigesters is executed by the company producing the digesters. It is joined by a maintenance provider who is responsible for the continued operation of the digesters throughout its technical lifetime. Monitoring data will be collected by the maintenance provider at the sampling households during the regular maintenance visits.

A very important point in designing the PoA is the way different actors are incentivised. All actors need a strong inherent interest in participating in the programme either by a financial incentive (grant, loan subsidy for the households) or nonmonetary benefits (health of family members, expansion of client base for financial institution, cost-recovery for maintenance, quality improvements of suppliers or technical assistance etc.). These incentives are success factors for the PoA.

5.4 Carbon revenues and financial requirements

5.4.1 Carbon revenues

There are several domestic biogas projects under the CDM as summarised in Table 14. The first two projects listed in the table claimed for methane emission reductions only, while the last two were both methane and fuel switch options.

Needless to say, the size of biodigesters has a decisive impact on the emission reduction potential. In addition, the methane emission reduction potential highly depends on the local conditions because, for example, ambient temperature has a strong impact and the feed regime of animals may vary widely due to the available feedstock sources. Furthermore, the emission reduction potential from the fuel switch is sensitive to the baseline fuel type.

Programme name	Nr. of households (hh)	Size of biogas digester (m ³)	Costs of biogas digester (EUR)	Emissions from manure /hh (tCO ₂ e)	Emissions from fossil fuels/hh (tCO ₂ e)	Emissions from fuel-wood/hh (tCO ₂ e)	Annual amount of CERs	Average amount of CERs per biogas digester
Bagepalli CDM Biogas Programme (India) (AMS-I.C)	5,500	2	N/A	N/A	0.08 (kerosene)	3.56	19,553	3.56
Biogas Support Program – Nepal (BSP-Nepal) Activity-1 & 2 (AMS.-I.C)	Project 1: 9,708 Project 2: 9,688	4-10	183-287	N/A	0.07 (kerosene)	7.52	Project 1: 46,990 Project 2: 46,893	7.00
Hubei Eco-Farming Biogas Project Phase I (China) (AMS.-I.C+AMS-III.R)	33,000	8-15	296-420	0.5-0.8	2.5-3.1 (coal)	N/A	58,219	1.76
Kolar Biogas Project and Hassan Biogas Project (India) (AMS.-I.C+AMS-III.R)	10,000	2-3	250-290	3.47	0.09 (kerosene)	3.26	61,883	6.2

Table 14: CER estimation of model domestic biogas programme

5.4.2 Financial requirements

High initial costs are the main barrier for small biogas projects. The investment costs for one domestic biogas digester are around EUR 200 - 400 in Asia, and EUR 500 - 1,000 in Africa. The cost difference between the regions results from different aspects that – inter alia – include the costs of the production factors (raw materials, design, technology, human resources etc.), the way the installation is organised and the interaction between supply and demand. As stove production in Asia tends to have a bigger market it tends to have cheaper options for the end user. There are two ways to overcome the high initial cost barrier for the families: (i) grants and (ii) loan financing. A grant system can be introduced to reduce the amount of the initial payment. In the Nepal biogas programme the grants were adjusted to local circumstances and averaged around 25% - 40% of the whole investment. For farmers in the hills, the grant was increased as they had to compensate the higher construction cost and lower biogas output (SNV 2005).

To encourage poorer people without access to loans or just unrealistic loans, a micro credit system with more attractive interest rates should be introduced. The Nepal programme was organised in association with the Agricultural Development Bank (ADB) of Nepal and KfW Development Bank to provide

affordable financing options. Loans were provided at 17% annual interest and with a 7-year repayment term. As a result, 76% of the first installed plants were constructed with loan financing.

The private biogas sector needs financial support to develop small-scale digesters suitable for country-specific conditions, especially in rural areas. The support is required over a long period (5 to 10 years) as sector development cannot be achieved quickly (van Nes 2007). During the different phases of the BSP programme, 5-15% of the entire budget was spent on the sector support, around 20% on the investment grant, and the rest on the net investment of the plant which was not covered by the owner's payments (van Nes 2007).

The following cost summary is adapted from the budget estimation of an African biogas programme for dissemination of 15,000 biogas plants (SNV 2005). To be on a conservative side, a 10-year crediting period is applied. The monitoring sample size is assumed to be 200 households.

Cost components		Upfront (EUR)	Annual (EUR p.a.)
Fixed costs	Project design and CDM documentation	200,000	30,000
	Monitoring ⁴⁰	15,000	10,000
	CDM fees	50,000	30,000
Variable costs	Biodigester procurement and installation	348 per digester	-
	Training on biodigesters	14.9 per digester	-
	Maintenance	-	14.0 per digester
	Other costs	-	0.2 per digester

Table 15: Overview of the fixed and variable costs of the model domestic biogas programme (nominal)⁴¹

⁴⁰ Assumed costs for purchase & installation of monitoring equipment (flow meter) in 200 households (sample group) and setup of database are EUR 15,000 upfront. Annual costs of EUR 10,000 comprise the required physical inspection and meter reading at the biodigester (50 person-months for ground-work staff).

⁴¹ Note: Distribution of 15,000 biodigesters; Biodigester lifetime of 20 years (crediting period of 10 years assumed); Monitoring sample size of 200 households.

For this specific example, the nominal costs per biodigester would reach EUR 380.50 upfront and EUR 18.90 in annual costs. In order to allow successful dissemination of the biodigesters, the project employs a soft loan instrument. The digesters are offered to households together with low interest loans with a payback period of five years and an interest rate of 7%.⁴²

The assumptions lead to the following attractiveness table. The CER generation scenarios represent the following three cases: (i) 2.5 CERs/a resulting from a small to medium-sized biodigester, (ii) 5 CERs/a for one large-scale digester applying one methodology (either AMS-I.C or AMS-III.R), (iii) 10 CERs/a by the combination of the two methodologies.

Annual CERs per biodigester	CER minimum price for break-even (EUR)	CER price for IRR of 15 % (EUR)
10	2.4	3.3
5	4.7	6.5
2.5	9.4	12.9

Table 16: Indicative level of CER revenues and CERs per biodigester required for break-even and IRR of 15%⁴³

The financial information of the model projects allows for the calculation of the critical project size to achieve financial viability. The following CER revenue levels are considered for the analysis, assuming a CER price of EUR 12 and the annual CER per digester of 2.5, 5 and 7. Based on the three scenarios for the CER revenue per digester, the critical project size for the break-even and IRR of 15% are summarised in Table 17.

Annual CERs per biodigester	Critical size (number of biodigesters)	
	Break-even	IRR of 15%
10	1,100	1,300
5	2,600	3,500
2.5	8,000	21,000

Table 17: Critical size of a domestic biogas programme for the break-even and IRR of 15%⁴⁴

A household-level biodigester programme is attractive at a level of a few thousand systems, which can be achieved in countries with a high degree of smallholder livestock ownership.

⁴² The interest rate is to be lower than an average market interest rate for individuals. For the model calculation an interest rate of 7% is assumed. However, the offered loan conditions depend on the financial institution involved and the regional circumstances. The difference between the average market interest rate for individuals and the low interest rate may be considered as the programme subsidy. If the average market interest rate is 10%, the total programme subsidy over the 5-year payback period would be about EUR 514,000.

⁴³ Note: Discount rate of 10% for the calculation of the break-even.

⁴⁴ Note: Discount rate of 10% for the calculation of the break-even.

Key points and challenges

- 1.** Biodigesters help farmers deal with their waste management problems and create organic fertiliser for the farm or market. They contribute to the mitigation of greenhouse gases through methane recovery and avoidance of firing of firewood or fossil fuel. Biodigester 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.
- 2.** High initial costs and lack of access to the financial system are the main barriers for rural households to invest in biodigesters.
- 3.** The programmatic CDM could help overcome these barriers by providing additional revenues from sale of CERs to finance grants to end-users or subsidise loan conditions of financial institutions.
- 4.** A high-quality and cost-effective design of biodigesters and annual and solid after-sales service is important to ensure the lifetime of the installation and its use in the households.
- 5.** Biodigesters cost between EUR 200 and EUR 1000, depending on size and region and reduce between 2 and 10 t CO₂e/a.
- 6.** Key Challenge I is the need for financial transformation, as seed funding for grants and subsidies to credit lines is needed in this case. That implies that the financial institution, a potential CER buyer or a private investor would need to take the various risks of the programme if no public institution or international donor could play a role.
- 7.** Key Challenge II is the need for technical and management support which is particularly important when there is no biodigester producer available.

6. Solar water heating

6.1 Background

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 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 income. 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. The latter also applies to households that use fossil-fuel-based water heating. In addition, fossil-fuel-based water heating has negative environmental impacts as it affects the indoor and outdoor air quality and contributes to global warming. An option for addressing these problems is solar water heating (SWH).

SWH is a cost-effective and environmentally friendly solution to provide hot water for households. Commonly used residential SWHs require only two thirds of the energy used by conventional systems. SWHs consist of a solar collector and a storage tank and use solar energy to heat either water or a heat-transfer fluid. The heated water is kept in the storage tank, which may optionally be equipped with a fossil-fuel-based back-up system providing additional heating (EERE 2008). With this, the hot water supply becomes more or less independent from the conventional systems, and leads to energy cost savings. Furthermore, the use of a SWH directly improves the air quality and significantly reduces GHG emissions (Milton and Kaufman 2005).

Although high energy prices are an important driver for the use of SWHs, market penetration of SWHs is still very low, especially in developing countries and countries in transition. A major barrier to a wider diffusion is the high initial cost of SWHs of several hundred euros – basically interested households often cannot afford the purchase of the system. Furthermore, the lack of trust in the performance of the technology may prevent households from taking up SWHs. In order to overcome these barriers, it is necessary to establish incentives and financing mechanisms for SWHs (GTZ 2006, 2).



Installation of a solar home system in Bangladesh
Source: KfW photo archives,
photographer: Jörg Böhling

CDM/JI is an option to achieve the broader dissemination of SWHs by offering revenues from the reduction of GHG emissions. In the following sections, the methodological and financial requirements for SWH programmes are discussed. Building on the lessons learnt in existing SWH programmes, a business model for SWH programme implementation is developed.

6.2 Methodological requirements

At the time of writing the only approved methodology that allows for implementation of SWH programmes under the CDM is AMS-I.C “Thermal energy for the user with or without electricity” (version 13)⁴⁵. By nature, small-scale (SSC) methodologies are just a very general outline for an emission reduction calculation, which allows project developers to shape the programme according to the specific characteristics of the project activity. In order to set up a PoA for SWHs with AMS-I.C, the following criteria have to be considered:

- AMS-I.C addresses SSC projects comprising renewable energy technologies that supply individual users with thermal energy that displaces energy from fossil fuels. The threshold of 45 MW_{th} (equals an installed area of 64,000 m²) for SSC projects applies to every individual CPA under the PoA. The entire PoA, however, is not limited in size and therefore can exceed the SSC threshold by aggregating a number of CPAs.
- The amount of emission reductions that can be generated under SWH programmes largely depends on the energy savings. As per AMS-I.C, baseline emissions are the sum of the energy use of each conventional water heating installation multiplied by the emission factor of the applicable fuel type. Therefore, project developers need to know the amount of energy used in the baseline scenario. Depending on the fuel type, the baseline scenario can either apply the grid emission factor⁴⁶ or use the emission factor of the specific fuel type(s). Parameters generally required for calculation of the energy savings under AMS-I.C are: (i) number of distributed SWHs (new installations or replacement of conventional systems) and (ii) energy use of the distributed SWHs.
- AMS-I.C. allows three options of monitoring, of which two are applicable to a SWH PoA. Monitoring comprises metering the energy produced by a sample of the systems where the simplified baseline is based on the energy produced multiplied by an emission coefficient⁴⁷. However, if emission reductions per SWH unit are less than 5 tCO₂e/year, the methodology only requires annual recording of the number of systems operating as evidence for their continuing operation (e.g. by ongoing rental/lease payments) as well as the annual estimation of operating hours of an average system (surveys may be used).

⁴⁵ An application for a new large scale methodology focusing on SWH was recently submitted, but rejected (NM0263).

⁴⁶ According to the UNFCCC tool to calculate the emission factor for an electricity system.

⁴⁷ This option is based on the M&V approach.

- Leakage is normally not considered under AMS-I.C unless replacement of old water heating systems occurs. However, project developers should ensure that the existing equipment is not used after the implementation of the project activity – neither outside nor inside the project boundary. The solar water heaters should also be new equipment, not transferred from another location (i.e., second-hand sales).

6.3 Programme design

6.3.1 Lessons from existing SWH programmes

A number of programmes promoting SWH have been implemented in industrialised and developing countries. The German Technical Cooperation (GTZ)⁴⁸ conducted a survey on the international experiences with the promotion of SWH at household level (GTZ 2006, 2). Based on the assessment of five programmes⁴⁹, the following recommendations were made for the design of promotion mechanisms for the dissemination of SWHs.

The overarching statement is that financial incentives can significantly increase the market penetration of SWHs. However, a financial incentive alone is not a sufficient condition for programme success. As regards the main barrier of high initial costs, the applicability of a specific financial incentive needs to be assessed carefully. Direct grants and tax deduction, for instance, offer incentives that materialise after the implementation of the SWH. Payments are either made on submission of the receipts or via tax depreciation after the SWH is bought by the end-user.

Another financing option is low-interest loans on a micro financing⁵⁰ level that offer financing for SWHs at an attractive interest rate and therefore do not require the buyer to lend the money in advance. It has been very effective to pay back the loan through the electricity bill, which, however, requires collaboration by a utility company.

The programmes were initiated and managed by governmental or supranational bodies like environment ministries, development agencies or the United Nations. Regarding the institutional transaction costs that arise with the management of a PoA, it seems promising to let such an organisation be the PoA operator. Governmental or supranational authorities enjoy credibility with private and public partners; moreover, they are assumed to have a reasonable infrastructure as well as the existing network to set up a functioning framework. Since financial incentives are applied, a financial institution can also serve as the PoA operator.

The motivation of individual households to purchase an SWH is mainly driven by financial reasons; other parameters such as ecological considerations or the

⁴⁸ The GTZ is active in the field of development aid and is involved in several programmes to promote solar water heating.

⁴⁹ The programmes were conducted in Germany, Greece, France, Tunisia and Spain.

⁵⁰ For example, Grameen Shakti Bank in Solar Home System Project in Bangladesh

climatic conditions (e.g. insulation rate) of the host country play a minor role. A reduced energy bill is therefore the key success factor.

The programme should be easy to understand and access in order to ensure demand for the incentive provided by the programme. Complexity as well as high transaction costs will discourage interested people. Regarding the accessibility of the incentives, programmes should focus on a binding, reliable and medium to long-term framework. As with the technologies assessed in the other chapters, the technology must be easy to use and be of good quality to generate a steady demand for the SWHs under the programme.

Linking the incentives with quality standards is important to enhance trust in the technology. Also, marketing and capacity building measures are important. Campaigns should point out particularly the financial benefits associated with the programme. Involving players from the private sector both in design and intermediation of the promotion seems reasonable. In order to establish a sustainable market that persists after the end of the programme, it could be beneficial to decrease the amount of incentives over time. Otherwise, the demand for SWHs might decrease significantly after the end of the programme.

6.3.2 Business model and institutional requirements

Reflecting the experiences from the existing SWH programmes, the following SWH PoA business model is developed. Figure 5 illustrates the key actors and their responsibilities in the business model.

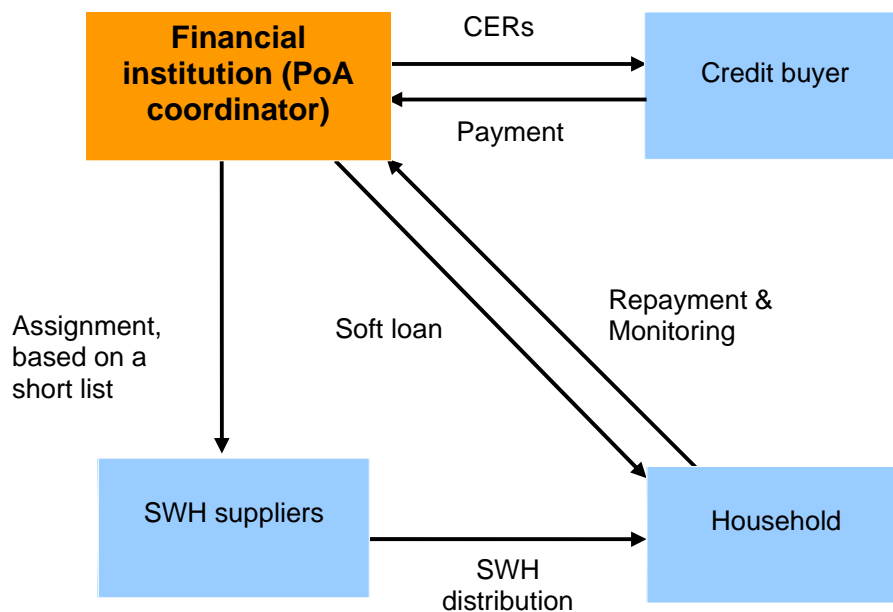


Figure 5: SWH programme business model example

The model is developed in regard to overcoming the barriers that prevent stronger market penetration of SWHs as follows:

- Initial cost barrier - Provision of low interest loan keeps the financial and administrative burden for the households to a minimum
- Technological barrier- Ensuring high quality of equipment, e.g. by applying quality standards
- Information/behavior barrier - Awareness raising by the PoA coordinator, the power utility and the SWH supplier

Regarding the ownership of SWHs, two scenarios are thinkable: Either the PoA coordinator or the household owns the SWH. The model proposes that the households should finance the SWH.

Aim of the PoA: The aim of the PoA is to provide a motivation to individual households 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.

Target group: The PoA addresses the residential sector, i.e. individual households using the SWH to heat water for private use.

Managing entity: The PoA coordinator is a financial institution. Experiences in developing comparable programmes is required as well as the logistical capacity in the programme area. A good reputation is paramount.

The PoA coordinator has to manage the financial streams under the programme, i.e. to set up financing contracts with the SWH producer in order to allow them to offer the SWHs and receive the monthly repayment from the households.

Actors involved: Besides the PoA coordinator and the households, the programme involves SWH companies (producers with retail network and available technicians). Moreover, local craftspeople should be involved for maintenance of SWHs.

Programme implementation:

- The PoA coordinator assigns the respective SWH supplier(s) for the production and distribution of the SWH to the households. The SWH supplier offers SWHs via its retailer(s), together with a loan contract of the coordinating bank that is provided at a low interest rate and has to be paid back over about five years. The contract has to include maintenance over the crediting period. To ensure a smooth processing, contractual arrangements need to be made between the PoA coordinator and the SWH supplier as well as the PoA coordinator and the households (via retail/loan agreement).
- The repayment of the loan is done either via the retailers or directly to the PoA coordinator. It comprises the payback rate for the SWH and the applicable interest. As the household saves costs for electricity (or fossil fuel) to run the conventional water heating, the financial burden is partially absorbed.
- Since the assumed emission reductions per system (SWH) are less than 5 t CO₂/a, the monitoring requirements comprise only the annual recording of the number of systems operating as evidence of continuing operation as well as the annual estimation of operation hours of average systems. As all SWHs are registered and frequent payments are to be made under the soft loan programme, the number of operating SWHs can be tracked by the loan collection agents of the PoA coordinator. For example, the annual repayment receipt of each participating household would be processed by the PoA coordinator for direct use in monitoring reports. Regarding the estimation of the operation hours, the annual insolation duration for the specific region can be applied.

6.4 Carbon revenues and financial requirements

6.4.1 Carbon revenues

Currently, four CDM project activities for SWH dissemination are in the validation stage, all of which apply AMS-I.C. Two of them are conventional SSC projects in India. The other two are PoAs based in South Africa and Tunisia (GTZ, 2008). Whereas the Indian and the Tunisian activities focus on private households, the South African programme supports larger public installations of SWHs. The difference in the application of SWHs makes them difficult to compare. As this guidebook focuses on distribution of SWHs to households, the following analysis concentrates on the Indian and Tunisian projects/programmes.

Estimating the CER potential of a SWH programme under the CDM largely depends on the project design and the location. Table 18 summarises the key parameters for the CER estimation of the concerned projects.

Project name	Number of SWHs to be distributed	Base-line fuel	Average tank capacity [l]	Average installed capacity [m ²]	Average annual energy output of SWHs [MWh _{th}]	Emission factor [tCO ₂ /MWh _{th}]	Annual amount of CERs	Annual amount of CERs per m ²
Solar Water Heater Programme, Tunisia* (AMS-I.C,v.13)	20,000	Various fuels	250	3.0	1.96	0.26	10,000	0.17
CDM Solar Hot Water Project of Emmvee Ltd., India (AMS-I.C,v.12)	21,333	Electric geyser	150	3.0	2.62	0.93	51,907	0.81
Bagepalli CDM Solar Hot Water Heating Programme, India ** (AMS-I.C,v.08)	25,790	Electric geyser	200	2.5	1.75	0.88	39,783	0.62

Table 18: CER estimation of model SWH programme

*PoA under validation, data from real-case CPA.

** The CER estimation for Bagapelli is based on the number of SWHs. However, the PDD applies a different baseline approach and therefore calculates more CERs.

The expected annual potential for CERs varies over the different projects according to the project design. The most important parameters in this regard are the average installed capacity and the baseline emissions. For the calculation of baseline emissions, different approaches can be applied. As can be seen from the Indian and the South African examples, one possibility is to assume that all households are connected to the grid. The baseline emissions in this case are calculated by multiplying the cumulated annual energy output of all SWHs with the grid emission factor. The Tunisian case applies a more complex baseline considering all fuel types that are commonly used to heat water. Then the baseline emissions are calculated by multiplying the cumulated annual energy output of all SWHs with the specific fuel emission factors. The annual emission reductions per installed m² range from 0.17 tCO_{2e}/year to 0.81 tCO₂/year.

6.4.2 Financial requirements

Market surveys indicate the average procurement costs for a SWH at approximately 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 (Milton and Kaufman 2005). SWHs have a relatively long lifetime (between 15 and 30 years) and therefore procurement costs are only caused once during the first crediting period. Installing a system is expected to take one to two person-days of a local skilled technician at a wage level of EUR 500 per month. This

leads to a SWH installation cost of approximately EUR 30/SWH.⁵¹ Therefore, the SWH procurement and installation costs are estimated to be EUR 730/SWH.

As to the monitoring costs, the SWH system size normally does not lead to annual emission reductions over 5 tCO₂. As described above, AMS-I.C allows for a simplified monitoring procedure in this case. As long as the installations are registered under the project (e.g. via soft loan mechanism), the monitoring requirements can easily be met. Therefore, it is assumed that the monitoring costs are marginal.

State-of-the-art SWHs run on their own and do not require extensive maintenance services. An annual check by the SWH user and a detailed check by a professional technician every 3-5 years should be sufficient. On average, 0.3 person-days of local technicians are assumed at a wage level of EUR 500 per month, which leads to annual maintenance costs of EUR 5/SWH.

Based on the above information, Table 19 summarises the costs of a model SWH project. SWHs typically have a lifetime of 15-30 years. To be on the conservative side, a 10-year crediting period is applied. Monitoring is performed for all SWHs.

Cost components		Upfront (EUR)	Annual (EUR p.a.)
Fixed costs	Project design and CDM documentation	200,000	30,000
	Monitoring ⁵²	3,000	200
	CDM fees	50,000	30,000
Variable costs	SWH procurement	700 per SWH	-
	SWH installation and baseline water heating equipment replacement ⁵³	31.3 per SWH	-
	Maintenance	-	5.0 per SWH
	Other costs	-	0.2 per SWH

Table 19: Overview of the fixed and variable costs of the model SWH programme (nominal)⁵⁴

For this specific example, the nominal costs per SWH would thus reach EUR 743.90 upfront plus EUR 8.20 in annual costs. In order to allow a successful dissemination of the SWHs the project employs a soft loan instrument. The SWH are offered to households together with low-interest loans with a payback period

⁵¹ For installation details see for instance the producer Quantumenergy (http://www.quantumenergy.ca/products_and_services/solar_water_heaters.html) or the renewable energy portal energy saving trust (http://www.energysavingtrust.org.uk/generate_your_own_energy/types_of_renewables/solar_water_heating)

⁵² Assumed upfront costs comprise the set up of a database (EUR 3,000). Annual costs assume that the monitoring is integrated into the existing business and the additional costs are marginal (approx. EUR 200 p.a. for administration).

⁵³ Installing a system is expected to take one to two person-days of a local skilled technician at a wage level of EUR 500 per month.

⁵⁴ Note: Distribution of 20,000 SWHs; SWH lifetime of 15-30 years (crediting period of 10 years assumed); monitoring of all SWHs.

of five years and an interest rate of 7%⁵⁵. It is furthermore estimated that the average SWH has a collector area of 3 m², which leads to an annual range of 0.5 to 2.5 CERs per SWH. Given the above assumptions the following attractiveness table is illustrated for a model SWH programme.

Annual CERs per SWH	CER minimum price for break-even (EUR)	CER price for IRR of 15% (EUR)
2.5	6.8	13.7
1.25	13.6	27.4
0.5	33.9	68.5

Table 20: Indicative level of CER prices and CERs per SWH required for break-even and IRR of 15%⁵⁶

The financial information of the model project allows for the calculation of the critical project size to achieve financial viability. The following CER revenue levels are considered for the analysis, assuming a CER price of EUR 12 and the annual CER per SWH of 0.5, 1.25 and 2.5. Based on the three scenarios for the CER revenue per SWH, the critical project size for the break-even and IRR of 15% are summarised in Table 21.

Annual CERs per SWH (EUR)	Critical size (number of SWHs)	
	Break-even	IRR of 15%
2.5	5,600	85,000
1.25	32,500	Unlikely to achieve
0.5	Unlikely to achieve	Unlikely to achieve

Table 21: Critical size of a SWH programme for the break-even and IRR of 15%⁵⁷

The financial attractiveness of SWH programmes strongly depends on the baseline emissions factor; the higher the emission factor and baseline emissions are, the higher the financial viability will be. Nevertheless, projects can and should be considered everywhere. In all countries, high numbers of SWHs have to be distributed to make the PoA a success.

⁵⁵ The interest rate is to be lower than an average market interest rate for individuals. For the model calculation an interest rate of 7% is assumed. However, the loan conditions to be offered depend on the financial institution involved and the regional circumstances. The difference between the average market interest rate for individuals and the low interest rate may be considered as the programme subsidy. If the average market interest rate is 10%, the total programme subsidy over the 5-year payback period would be about EUR 1.34 million.

⁵⁶ Note: Discount rate of 10% for the calculation of the break-even.

⁵⁷ Note: Discount rate of 10% for the calculation of the break-even.

Key points and challenges

1. Hot water plays an important role in the daily life of all societies. Residential water heating systems are mainly based on fossil fuels or electricity from the grid which leads to high electricity or fuel costs and a contribution to GHG emissions and outdoor air pollution.
2. Solar Water Heaters are an environmentally friendly solution to provide hot water for households as commonly used SWHs require only 30% of the energy used by conventional systems. State-of-the-art SWHs are easy to handle and do not require extensive maintenance. The reduced energy bill for the end-user is key for the success of the PoA.
3. High initial costs are the main barrier of investing in a SWH. Nevertheless, the applicability of a specific financial incentive needs to be assessed carefully.
4. The programmatic CDM can provide additional revenues from sale of CERs to finance grants to end-users, tax deductions or subsidised loan conditions of financial institutions.
5. A SWH costs between EUR 500 and 1,500 and can reduce up to 5 t CO₂/a.
6. A key challenge to the PoA is the need for financial transformation if seed funding for grants and/or subsidies to credit lines is needed. That implies that the financial institution, a potential CER buyer or a private investor would need to take the different risks of the programme if no public institution or international donor could play a role.
7. A high critical mass of SWHs has to be distributed to secure the financial attractiveness of the programme. This and the potentially high number of programme participants (SWH supplier, retailer, installers, households and – if applicable – various banks) leads to a complex programme which needs to be elaborated and implemented with care.

7. Industrial boilers

7.1 Background

Almost all continuous industrial process plants (e.g. in the pulp and paper, chemical, textile, food processing and sugar industry) require an uninterrupted input of energy in the form of electric power and/or steam to sustain their industrial processes. This energy is usually supplied by steam boilers that generate steam for electricity generation or process steam. Industrial steam boiler sizes range from less than 1 MW to around 100 MW. Steam boilers may be fired by coal, oil, naphtha, natural gas or biomass.

Boiler refurbishment or replacement projects by state-of-the-art industrial steam boilers are interesting candidates for the CDM (Hayashi and Krey 2005). The applied fuel type has a significant effect on boiler efficiency.

The thermal efficiency hierarchy in descending order is coal, heavy fuel oil and natural gas due to the high hydrogen to carbon ratio in natural gas (Besette 2002). The hydrogen which burns to form water removes a significant amount of heat from the combustion process. Hence, it has to be borne in mind that 95% is the maximum achievable efficiency if coal is used. For other fuels the efficiency can be assumed to be a few percentage points lower.



Reduced energy consumption by improved processes and installations
Source: KfW photo archives

In developing countries, industrial boilers are often outdated and the efficiency gap compared with Western standards is wide. In the early 2000s, coal-fired industrial boilers in China on average only operated at 65% efficiency (Lu 2005). By 2000, 500,000 industrial boilers were reported to exist in China (GEF 2001) with an average size of 2.3 t of steam per hour (tph) which would approximately translate into 1.7 MW average installed capacity (Wu and Wei 1998). Annual boiler sales were 20,000 with an average capacity of 3 MW (Minchener 2001). Closing the efficiency gap of the existing boiler park in China by replacing the old with state of the art boilers could save about 2 Petawatthours (PWh) of thermal energy and lead to an annual reduction of 700 million t CO₂. Realistically, the potential would be considerably smaller, as efficiency increases through refurbishment typically reach 5-6%, limiting savings to 115-140 million t CO₂.

Pure boiler refurbishments can achieve energy efficiency improvements as illustrated in Table 22 below.

Measure	Energy efficiency improvement
Improved process control (optimisation of fuel/air mixture)	1.5% boiler efficiency improvement per 10% reduction in excess oxygen
Economiser (pre-heating of air, water or steam with flue gas)	1% of fuel saved per 20-25°C reduction in exhaust temperature
Condensate return	~10% fuel saved

Table 22: Efficiency gains of boilers due to refurbishment.

Source: Galitsky et al. (2003)

Often, boiler replacement projects will not be limited to replacement of an inefficient steam-only boiler with a more efficient steam-only boiler of the same type, but involve a fuel switch (e.g. to natural gas), installation of a CHP unit or both. Table shows typical technical characteristics of state-of-the-art industrial CHP systems.

Type	Typical fuel	Efficiency (%)		Grade of heat or pressure
		Thermal	Electric	
Gas turbine (combined cycle) with heat-recovery steam generator	Natural gas	31	42	Medium
Gas turbine (single cycle) with heat-recovery steam generator	Natural gas	47	33	High
Steam boiler and back-pressure steam turbine	Coal, oil	76	8	Low – Medium

Table 23: Technical characteristics of typical CHP system designs⁵⁸

Source : Bessette (2002), Krushch et al. (1999), UK-ETSU (1999) and own assumptions

7.2 Methodological requirements

As of December 2008, the following approved methodologies are available for boiler refurbishment and replacement programmes: AM0056,⁵⁹ AM0044⁶⁰ and AMS-II.D⁶¹. A very specific methodology with limited applicability is AM0054⁶². Cogeneration is covered by AM0049⁶³ and AM0014⁶⁴, but due to their very

⁵⁸ Note: Figures given represent typical orders of magnitude for thermal and electric efficiencies for the respective CHP systems

⁵⁹ AM0056 (version 01): Efficiency improvement by boiler replacement or rehabilitation and optional fuel switch in fossil fuel-fired steam boiler systems.

⁶⁰ AM0044 (version 01): Energy efficiency improvement projects: boiler rehabilitation or replacement in industrial and district heating sectors.

⁶¹ AMS-II.D (version 11): Energy efficiency and fuel-switching measures for industrial facilities.

⁶² AM0054 (version 01): Energy efficiency improvement of a boiler by introducing oil/water emulsion technology.

⁶³ AM0049 (version 01): Methodology for gas-based energy generation in an industrial facility.

⁶⁴ AM0014 (version 04): Natural gas-based package cogeneration.

limited applicability and high complexity, these methodologies will not be assessed here.

All these methodologies have not yet been applied to a significant extent.

AM0056, **AM0044** and **AMS-II.D** are the most widely applicable. The key challenge is to determine the remaining technical lifetime of the replaced or refurbished boiler. In all methodologies, common practice regarding boiler lifetimes in the sector and country has to be documented based on industry surveys, statistics, technical literature, etc. Alternatively, the common practices of the responsible industry regarding replacement schedules can be used, e.g. through historical replacement records.

Additionality can be tested in AM0056 and AM0044 using the following barriers:

- Access to capital required to replace/rehabilitate boiler(s) and implement fossil fuel switch by the owners of the project facility site is constrained;
- Access to capital by the third party to implement the proposed project activity is either constrained or expected returns are considerably low;
- Lack of technical expertise among the owners of the project facility to install/operate the new boiler(s) that may result in additional costs due to the need to hire required specialists

In **AM0044**, investment analysis is mandatory if the project is done by a third party, such as an energy service company (ESCO). A benchmark analysis is to be used. For calculation of the project IRR, the ten boilers with the highest efficiency improvements are to be looked at and the boiler with the highest IRR is used for comparison with the benchmark. A control group has to be surveyed to prove that less than 33% of that group uses improved boilers similar to the project boilers. **AM0056** uses the combined additionality tool, where a barrier analysis is followed by an investment analysis for the remaining alternatives.

In **AMS-II.D**, the baseline is the historical boiler energy consumption, and monitoring is done through metering of boiler energy use. This seems straightforward, but given experiences with interpretation of small-scale (SSC) methodologies, it is likely that regulators will require a more elaborated procedure.

AM0056 requires measurement of the pre-project capacity of the boiler. In a relatively complex procedure, the load characteristics of the boiler have to be determined. Specific fuel consumption of the boiler is determined through performance tests defined by international standards, which are to be conducted for a range of loads within a load class. These tests have to be done three times before project start. During the project, boiler steam generation, pressure and temperature have to be measured every 15 minutes.

AM0044 requires three years measurement of average thermal output and fuel consumption of replaced/refurbished boilers before project start. Alternatively, thermal efficiency of the replaced/refurbished boiler can be measured once at project start, but this leads to a decrease of baseline emissions according to measurement uncertainty. For boilers of less than 29 MW, efficiency data from similar boilers in the region can be used but need to be discounted by 37%. In case of CDM programmes using AMS II.D, scrapping of replaced boilers has to be shown.

The key methodology elements influencing the design of boiler refurbishment programmes are the data availability of the baseline boilers.

In case robust, long-term measurements are available, AM0044 is preferable. If this is not the case, AM0056 should be used as it only requires measurement of the capacity. The monitoring becomes more complex in return.

For multi-boiler systems, AM0056 is the only methodology that can be used.

As the 180 GWh_{th} threshold for conventional SSC projects does not apply to a SSC-PoA, it is very likely that AMS-II.D leads to an easier PoA implementation than AM0056 and AM0044 without compromising the scale of the PoA. The following sections focus on AMS-II.D and AM0056.

7.3 Programme design

7.3.1 Lessons from existing boiler programmes

The largest boiler efficiency programme to date was implemented by the Global Environment Facility (GEF) in China between 1996 and 2004 (World Bank 2004, GEF 2001, 1996). The programme had a total cost of EUR 73.9 million, of which EUR 25.4 million was provided by the GEF; EUR 2.0 million covered project management and technical assistance. It started with assistance to enable eight Chinese manufacturers to produce state-of-the art boilers. Subsequently, production of such boilers was subsidised. Efficiency of sold models increased from 73% to 78% on average, with sales reaching 9,230 tph (i.e. 6,820 MW) in 2004, reducing annual CO₂ emissions by 0.35 million t (World Bank 2004). While the GEF-supported boilers cost 10% to 20% more to manufacture than traditional models, primarily due to an increase of steel consumption, the higher cost of GEF-supported boiler equipment is compensated by significant fuel cost savings with a payback time shorter than three years in most cases. Due to savings in refractory materials and shorter installation time, the installed cost of some GEF-supported boilers was lower than those of comparable traditional boilers.

The most problematic element of the project was the initial technology transfer which was delayed by two years compared with the plan. It was difficult to find companies willing to transfer the technology, and project management was cumbersome given 20 Chinese agencies, institutes, and companies were involved. The strict and complex approaches and rules of contracting,

procurement, and project management slowed implementation. So far, no boiler refurbishment programme has been done with public subsidies. In some countries, ESCOs have embarked on boiler refurbishment.

7.3.2 Business model and institutional requirements

A boiler refurbishment PoA business model is conceptualised in Figure . The figure summarises the key actors and the responsibilities of these actors. The situation differs from other project types inasmuch as the financing of the boiler refurbishment has to be done in a way that integrates the subsidy into the finance package. Thus, the role of a local financial institution that collaborates with an industry association becomes paramount. Moreover, an experienced ESCO has to implement the refurbishment activities. Theoretically, the coordinator could implement the PoA without an ESCO but this is not recommended due to the lack of knowledge of the technical aspects of refurbishment.

It has to be kept in mind that other functional options (e.g. association as a PoA coordinator that ties up with one or multiple FIs or a joint implementation with manufacturers to provide additional discount and support with Measurement and Verification) regarding the different actors and their roles and responsibilities are possible. That depends on local interests and circumstances. The development of the business model should be oriented towards the core competencies of the different actors, especially the core interests and strengths of the PoA coordinator.

The figure summarises the key actors and their responsibilities.

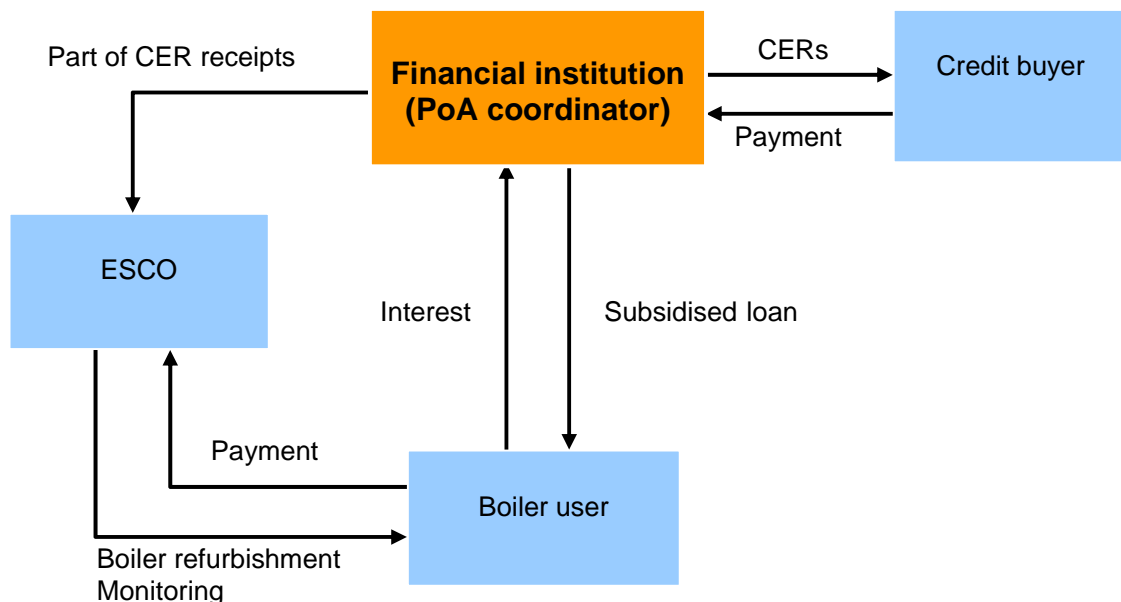


Figure 6: Boiler refurbishment programme business model example

The model seeks to address the barriers to boiler refurbishment in the following manner:

- Initial cost barrier - subsidised loans are made available
- Technological barrier involvement of a qualified ESCO to guarantee high-quality refurbishment.

Aim of the PoA: The aim of the PoA is to enhance the number of boiler refurbishments by bringing down the cost of refurbishment, which has been a high barrier to date. The carbon revenues are utilised to reduce the amount of loan financing.

Target group: Medium to large industries, which are members of the respective industry association.

Managing entity: The PoA coordinator is a joint venture of a financial institution with an institution with good links to industry, preferably a sectoral or umbrella industry association.

The financial institution provides concessional loans in exchange against a share in carbon revenues. This bank must have experience with the type of industrial clients targeted by the PoA.

The PoA coordinator identifies potential participants in the boiler refurbishment programme, develops PoA documentation and coordinates the ESCO's boiler refurbishment schedule.

Actors involved: An ESCO with substantial know-how in boiler engineering has to be involved to actually implement the refurbishments. It will be paid by the industries from the loan amount. In order to obtain competitive rates for refurbishment, several ESCOs can be involved. To provide an incentive for proper work by the ESCO, part of its payment should be dependent on the CER volume generated by each refurbishment. In countries with limited ESCO presence or quality, this could be a manufacturer, local suppliers or even engineering consultants.



Saving energy, equipment of a passive house, May 2008, Germany
Source: KfW photo archives, photographer: Thomas Klewar

Programme implementation: On the basis of the membership lists of the PoA coordinator, candidates for boiler refurbishment are identified. The bank and the ESCO arrange visits to these companies and present a refurbishment package including a loan. Once agreement on the package has been reached, the site is included in the PoA. An ESCO officer records fuel consumption of the boiler and then initiates the refurbishment. The ESCO monitors fuel consumption and sets up a monitoring report. The monitoring report has to be submitted by each industrial participant with each annual loan installment repayment.

7.4 Carbon revenues and financial requirements

7.4.1 Carbon revenues

Taking an oil-fired boiler refurbishment programme in Peru (GTZ, 2003) as a case study, Table 24 summarises key parameters for CER estimation of the project.

Number of boilers	Capacity (MWth)	Fuel consumption before project (TJ)	Average lifetime of boiler (years)	Average pre-project efficiency (%)	Average efficiency improvement (%)	Annual amount of CERs	Annual amount of CERs per MWth
130	1,270	11,800	35	83	6	70,000	55

Table 24: CER estimation of a model boiler refurbishment programme⁶⁵

The CER potential strongly depends on the achievable degree of efficiency improvement, the remaining lifetime of the boilers and the fuel used. The emissions impact is highest if coal is used, followed by oil and gas. Per unit of energy, CO₂ emissions from coal are about 30% higher than for fuel oil and 75% higher than for natural gas. Given that the costs of boiler replacement strongly depend on the remaining lifetime, it is appropriate to target boilers with a remaining lifetime of about 10 years if convincing barriers to boiler replacement can be shown.

Regarding the financial attractiveness, the fuel costs as well as the costs for boiler refurbishment/replacement play a key role. Boiler refurbishment usually consists of a package of many small measures (e.g. automatic control of excess air, automatic control of boiler blowdown, replacement of the burner, and installation of an economiser). GTZ (2003) stresses that many measures have very short payback periods so actually have negative costs.

⁶⁵ Note: The calculation is based on AMS-II.D.

7.4.2 Financial requirements

Around 2000, a new coal-fired boiler cost about EUR 50,000/MW_{th} in the EU and about EUR 12,500/MW_{th} in China (Minchener 2001). Small gas-fired boilers were more expensive in China, reaching EUR 15,000/MW_{th}, due to lower manufacturing costs, whereas the EU cost was around EUR 30,000/MW_{th}. In the meantime, steel prices have increased considerably, which means that recent boiler prices probably reached twice or even three times the level quoted above. The refurbishment of a 1 MW_{th} gas boiler through new digital controls, economiser, new fan wheel and variable frequency drive on combustion air fan costs on average about EUR 110,000 (IDFA 2008). For a set of 20 to 50-year old boilers using various fuels and having sizes between 2 and 180 MW_{th} in the U.S., costs of a typical range of refurbishment options reach about EUR 150,000 (Delta Institute 2002). As the cost seems to be relatively independent of the boiler size, we assume that the average size of the refurbished boiler is 10 MW_{th} and average cost for refurbishment of 1 MW_{th} at EUR 15,000. This does not include costs of temporary production shutdown due to the refurbishment. These costs are extremely dependent on the capital intensity of the production process and thus cannot be calculated here.

Key assumptions on the cost overview for an average boiler refurbishment project for 500 boilers with a total of 5,000 MW_{th} are summarised in Table 25. Given that loan interest rates for industrial clients vary considerably from country to country, we do not specify a specific soft loan interest rate, but assume that a loan subsidy will be granted that covers 25% of the refurbishment cost. As boiler lifetime is case-specific and difficult to estimate, we simply assumed a 10-year crediting period. Monitoring is performed for all boilers.

Cost components		Upfront (EUR)	Annual (EUR p.a.)
Fixed costs	Project design and CDM documentation	200,000	30,000
	Monitoring ⁶⁶	30,000	5,000
	CDM fees	50,000	30,000
Variable costs	Identification of measures for each boiler	8 per MW _{th}	-
	Boiler refurbishment loan subsidy costs (25% of total refurbishment cost)	3,750 per MW _{th}	-
	Monitoring	-	7 per MW _{th}
	Other costs	-	1 per MW _{th}

Table 25: Overview of the estimated fixed and variable costs of the model boiler refurbishment programme (nominal)⁶⁷

⁶⁶ Assumed costs for purchase & installation of monitoring equipment and set up of database are EUR 30,000 upfront. Annual costs of EUR 5,000 comprise the required physical inspection and meter reading at the biodigester (25 person months for ground-work staff).

⁶⁷ Note: Refurbishment of 500 boilers; Crediting period of 10 years; Monitoring of all boilers.

For this specific example, the nominal costs per MW_{th} would thus reach EUR 3,759 upfront plus EUR 13 in annual costs. This generates the following attractiveness table. The CER generation scenarios represent the following three cases: (i) 44 CERs/year per MW_{th} in case of gas use, (ii) 55 CERs/year per MW_{th} in case of oil use (iii) 71 CERs/year per MW_{th} in case of coal use.

Annual CERs per MW _{th}	CER minimum price for break-even (EUR)	CER price for IRR of 15% (EUR)
71	9.0	10.9
55	11.6	14.1
44	14.5	17.6

Table 26: Indicative level of CER revenues and CERs per MW_{th} of boiler refurbishment required for break-even and IRR of 15%⁶⁸

The financial information of the model projects allows for the calculation of the critical project size to achieve financial viability. The following CER revenue levels are considered for the analysis, assuming a CER price of EUR 12 and the annual CERs per MW_{th} as above. Based on the three scenarios for the CER revenue per boiler, the critical project sizes for the break-even and IRR of 15% are summarised in Table 27.

Annual CERs per MW _{th}	Critical size (MW _{th} refurbished)	
	Break-even	IRR of 15%
71	470	1,200
55	2,350	Unlikely to achieve
44	Unlikely to achieve	Unlikely to achieve

Table 27: Critical size of a boiler refurbishment programme for the break-even and IRR of 15%⁶⁹

Boiler refurbishment programmes make commercial sense where coal is used and where several hundred boilers can be covered. This will especially be the case in economies with a large productive sector, such as China, India and Indonesia.

A very important point in designing the PoA is the way different actors are incentivised. All actors need a strong inherent interest in participating in the programme either by a financial incentive (grant, loan subsidy etc.) or nonmonetary benefits (energy audits, expansion of client base for financial institution, cost-recovery for maintenance, quality improvements of suppliers or technical assistance etc.). Especially in this type of PoA, a careful assessment of the real barriers for the enterprises to invest in energy efficient equipment is

⁶⁸ Note: Discount rate of 10% for the calculation of the break-even.

⁶⁹ Note: Discount rate of 10% for the calculation of the break-even.

important to prevent wasting CER revenues on the wrong incentive. Especially where enterprises have capital and the amortisation of the investment is short it might be more adequate to set up a grant programme or a combined measure.

As the revenues from the sale of the CERs will only accrue at a later stage the pre-financing or seed funding issue might be a barrier for the project implementation even if a financial institution is involved. Possible providers of seed funding can be (at least partly) the buyer of the CERs, international and local financial institutions, international manufacturers and, to a lesser extent, public funding.

Key points and challenges

1. Industrial processes consume a huge amount of electric and thermal energy. Energy efficiency in producing companies can therefore contribute to a big extent to reduce GHG emissions. Industrial boilers are used in almost all industrial processes and are therefore a good candidate for replacement programmes.
2. In many cases high initial costs are the main barrier; nevertheless a careful analysis of the barriers is necessary to design the structure of incentives of the PoA.
3. The programmatic CDM could help overcome these barriers by providing additional revenues from sale of CERs to finance loan subsidies or grants to companies of the producing industry.
4. A key challenge to the PoA is the need for financial transformation, e.g. seed funding for grants and subsidies to credit lines. That implies that the financial institution, a potential CER buyer or a private investor would need to take the various risks of the programme where no public institution could play a role.
5. The CER potential depends strongly on the degree of efficiency improvements, the remaining lifetime of boilers and the fuels used. For a PoA it is therefore important to reach out to a good critical mass of mainly homogenous enterprises which are able to achieve high emission reductions.

8. Building refurbishment⁷⁰

8.1 Background

Every year around 4 billion square metres are constructed worldwide. Construction itself, but to a large extent the operation of already existing and new buildings consumes huge amounts of energy (Richerzhagen et al. 2008). Worldwide, 30%–40% of all primary energy is used in residential and public buildings. The pattern of energy use in buildings is strongly related to the building type and the climate zone in which it is located. Importantly, most of the energy consumption occurs during the building's operational phase, for heating, cooling and lighting purposes. This clearly shows the need for producing more energy-efficient buildings and renovating existing building stocks (UNEP 2007). Through **mitigation** measures in the residential and commercial sectors, approximately 3.2, 3.6 and 4.0 billion tCO₂e can be avoided globally from the business-as-usual-level in 2020 at zero cost, EUR 14.6/tCO₂e and EUR 73/tCO₂e respectively (Levine et al. 2007).⁷¹ Especially in countries in transition, decades of neglect of buildings means that there is a huge potential for building refurbishment programmes.

Common building refurbishment options include:

- Improvement of insulation level;
- Modern window technology;
- Efficient lighting;
- Efficient heating and/or cooling systems; and
- Hot water production using renewable or regenerative sources (solar, heat pumps, waste heat from industry, etc.) (adapted from UNEP 2007; Thorne 2003).

In almost all countries, efficient lighting technologies are among the most promising measures in buildings, in terms of both cost-effectiveness and size of potential savings. In economies in transition (typically in cooler climates), insulation of walls, roofs, windows and floors, as well as improved heating controls for district heating are found most cost-effective. In terms of the size of savings, improved insulation and district heating in the colder climates and efficiency measures



Insulation material
Source: KfW photo archives,
photographer: Thomas Klewar

⁷⁰ By nature, building refurbishment has a certain overlap with efficient lighting (e.g. CFLs) and renewable thermal energy supply for users (e.g. SWHs).

⁷¹ Converted from the original figures of USD 20/tCO₂e and USD 100/tCO₂e.

related to space conditioning in the warmer climates are considered most important (Levine et al. 2007).

One of the most significant barriers to energy-efficient building design is that buildings are **complex systems**. Minimising energy use requires optimising the system as a whole by systematically addressing building form, orientation, envelope, glazing area and a host of interaction and control issues involving the building's mechanical and electrical systems (Levine et al. 2007).

The high investment costs involved, the lack of information on energy-efficient solutions at all levels, as well as the (perceived or real) lack of availability of solutions to specific conditions, are also considered as the major barriers.

Furthermore, there can be a number of organisational barriers, such as different decision making levels, privatisation/deregulation processes, different stakeholders deciding on the energy system and shouldering the energy bill accordingly (i.e. split incentive problem or principal-agent problem), etc. (UNEP 2007).

Under the CDM/JI, so far there are only a few projects in this category, all of which are limited to active solutions, such as CFLs, SWHs, energy-efficient heating, ventilation, and air conditioning (HVAC) systems, insulation, or other measures that make use of technological options. Passive solutions, such as the design of better oriented and ventilated buildings, have not yet been proposed (UNEP 2007).

The lack of building refurbishment projects is largely due to the comparatively high transaction costs and the lack of suitable approved methodologies. The programmatic approach could help overcome at least the transaction cost barrier by aggregating small and dispersed building refurbishment activities.

8.2 Methodological requirements

In case of building refurbishment, there is no “one size fits all” approach to quantify the energy savings achieved by the project. The size and complexity of the building refurbishment project determines the methodological approaches. The following three broad categories of methodological approaches are available for quantifying the energy savings from building refurbishment projects:

- (i) Deemed savings approach,
- (ii) Large-scale data analysis approach⁷² and
- (iii) Measurement and Verification (M&V) approach.

⁷² Large-scale data analysis approach conducts statistical analyses on the energy usage data (typically collected from the meter data reported on utility bills) for all or most of the participants and possibly non-participants in the programme.

The methodological choice has important implications for the programme design, especially in monitoring. Therefore, the three options and suitable activity types are briefly summarised below.

- The deemed savings approach is most commonly used for programmes that involve simple retrofit energy-efficiency measures with well-defined applications. Examples might be T-8 fluorescent lamp retrofits in office buildings or CFL give-aways for households (compare Chapter 3). With the use of deemed savings, there are no or very limited measurement activities, and only the installation and operation of measures is verified. This approach is only valid for projects with fixed operating conditions and well-known, documented stipulation values (NAPEE 2007).
- The large-scale data analysis approach is most commonly used for programmes that involve large-scale retrofit programmes with many participants. It is primarily used for residential programmes with relatively homogeneous participants and measures, when project-specific analyses are not required or practical. A typical example is a residential customer weatherisation programme with thousands of homes being retrofitted with a variety of measures such as insulation, weather stripping, low-flow showerheads, and CFLs (NAPEE 2007).
- The M&V approach is used for almost any type of programme that involves retrofit projects. It is generally applied only to a sample of projects in a programme because it is more expensive on a per-project basis than the other two approaches. It is the most common approach used for programmes involving non-residential facilities, in which a wide variety of factors determine savings. In general, the M&V approach is applied when the other approaches are not applicable or when per-project results are needed. An example is a performance-contracting programme⁷³ with multiple contractors (NAPEE 2007).⁷⁴

As of September 2008, there is only one approved methodology which is specifically designed for building refurbishment projects: AMS-II.E “Energy efficiency and fuel-switching measures for buildings” (version 10)⁷⁵.

It is based on the Measurement & Verification (M&V) approach and applicable only if it is possible to directly measure and record the energy use within the project boundary. Also, the impact of the measures implemented (improvements

⁷³ Through performance contracting, participating entities can hire the prequalified contractors for energy efficiency upgrades and pay for it with energy savings.

⁷⁴ The M&V approach is further divided into the four sub-categories: Option A - Retrofit isolation – key parameter measurement; Option B - Retrofit isolation – All parameters measurement; Option C - Whole facility; Option D – Calibrated simulation. For further details on the applications for each option, see NAPEE (2007).

⁷⁵ Excluding methodologies for technology-specific demand-side efficiency measures such as CFLs (AMS-II.C), SWHs (AMS-I.C), etc.

in energy efficiency) by the project activity must be clearly distinguished from changes in energy use due to other variables (including interactive effect of efficiency measures) not influenced by the project activity.

The strong emphasis on the causality between the project activity and the emission reductions put in AMS-II.E may be the main reason why all the existing building refurbishment CDM projects were developed for “system-specific” building refurbishment activities⁷⁶, which focused on particular building systems or components. In contrast, a “whole-facility” approach attempts to systematically address the biggest problems as identified by facility-by-facility analysis. The first step to taking a whole-facility energy-efficiency approach is to find out which parts of the building use the most energy.

A building energy audit will show where they are and suggest the most effective measures for reducing energy consumption. The whole-facility approach is a more comprehensive and effective measure for building energy-efficiency improvement, but requires highly sophisticated and comprehensive examination. As energy savings values per individual measure are likely to be difficult to measure, a new methodological approach (e.g. benchmarking) has to be developed to realise the potential of whole-facility building refurbishment activities.

8.3 Programme design

8.3.1 Lessons from existing building refurbishment programmes

Thorne (2003) reviewed a number of residential building refurbishment programmes implemented in the U.S. Common programme elements include contractor training and certification programmes, diagnostic tools, guidelines or specifications for best practices, customer education and marketing, and financial incentives (most commonly, rebates) (Thorne 2003).

These programmes were typically implemented by utilities, government, or specialised energy-efficiency alliance organisations.

As discussed above, the programmes are categorised into system-specific and whole-facility refurbishment programmes. Early efforts to improve the efficiency of existing buildings, in particular, sought to address the most common problems contributing to building energy waste (e.g. HVAC systems in the early and mid-1990s) and to work through specific, established contractor trades. Generally speaking, the system-specific efforts have targeted the following equipment and services:

⁷⁶ Following the definition of Thorne (2003), we use “system” in this report to refer to the set of components that work together to meet a particular functional need in a building.

- HVAC installation and maintenance;
- Air sealing;
- Duct repair and scaling;
- Insulation;
- Window replacements;
- Lighting and appliances.

The substantial growth in knowledge of building science and understanding of the complex interactions among building systems and components enabled the development of new methods for diagnosing home performance problems and implementing solutions to these problems. In turn, this has led to a growing interest in promoting building refurbishment that can capture the compounding savings from addressing whole buildings instead of specific systems. Many whole-facility refurbishment programmes incorporated the components of the system-specific programmes described above (Thorne 2003).

Importantly, building refurbishment programmes, be it system-specific or whole-facility, require recruiting members of often highly fragmented and specialised contracting trades⁷⁷. Greater consumer awareness and demand for whole-facility refurbishment will be required, especially if programme implementers expect contractors to invest in training, credentialing, new equipment, etc. Some key lessons learnt from the existing U.S. programmes are summarised below:

- Actors on both supply and demand sides of the building refurbishment market need capacity building and awareness raising. On the supply side, the most important initial efforts required are training, certification, and licensing for contractors. On the demand side, consumer education is required for creating lasting demand and transforming the market.
- Consumer rebates can be a helpful tool to attract end-users' attention, but they cannot be the centerpiece of a programme or its main element. Without adequate consumer education and attention to building a strong contractor base, rebates cannot spur a sustainable demand for effective building refurbishment services or create the infrastructure to provide these services.
- Efforts to reduce the risk to contractors interested in offering the whole-facility services can be very important in encouraging them to take the first steps into the business. The successful strategies include: offering financing or other assistance with the purchase of necessary tools and

⁷⁷ In general, contractors for building refurbishment can be classified as either general contractors or specialty contractors. The general contractor will handle all aspects of a remodelling or building improvement project, but usually employs specialty sub-contractors to handle specific tasks such as insulation, window replacement, HVAC installation, etc. The specialty contractor rarely deals in more than one of these core trades (Thorne 2003).

- equipment; providing strong marketing leads; and giving compensation for the time it takes to establish relationships with other contractors and make the necessary referrals.
- As building refurbishment is very heterogeneous, better characterisation of the opportunities available in different climate regions, in buildings of a particular construction and vintage, and in specific comfort conditioning systems may allow contractors to use a more prescriptive set of improvements as a starting point (Thorne 2003).

It is of note that Germany has also been implementing the very successful KfW CO₂ Building Rehabilitation Programme (KfW-CO₂-Gebäudesanierungsprogramm) (Neeteson 2007). The programme, established in 2001, provides subsidised loans for the refurbishment of buildings built in Germany before 1979. The subsidy reduced interest rates by about 1-2% compared with the market rate. A household is only eligible for a subsidised loan if the



Promotion of the CO₂ Rehabilitation Programme.
Source: KfW Bankengruppe

applied measures lead to an annual CO₂-reduction of 40 kgCO₂ per m², which has to be certified by an authorised energy consultant (Korytarova 2006).

The KfW programme is regarded very favourably by the policymakers. It is part of the National Programme of Climate Protection. KfW programme applications reached over 140,000 from 2001 to 2006 (Neeteson 2007), with a refusal rate of only 1% of applications, and the provided governmental funds to lower the interest rates were fully exhausted. In 2005 and 2006 the programme resulted in CO₂e-reductions of more than 1 million t. In terms of energy savings more than 2 billion kWh/a was saved. Another important result revealed by an evaluation of the programme shows that the savings in heating costs added up to ca. EUR 4.2 billion over a period of 30 years. This is 83-90% of the investment sum. That shows that from the perspective of an average household the investment is nearly amortised in the long term through the reduction of energy costs.

Jointly with IWU (Institut Wohnen und Umwelt) the programme has developed a model allowing the estimation of energy savings out of a variety of measures in individual buildings in using a limited number of building-specific data that can be collected through surveys. The model includes a typology of buildings as well as external parameters like temperature profiles which are country-specific. Currently the model is calibrated for Germany but it might be possible to recalibrate it for other countries as well. The advantage of the model is that it allows an energetic profiling on the level of each single building (probably

required under JI) without the need to do (probably prohibitively expensive) individual energy audits.

The KfW programme was also successful in drawing public attention towards building modernisation with energy-efficient measures (Korytarova 2006).

One of the key success factors is a widespread and **well-targeted information dissemination** with the help of private banks, which onlend the KfW loans to private households and housing companies, together with the **reduced interest rates** and other favourable loan conditions (such as grace periods etc.). The large variety of modules of the KfW programmes and the possibility of combining the loans from several modules allowed most of the refurbishment costs to be covered by cheap loans. Moreover, the implementation at the level of the federal KfW bank enabled transparent administration. Furthermore, experience shows that it is recommended to establish a goal based on an indicator such as CO₂ reduction per m², kWh reduction per square metre etc. Lastly, the support for building refurbishment should be developed in two parallel paths: (i) support in the form of single measures (replacement of windows, ceiling insulation, boiler replacement, etc.), and (ii) complex refurbishment. Such parallel attempt would motivate both tenants and building owners to improve energy efficiency in buildings (Korytarova 2006).⁷⁸

8.3.2 Business model and institutional requirements

Building on the lessons learnt from the building refurbishment programmes described above, a PoA business model for this category is conceptualised in Figure 7. Other options regarding the different actors and their roles and responsibilities are possible. That depends on local interests and circumstances. The development of the business model should be oriented towards the core competencies of the different actors, especially the core interests and strengths of the PoA coordinator.

⁷⁸ For more information please refer to www.kfw.de.

The figure summarises the key actors and their responsibilities.

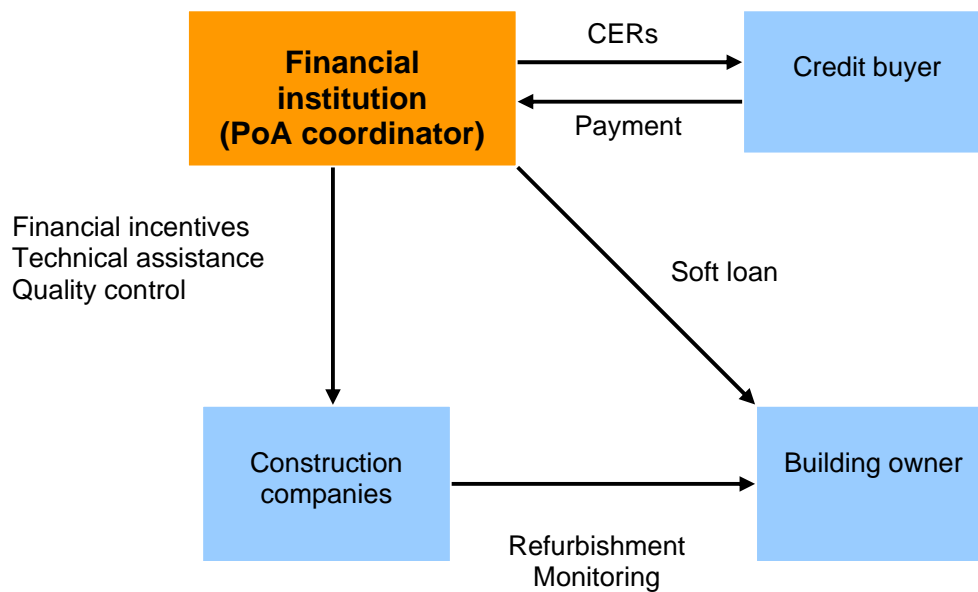


Figure 7: Building refurbishment programme business model example

The model is developed so as to overcome the barriers to building refurbishment in the following manner:

- Technological barrier - Training, certification, and licensing for construction companies as well as necessary equipment financing create an enabling environment for the construction companies to expand their expertise to address the building problems as complex systems.
- Initial cost barrier - Provision of soft loans to building owners helps create affordable finance to pay the costs associated with recommended building refurbishment measures.
- Information/behaviour barrier - Consumer education by the PoA coordinator helps create lasting demand and transform the market.

Aim of the PoA: The aim of the PoA is to enhance the energy efficiency of existing residential and/or commercial buildings by aggregating the often highly fragmented and specialised building refurbishment contractor market, and providing building owners with soft loans and education to create sustainable demand for the market.

Target group: Residential and/or commercial building owners. Strong market research should be conducted to identify key target segments by location or specific customer characteristics (e.g. high energy use) because the building refurbishment is very heterogeneous.

Managing entity: The PoA coordinator is a financial institution with strong technical and marketing skills in building refurbishment. Consider engaging one

or a panel of experienced construction companies to provide necessary technical assistance to participating construction companies (Thorne and Nadel 2003).

As the PoA coordinator, the financial institution shall provide financial incentives and – when necessary – technical assistance to the construction companies, and consumer education and soft loans to the building owners. It is also important to lead the marketing activities as construction companies often lack the marketing and sales skills or do not have the appropriate information to successfully sell their building refurbishment services (Thorne 2003).

Actors involved: Besides the financial institution and building owners, the business model involves construction companies to provide building refurbishment services and monitoring. In some cases utilities might also play a role in performing the monitoring. In order to facilitate the effective participation of construction companies, one may also consider involving an association of construction companies. Normally, such an association not only serves as an outlet for training and networking among their members, but also supports professional development activities such as certification programmes (Thorne 2003). Therefore, it can act as an effective coordinator of the construction companies.

A challenge to the programme could be maintaining the participation of construction companies during the busy months (e.g. summer). To encourage ongoing participation during the busy months, a sales incentive payable to the contractor can be introduced to give incentives for the time spent on selling the programme and bringing in sub-contractors to perform additional work (i.e. referral incentive). Also, it is a common challenge for many programme coordinators to engage small construction companies (Thorne 2003).

Programme implementation:

- The initial planning phase should focus on market research to identify the key target segment, and develop effective strategies for the assignment of construction companies to reach the identified target segment. The programme should assign trained construction companies that not only know how to perform quality work, but also how to sell quality to consumers. It is also important to develop a plan for directing specialised marketing materials to these building owners. The marketing efforts can be backed up by coordinated referrals that make the transaction as simple as possible for the building owners (Thorne 2003). Soft loans are to be set as a key instrument of a programme, which enables building owners to afford the recommended building efficiency improvement measures.

- The investigation phase is to include a clear building energy analysis based on thorough assessment of the building and its energy usage patterns, and development of proposals for recommended improvement measures. Clear information on the recommended options, sub-contractors, and financing helps building owners through the decision-making process (Thorne 2003).
- The implementation phase requires technical assistance and financial incentives to the construction companies. In addition, marketing, consumer education, and soft loans to the targeted building owners also play an important role. The PoA coordinator could provide the construction companies with necessary training at discounted rates, equipment financing, sales incentives for job completion, and co-op advertising. Marketing of whole-facility refurbishment will likely be more difficult than a system-specific one, as it involves much higher costs and its consumer awareness is lower. In order to overcome this barrier, the PoA coordinator can develop customer outreach materials that educate building owners on the higher return on investment, attractive paybacks, and improved comfort associated with whole-facility refurbishment. The soft loans can also be adjusted to cover a greater portion of the incremental cost (Thorne 2003).
- Whether the programme is system-specific or whole-facility refurbishment, construction companies are best positioned for monitoring the energy savings. In system-specific refurbishment programmes, the energy savings achieved by each refurbishment measure have to be measured. In case of whole-facility refurbishment, it is more appropriate to determine energy savings by utility meters or whole building sub-meters. The data can be used to improve or optimise the operation of the equipment, thereby improving the benefit of the refurbishment measure itself (IPMVP 2002).

8.4 Carbon revenues and financial requirements

Building refurbishment measures are extremely diverse. Furthermore, a combination of different measures would lead to positive (or negative, if badly designed) synergy effects. Therefore, the energy savings and costs of each measure are not additive. Table 28 provides an overview of investment and O&M costs of different building refurbishment measures (N.B.: the figures are estimated for a Greek case study (Mirasgedis et al. 2004)).

Measure	Unit	Investment cost	O&M cost
Replacement of old diesel boilers (by diesel ones)	EUR/building	2,839	-
Replacement of old diesel boilers (by natural gas ones)	EUR/building	4,797	-
Regular inspection of boilers	EUR/building	-	103.5
Use of intelligent programmable controls	EUR/building	851	-
Use of thermostats in central heating boilers	EUR/unit	19.3	-
Insulation of external walls	EUR/m ²	34.8	-
Roof insulation	EUR/m ²	27.1	-
Sealing of openings	EUR/m ² of opening	5.8	-
Double glazed windows	EUR/m ² of opening	156	-
Use of low-energy bulbs	EUR/m ² of floor	1	-
Solar collectors	EUR/m ² of collector	290	2.9
External shading	EUR/m ² of shading component	24.2	-
Roof ventilators	EUR/unit	48	-
Replacement of old air conditioners	EUR/unit	676	-

Table 28: Investment and O&M costs of building refurbishment measures⁷⁹
Source: Mirasgedis et al. (2004)

Thorne (2003) roughly estimated energy savings from common building refurbishment measures, which are summarised in Table 29 (note the figures are estimated for a U.S. case study). Energy savings are highly dependent on the building construction and vintage, local climatic conditions, etc. Therefore, the figures must be handled carefully.

Measure	Annual energy savings
Air sealing (incl. insulation and window replacement)	20%
Duct repair and sealing	15%
HVAC equipment upgrade	20%
Improved HVAC installation practices	15%
Lighting and appliance upgrades	10%

Table 29: Energy savings of building refurbishment measures⁸⁰
Source: Thorne (2003)

⁷⁹ Note: Costs of individual measures are not additive. Costs are estimated for a Greek case study.

⁸⁰ Note: Energy savings from individual measures are not additive. Energy savings are estimated for a U.S. case study.

The highly heterogeneous nature of building refurbishment measures makes the assessment of financial requirements and carbon revenues extremely difficult. Therefore, the following analysis will focus on system-specific improvement of thermal performance, one of the most logical solutions in order to reduce a building's energy consumption (UNEP 2007).

8.4.1 Carbon revenues

The “Kuyasa low-cost urban housing energy upgrade project, Khayelitsha” (Kuyasa project) is the first registered project which applied AMS-II.E. It targets low-income households in Cape Town, South Africa, and introduces CFLs, SWHs, and ceiling insulation to improve building efficiency. The relevant component of our analysis is the installation of ceiling boards (9 mm rhino board – gypsum and cardboards) and sisalation (one-sided foil sandwiched fibre). Table 30 summarises key parameters for CER estimation from the ceiling insulation part of the project.

Number of households	Average insulation area per household [m ²]	Total insulation area [m ²]	Total annual energy savings [MWh]	Grid emission factor [tCO ₂ e/MWh]	Transmission & distribution loss [%]	Annual amount of CERs	Annual amount of CERs per m ²
2,309	30	69,270	3,106	0.89	10	3,041	0.044

Table 30: CER estimation of Kuyasa programme in South Africa (ceiling insulation only)

The CER potential depends on a number of factors. For example, the energy savings are dependent on thermal performance of the baseline and project ceiling equipment, meteorological data of the project location, physical dimension of the households, etc. Furthermore, the type of energy used for heating and/or cooling plays a key role in converting the energy savings into emission reductions. The households in the Kuyasa project consume grid electricity for heating, which is coal-dominant.

8.4.2 Financial requirements

The financial data were not made available in the Kuyasa PDD. Therefore, the following financial analysis is based on publicly available information, which may differ significantly from that of the Kuyasa project. According to CIS (2008), the ceiling insulation costs are estimated to be around EUR 11.7/m² in South Africa (including the material and installation costs). Once installed, the ceiling insulation will incur virtually no maintenance costs.

The monitoring costs are divided into labour and non-labour costs. Over the 10-year crediting period, the labour costs assume 500 person-days of local skilled staff for metering of energy usage (4 households per person-day), 50 person-days of experts for supervision of the monitoring process. These contribute to the annual monitoring costs. The upfront monitoring costs include development of a

database for recording monitoring parameters, installation of monitoring equipment in sample households, etc. The cost overview of the model project is given in Table 31. The analysis assumes a total ceiling insulation area of 69,270 m² (2,309 households with 30 m² each), an insulation lifetime of 21 years (crediting periods of 21 years are assumed), and a monitoring sample size of 200 households.

Cost components		Upfront (EUR)	Annual (EUR p.a.)
Fixed costs	Project design and CDM documentation	200,000	30,000
	Monitoring	14,000	1,800
	CDM fees	50,000	30,000
Variable costs	Ceiling insulation installation (incl. material costs)	11.7 per m ²	-
	Other costs	-	0.04 per m ²

Table 31: Overview of the estimated fixed and variable costs of the model ceiling insulation programme (nominal)⁸¹

For this specific example, the nominal costs of ceiling insulation per m² would thus reach EUR 15.50 upfront plus EUR 0.90 annually. In order to permit a successful promotion the project employs a soft loan instrument. The low-interest loans are offered to households with a payback period of five years and an interest rate of 7%⁸². The above assumptions generate the following attractiveness table.

Annual CERs per m ²	CER minimum price for break-even (EUR)	CER price for IRR of 15% (EUR)
0.088	12.2	15.6
0.044	24.4	31.2
0.022	48.7	62.4

Table 32: Indicative level of CER prices and CERs per m² required for break-even and IRR of 15 %⁸³

The financial information of the model project allows for the calculation of the critical project size to achieve financial viability. The following CER revenue

⁸¹ Note: Total insulation area of 69,270 m² (2,309 households with 30 m² each); Insulation lifetime of over 21 years (crediting period of 21 years assumed); monitoring sample size of 200 households. The CDM methodologies require the monitoring only in the sample households. It is assumed in this report that the sample size is 200 households, so the monitoring costs are considered fixed.

⁸² The interest rate is to be lower than an average market interest rate for individuals. For the model calculation an interest rate of 7% is assumed. However, the loan conditions to be offered depend on the financial institution involved and the regional circumstances. The difference between the average market interest rate for individuals and the low interest rate may be considered as the programme subsidy. If the average market interest rate is 10%, the total programme subsidy over the 5-year payback period would be about EUR 97,000.

⁸³ Note: Discount rate of 10% for the calculation of the break-even.

levels are considered for the analysis, assuming a CER price of EUR 12 and the annual CER per m² of 0.022, 0.044 and 0.088. Based on the three scenarios for the CER revenue per CFL, the critical project sizes for the break-even and IRR of 15% are summarised in Table 33.

Annual CERs per m ²	Critical size (insulation area in m ²)	
	Break-even	IRR of 15%
0.088	70,000	88,000
0.044	117,000	159,000
0.022	175,000	265,000

Table 33: Critical size of a ceiling insulation programme for the break-even and IRR of 15%⁸⁴

Key points and challenges

1. Worldwide 30%-40% of all primary energy is used in residential and public buildings. Reducing energy consumption and contributing to GHG-reductions in residential areas can mitigate these emissions.
2. In many cases, high initial costs for the end-users and lack of awareness are the main barriers to investment in building refurbishment.
3. The programmatic CDM could help overcome these barriers by providing additional revenues from the sale of CERs to finance loan subsidies or grants (e.g. via a rebate system) to private homeowners.
4. Costs
5. Key Challenge I is the complexity of the programme which encompasses various measures if whole-facility refurbishment is aimed at. PoA developers should consider a step-by-step approach to develop experience when entering in building refurbishment programmes.
6. Key Challenge II might be the need for financial transformation, e.g. seed funding for grants and subsidies to credit lines. That implies that the financial institution, a potential CER buyer or a private investor would need to take the various risks of the programme if no public institution could play a role.

⁸⁴ Note: Discount rate of 10% for the calculation of the break-even.

9. Conclusions

As we have seen in the former sections, the development of a Programme of Activity is a promising but nevertheless challenging attempt. Experiences made so far refer to programmes that have been conducted without the help of CDM revenues, so that this new approach presents the unique opportunity to commercialise programmes that were typically supported by public funds, either international or national.

Various challenges have to be tackled by programme developers. There are an unlimited number of variations in programme design. As stated in the introduction, the business models presented in this guidebook are proposals based on present knowledge and experience. It should be kept in mind that a PoA coordinator should well understand the key barriers to penetration of the concerned technology. The subsequent design should try to overcome these barrier(s) as efficiently and effectively as possible. Methodological choice, incentive instrument, organisational arrangements, etc. shall take into account lessons learnt from existing programmes. The programmatic approach offers flexibility, leaves room for creative solutions and thus provides great opportunities for scaling up the potential of the CDM/JI.

- A PoA is managed by a coordinator who has the responsibility for all CDM documentation, monitoring and distribution of CERs. A good coordinator can increase cost-effectiveness of the CDM project cycle through a centralised management structure, and/or integration of monitoring procedures into the normal business operation. As shown in the different business models, various actors may play a role in the PoA so that coordination efforts need to be undertaken frequently and efficiently. This means, however, that the institutional capacity of a PoA coordinator and its partner agencies has to be very strong. A successful programme implementation in the past is surely a helpful indicator to determine the own capacity to structure and implement a PoA in the future. Guidance and advice can be found with the national DNAs, international operating consultant firms in the CDM market, carbon credit buyers or development organisations.
- The right choice of the methodological approach is key to the successful programme implementation. A PoA can use SSC methodologies without any limit to the size of the PoA. As SSC methodologies are much simpler and more standardised, it makes more sense to go for a SSC-PoA whenever possible.

- Needless to say, the choice of incentives to mobilise projects under the PoA also plays a critical role in its implementation and financial viability. Furthermore, it is important to carry out capacity building and awareness raising on both the technology supply and demand sides of a PoA. On the supply side, training and quality control for providing the technology and to support its continued operation are very important. On the demand side, consumer education and targeted outreach are essential to create sustainable demand for the products offered by the PoA and to transform the market. Not all these requirements lead to costly additional work. Some of them can be integrated into the existing business infrastructure with marginal incremental costs.
- The need for seed funding will apply in many cases of programmes. If the PoA coordinator cannot prefinance the incentive at the beginning of the programme, he needs to look out for external funding from banks, carbon buyers or other parties. The development of a good business model and a good presentation of the special features and possibilities of the programme will help to attract institutions which can prefinance the gap to finance the incentive at the beginning of the programme. Nevertheless, the prevailing challenge is that a decent risk assessment is quite difficult to undertake given the uncertainties in the market and the limited existing experience. Yet the interest to prefinance the seed funding exists although the bulk of it might stay in the initial phase with public funds or socially responsible capital investors.

The development of programmatic CDM is a success in the CDM history and represents a substantial change in direction. It addresses sustainable change in customs and habits of the different sectors and the whole society and tries to incentivise a low carbon future which is necessary to save our planet. It includes countries as possible participants in the carbon market that were not integrated yet. It gives a variety of actors such as banks, utilities, private enterprises and public agencies the opportunity to develop their own ideas to reduce GHG emissions and to market these emissions.

This guidebook presents only six key types of PoAs – energy-efficient lighting for households, improved biomass stoves, biodigesters for small farmers, solar water heaters, refurbishment of industrial boilers and improvement of building energy efficiency. PoAs can and should be set up for all kinds of CDM projects and can lead to changes in the daily lives of all participants. The potential is there, let us tap it.

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