Sumario

ANEXO A. MANUAL DE CONSTRUCCIÓN DEL DIGESTOR TUBULAR DE PLÁSTICO ____ 3

ANEXO B. MECANISMO DE DESARROLLO LIMPIO EN EL CASO DE DIGESTORES RURALES ____ 21

Anexo A. Manual de construcción del digestor tubular de plástico[1]

[1] Manual preparado para el GRUPO de Apoyo al Sector Rural de la Pontificia Universidad Católica del Perú

El digestor tubular de plástico

La mayoría de los digestores rurales que se han construido en el mundo pertenecen a dos tipos: el sistema de cubierta flotante desarrollado en India y el sistema de desplazamiento de líquidos desarrollado en China.
El costo relativamente alto de estos sistemas, y el hecho de que su construcción sólo puede ser realizada con éxito por técnicos calificados, han sido los mayores impedimentos para su adopción generalizada. En casi todos los lugares en los que estos sistemas han sido introducidos, en general han sido subsidiados por los gobiernos o por organismos de ayuda.
El biodigestor de manga de polietileno es una tecnología más económica y simple, que permite a los agricultores de pequeña escala producir gas. Es atractiva para los habitantes del campo debido a su bajo costo de instalación, así como a la mejora en la calidad del ambiente que resulta de su uso. Puede ser utilizado en zonas rurales o urbanas, tanto en lugares planos como donde el paisaje es accidentado.

El precio de los materiales de un sistema completo (digestor de 5 m3, tuberías, tanque de almacén, quemadores) se acerca a los 350 nuevos soles.

Su vida útil es determinada por la durada de las laminas de plástico, pudiendo llegar a los 4 años, después de los cuales se cambiaran solamente las mangas (aproximadamente con un gasto de 150 soles) y teniendo así un nuevo digestor.

El digestor es constituido por 2 o 3 largas mangas de plástico, encajadas una dentro la otra, con los extremos envueltos alrededor de dos tubos que servirán para la carga y descarga diaria del sustrato y del biol respectivamente. En la parte superior de la manga se abrirá una válvula para la salida del gas producido.

La naturaleza relativamente frágil de las láminas de polietileno es un punto débil del sistema y su modo de operación es relativamente ineficiente si se compara con el de otros biodigestores más sofisticados: ausencia de agitación, ausencia de calefacción externa, bajas presiones admisibles. Sin embargo, también en comparación con otros sistemas, el precio de construcción del biodigestor de manga de polietileno es muy bajo, como son los requerimientos de habilidades necesarias para construirlo.

Instalación

Las operaciones que permiten construir el digestor son sencillas. Dos personas pueden realizar enteramente la instalación en menos de una semana.

Acumular el estiércol

Antes de empezar la construcción del digestor, hay que empezar la recogida diaria del estiércol y acumular así una cantidad suficiente para la primera carga. Se acumula el estiércol en una zona sombreada y se deja cubierto.

Elegir el lugar

El primer paso antes de instalar el biodigestor es identificar la ubicación más adecuada.
Una buena regla dice que **el biodigestor pertenece al establo y no a la cocina**. Entonces este deberá estar cerca del corral del ganado donde se producen los desechos. Es una ventaja si los desechos del corral pueden ser escurridos con agua y luego, por gravedad, hacer que fluyan directamente hasta la entrada del biodigestor. Es relativamente económica una tubería larga para el biogás, pero difícil y tedioso transportar diariamente los desechos del establo hasta el digestor.

La instalación será posible solo se la familia tiene acceso a una fuente de agua suficiente para preparar la mezcla.

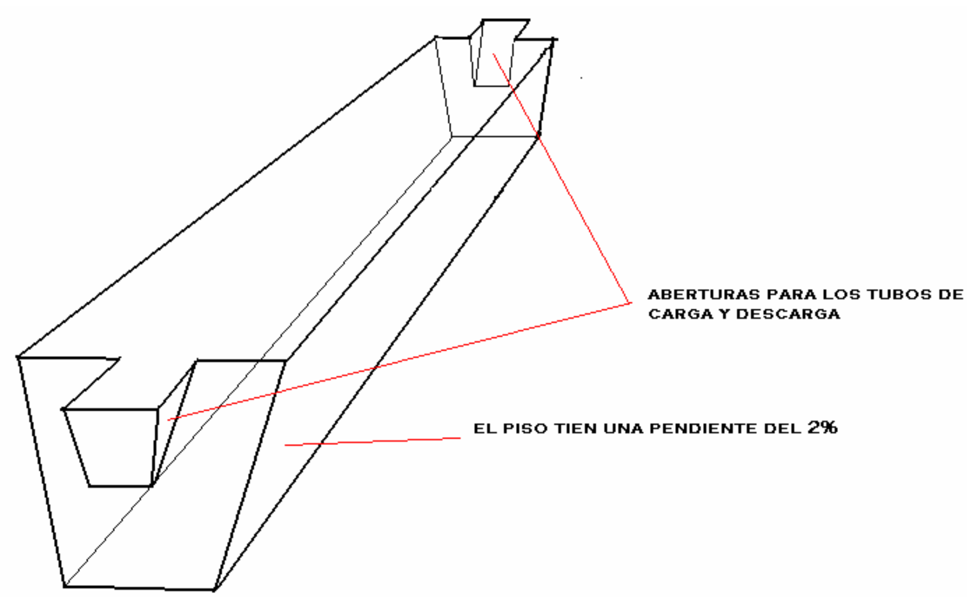
Otras reglas nacen cuando pensamos a la manera de usar el biol. Lo que aquí se quiere es que el transporte del biol del digestor a la zona de utilizo sea lo más breve y lo menos fatigoso. Por esta razón es bueno tener cultivos o pozas de crianza de peces cerca del digestor.
Lo mejor sería que el espacio donde se acumula el biol sea más elevado que su zona de utilizo, en manera tal que se pueda distribuir el biol por gravedad, mediante canales o un sistema de riego.

Hay que controlar que en el sitio escogido no se acumule agua en los días de lluvia. Cuando grandes cantidades de agua entran en el suelo alrededor del digestor se debilita el suelo, y las paredes de la fosa podrían perder estabilidad. Además la lluvia enfría el sustrato dentro del digestor, causando una disminución en la producción de biogás.

No deberían haber árboles demasiado cerca al digestor. Las raíces podrían destruir la lámina. Árboles viejos podrían caerle encima. Y también, si el área circunstante es demasiado sombreada entonces la temperatura del terreno será generalmente baja: esto conduce a una disminución en la producción de biogás.

Excavar la fosa

La bolsa de plástico necesita una estructura que la contenga y la proteja. Por esta razón se excava una fosa adaptada a las dimensiones del digestor.
Al cavar la zanja es importante considerar que los lados y el piso deben ser lisos, sin piedras o raíces que sobresalgan y puedan dañar la lámina de plástico. Los lados deberán ser inclinados para evitar que la zanja colapse. El suelo deberá tener una ligera pendiente para permitir el flujo continuo de estiércol líquido a lo largo del biodigestor (es buena una pendiente del 2%). La tierra que se saca de la zanja deberá ser llevada lejos de los bordes, de manera que no caiga sobre el plástico a causa de movimientos alrededor del biodigestor o por las lluvias.



Esquema de cómo debería ser excavada la fosa. Son presentes también los espacios que serán ocupados por los tubos de carga y descarga: se abren dos pequeñas zanjas a partir de la mitad de la pared, con una inclinación aproximadamente de 45º.

En comercio se encuentran mangas de plástico de diferente anchura, dando diferentes diámetros de la bolsa. Están comercializadas mangas con ancho de 60 cm, 1m, 1.5 m, 2 m, que corresponden a diámetros de 38.2 cm, 63.7 cm, 95.5 cm, 1.27 m.
Precedentemente se habrá calculado el valor del volumen del digestor. Ahora para cada tipo de manga tendremos un diferente valor de largo. Hay que escoger una manga en manera tal que la relación entre largo y diámetro del digestor sea entre 5:1 y 10:1

- Volúmenes del digestor inferior a 300 l -> manga de 60 cm (digestores de prueba)
- entre 300 l y 2000 l -> manga de 1m de ancho
- entre 2000 l y 5500 l -> manga de 1.5 m de ancho
- mayor de 5500 l -> manga de 2 m de ancho

A este punto se puede cavar la zanja, siguiendo estas recomendaciones:

- el ancho en la parte superior de la zanja sea igual al diámetro de la bolsa;
- el ancho en la parte inferior de la zanja sea el 80 % del ancho superior;
- la profundidad sea el 90 % del diámetro de la bolsa;
- el largo será igual al largo del digestor.

Ejemplo: queremos un digestor del volumen de 5 m3. Entonces escogemos una manga de 1.5 m de ancho (diámetro 95.5 cm). El largo del digestor será:

$5 / (0.955^2 / 4 * 3.14) = 7$ m

Excavaremos una fosa larga 7 m, con una profundidad de 0.9*95.5 = 86 cm, con un ancho en la parte superior de 95.5 cm y en la parte inferior de 0.8*95.5 = 76.4 cm
El piso de la fosa debe tener una pendencia del 2%, es decir habrá una diferencia de 7*0.02 = 0.14 m = 14 cm entre las profundidades de la fosa en los dos extremos. Entonces la profundidad de la fosa pasará de 79 cm a 93 cm entre un extremo y el otro.

Fosa acabada de excavar. Todavía faltan los espacios por donde pasarán los tubos de carga y descarga (en la foto pintados en rojo).

Materiales necesarios para construir el digestor

Hay que prestar particular cuidado al momento de la compra de la manga de plástico. En el caso se prevea construir diferentes digestores a lo largo del tiempo, la mejor elección es comprar un rollo entero de plástico, directamente a la fábrica: nos aseguramos su buena calidad.

En el caso se compre una pequeña cantidad, siempre hay que verificar la integridad del plástico: ausencia de huecos, de rasguñas… muchas veces los revendedores almacenan el plástico en posición vertical, dañando en manera irreversible los bordes de la manga.
Siempre escogemos el plástico que tenga el mayor grosor: al menos 200-250 microns. El más apropiado es el plástico que se usa para los invernaderos (agrofilm), que tiene un filtro para las ultravioletas, aumentando así la durada del plástico cuándo este está expuesto al sol. Solo se encuentra en mangas de 2 m de ancho.

Qué cantidad (largo) de plástico compramos? Obviamente una cantidad superior al largo de la fosa, ya que una parte del plástico es necesaria para permitir el amarre sobre los tubos.
Aproximadamente la cantidad justa para una dada fosa es:

Largo de la manga a comprar = Largo de la fosa + Diámetro de la manga + 80 cm

Multiplicar esta cantidad por el número de mangas insertada una dentro la otra

Si por ejemplo tenemos una fosa de 10 m de largo, con una manga de 2 m de ancho (diámetro 1.27 m), calculemos

10 m + 1.27 m + 0.8 m = 12.07 m

Si usamos agrofilm será suficiente usar dos mangas insertadas, entonces:

Largo total de plástico a comprar = 2 * 12.07 m = 24.14 m

En el caso de plástico de menor grosor se aconseja poner 3 mangas insertadas (total = 36.21 m).

Entonces el material necesario será:

- Manga de plástico transparente, largo y diámetro dependientes del volumen del digestor. El grosor (calibro) debería ser lo mayor posible. Se aconseja de usar un plástico transparente para permitir que los rayos solares puedan penetrar mejor al interior de la bolsa, calentando así parte del sustrato. Se construimos el digestor en climas calidos, se pueden usar también plásticos opacos.
- Manga de plástico, de cualquier tipo pero con buen grosor, para el almacén del gas. Largo y diámetro dependiendo del volumen del almacén.
- 2 tubos de plástico, cerámica o concreto. El largo será 1.25 veces el diámetro de la manga. El diámetro superior a las 4 pulgadas (10 cm). El tubo de plástico es el más fácil de manejar, pero el menos resistente (con el tiempo y el sol se puede deformar).

- Manguera de plástico o tubería de PVC para el transporte del gas (el largo depende de la distancia hasta la cocina). La tubería tiene mayor resistencia y menor riesgo de fugas, pero mayor coste. Diámetro de ¾”.
- 1 unión macho en PVC de ¾” de diámetro.
- 1 unión hembra en PVC de ¾” de diámetro.
- 1 te en PVC de ¾” de diámetro.
- Codos, en número suficiente para conducir el gas hasta la cocina.
- 1 frasco de pegamiento para tubos de PVC.
- 3 llaves de paso en PVC de ¾”, completas con sus uniones.
- 2 arandelas, preferiblemente en plástico, con agujero central de ¾” para permitir el ingreso en toda su longitud de la rosca del macho en PVC. Su diámetro total debe ser cerca 10 cm y su grosor cerca 3 mm. Se pueden fabricar utilizando el plástico de un balde (que sea plano y sin relieves). Se obtiene un disco circular, y mediante un tubo de hierro calentado se hace un hueco en el centro.
- 2 empaques obtenidos de una llanta usada, ligeramente más grandes que las arandelas de plástico, y igualmente con el hueco central para permitir la entrad ajustada del macho. Si el grosor de la llanta es inferior a los 2 mm, sacar 4 empaques.
- Correas de neumático usado, de 5 cm de ancho y largo total de al menos 10 metros. Serán suficientes dos llantas de camión o tres de carro. No usar llantas de bicicletas, ni de moto, porque no son suficientemente resistentes.
- 1 botella de plástico transparente de al menos 2 litros de capacidad.

Insertar las mangas de plástico

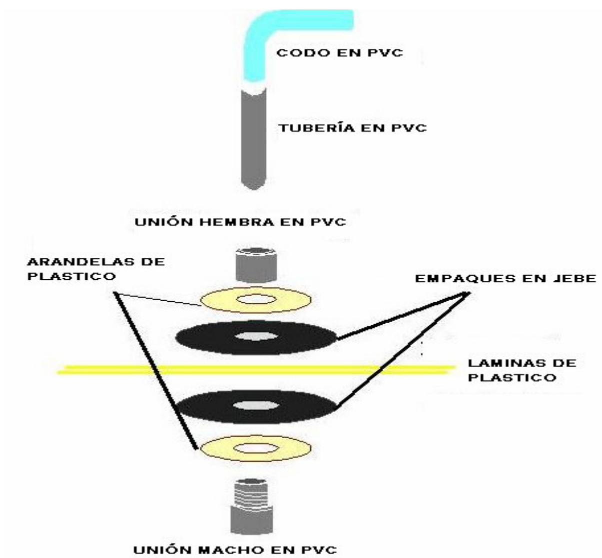
Toda lo operación de montaje debe ser ejecutada en un sitio amplio, plano y sin ningún tipo de asperidad que pueda dañar el plástico.

Primero se insertan las 2 o 3 mangas una dentro la otra. Para facilitar la operación se puede amarrar un largo tubo a un extremo de una manga, insertarlo y hacer en manera tal que salga por el otro extremo de la manga externa. O sino entrar arrodillados y descalzos dentro de la manga y transportar hasta el otro extremo el otro pedazo. En ambos casos debe asegurarse que las mangas encajen de manera ajustada, sin dobleces ni arrugas.

Insertando una manga dentro la otra

Instalar la salida del gas

Se marca sobre el plástico el punto donde se instalará la salida del gas. De este punto al extremo de la manga habrá una distancia igual al 20% del largo de la manga.



Entonces se introduce el brazo por la abertura de la bolsa, se localiza con la mano el punto recién marcado, se presiona con un dedo y desde el externo de la bolsa se corta el plástico, procurando de hacer un pequeño hueco circular a través del cual pasará de manera ajustada la unión macho. Atención a no hacer

el hueco demasiado grande, mejor hacerlo más pequeño y arreglarlo sucesivamente.
Luego insertamos desde adentro y hacia afuera la rosca de la unión macho, a la cual se le ha insertado previamente la arandela de plástico y posteriormente el empaque de jebe.
Una vez pasada la rosca al exterior de la bolsa, se enrosca la unión hembra igualmente completa con la arandela y el empaque. Enroscar con fuerza.

Instalando la salida del gas. Una persona dentro a la bolsa ayuda a que se cierren las uniones con más fuerza.

La salida del gas completada.

Instalar la tubería de entrada

Se cortan bandas de jebe de 5 cm de ancho de las cámaras usadas. Se introduce la tubería PVC (u otro material) en la manga de polietileno: la parte del tubo dentro de la manga será aprox.:

Largo = 30 cm + radio de la bolsa

Luego se dobla la manga de plástico alrededor del tubo. La unión se asegura envolviendo las bandas de jebe alrededor de la tubería de cerámica, empezando a 40 cm del extremo del plástico y trabajando en dirección a la parte expuesta de la tubería, con cada banda traslapada sobre la anterior y terminando en el tubo de manera que los extremos del plástico estén completamente cubiertos.

Doblando el plástico

Asegurando con jebe.

Válvula de seguridad

Es un elemento fundamental del sistema. Para asegurar que la presión de gas dentro del biodigestor no aumente demasiado es importante contar con un mecanismo de escape del gas, aliviando así la presión. Este puede ser fabricado con facilidad a partir de una botella de plástico parcialmente llena de agua.

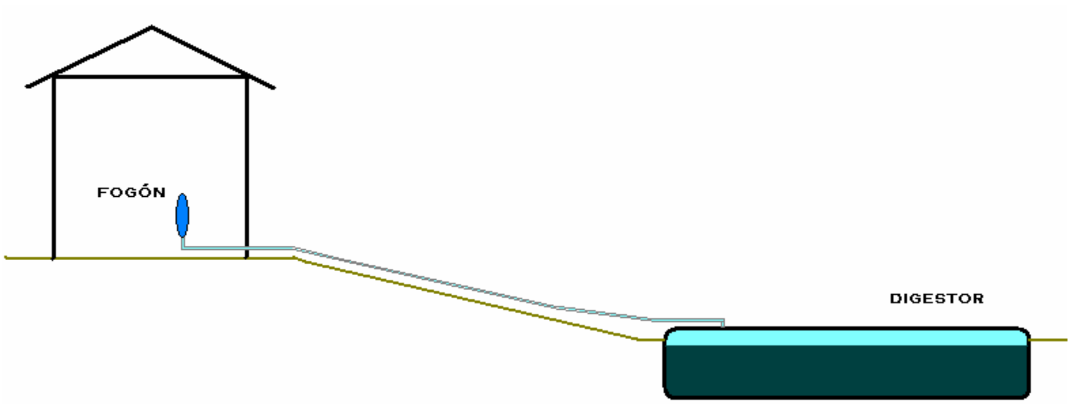
Válvula seguridad

Se inserta una te en la tubería que lleva el gas a la cocina, se agrega un pedazo de tubo de 15 - 20 cm de largo que se insertará en la botella. Los otros dos

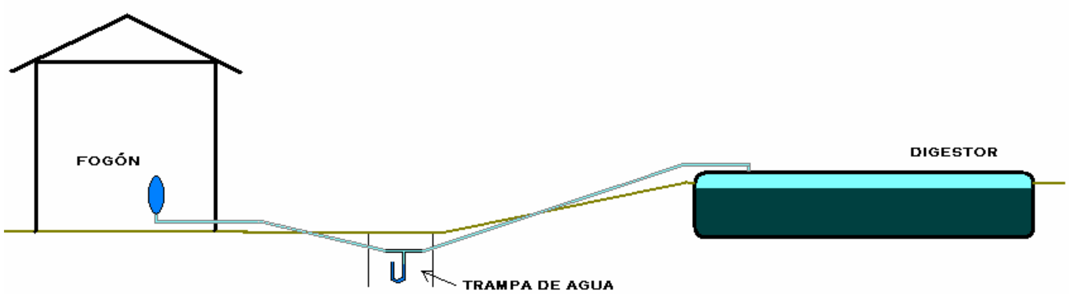
extremos superiores de la te son conectados al tubo proveniente del biodigestor y a lo que va hacia lo cocina.
La botella debe tener una apertura por donde versar nueva agua cuando el nivel de esta se haya bajado. También se hacen uno pequeños huecos aproximadamente a la mitad de la botella, para evitar que suba demasiado el nivel del agua (por ejemplo a causa de la lluvia).
Entonces se introduce el tubo dentro la botella de agua, de tal manera que penetre en el agua aproximadamente tres centímetros. La botella puede fijarse sobre un muro o amarrándola a un palo suficientemente alto (aprox. 1.50 m) de manera que sea posible observar con facilidad el nivel del agua y volverla a llenar cuando sea necesario.
Si el nivel baja demasiado entonces el gas se escapará con mucha facilidad (se ven burbujas dentro de la botella). Si la parte de tubo sumergida supera los 5 cm. entonces la presión dentro el digestor será demasiado alta: difícilmente explotará, pero el plástico será sometido a un esfuerzo que le disminuirá su vida.

Trampa de agua

Solamente se instala en algunos casos, dependiendo del recorrido que hacen las tuberías que conductoras de biogás.
El biogás que sale del digestor está saturo de vapor de agua. El gas que se mueve a través de las tuberías podría enfriarse, y el vapor en ello contenido condensarse.



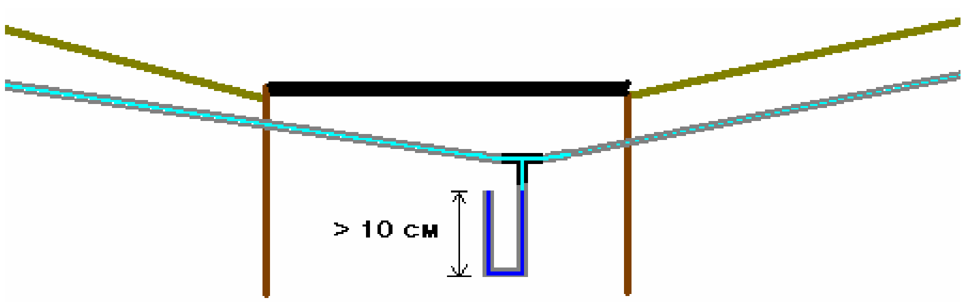
El recorrido de las tuberías es ascendiente. El eventual condensado vuelve al digestor.



En este caso en el recorrido de la tubería hay un punto más bajo en el cual se acumularía el agua que ha condensado: con el tiempo el agua acumulada bloquearía el paso al gas. Para evitar este problema se instala la trampa de agua, propio en el punto más bajo.

Primeramente se pone una te en el punto más bajo de la tubería. Este punto puede encontrarse bajo tierra como no. Luego se puede completar la te en dos maneras distintas.

- se puede construir un mecanismo similar a la válvula de escape, con un tubo que entra dentro de una botella llena de agua. Aquí el tubo se puede sumergir por más de tres cm.
- Diversamente, se completa la te con un tubo a U, construido con dos codos, como en el dibujo. El extremo abierto de la U debe ser lleno de agua.



Ejemplo de trampa a U. Las tuberías viajan bajo el suelo y se pone la trampa en una caja con cubierta.

Trampa de agua. Las tuberías están enterradas.

Instalar la tubería de salida y llenar el digestor con aire

Se instala la segunda tubería siguiendo el mismo procedimiento que el usado para la tubería de entrada.

Luego, antes de colocar el biodigestor ya terminado en la zanja, es necesario llenar la manga de aire.
La tubería de entrada y la salida del gas se cierran con una película de plástico (o una bolsa de plástico) y bandas de jebe. Se ata con jebe a la tubería de salida otro pedazo de manga, por ejemplo la que se usará par construir el almacén del biogas. Se fuerza el aire hacia el interior de este nuevo pedazo de manga mediante olas creadas al agitar el extremo de la manga con un movimiento propulsor de los brazos hacia adelante. Luego se empuja este aire dentro la bolsa del digestor. Se repite la operación varias veces hasta que la bolsa esté bien inflada, evitando que al mismo tiempo el aire salga del digestor.

Secuencia de las operaciones para llenar el digestor con aire. El digestor aparece a le izquierda en la primera foto.

Otra manera es la siguiente. Se cierran los dos tubos de entrada y salida y se conecta la salida del gas al escape de un cualquier motor, por el tiempo necesario para llenar la bolsa completamente. Como conexión entre el motor y la bolsa se puede usar una manguera y mojarla continuamente para evitar que se derrita, mientras que en el humo del motor se introducirá un tubo de hierro, bien amarrado a la manguera con correas de jebe.

Llenar el digestor es una operación importante:

- Viendo el digestor inflado y bien formado, nos aseguramos de haber hecho un buen trabajo. Se pone el digestor inflado en la zanja, y si las dimensiones no fueran justas, se puede intentar arreglar el error.
- Poner la bolsa vacía dentro de la zanja, y así empezar a llenar con el sustrato es una operación desaconsejada. El digestor podría doblarse sobre si mismo, se pueden formar arrugas, y solo al final nos daríamos cuenta si las dimensiones del digestor coinciden con las de la zanja. Cualquier error a este punto no sería resoluble.
- Con el digestor lleno de aire se pueden detectar huecos y fugas (más fácilmente si se llena de humo). Si existe alguna fuga se puede sellar pegando al plástico un pedazo de llanta con pegamiento acrílico o terocal.

Llevando el digestor lleno de aire a la fosa

Colocar el biodigestor en la zanja

La manga ya inflada se carga hasta la zanja con mucho cuidado para que no entre en contacto con objetos filudos. Se le coloca dentro de la zanja de tal manera que el escape de gas esté en la parte superior de la manga, la entrada al extremo más alto de la zanja y la salida al extremo más bajo. Cuidado que las tuberías de entrada y salida queden bien situadas en los huecos de los extremos de la fosa.

Entonces se conecta la salida del gas a la tubería que llega hasta la cocina, procurando poner una llave de paso apenas después la salida del gas. Esta llave deberá estar siempre abierta, solo se cerrará cuando habrá que trabajar en otras partes de la instalación, evitando que el gas contenido en el digestor se escape en al zona de trabajo.

También se prepara un soporte que sujete a la tubería que sale verticalmente por el digestor.

Llenar el biodigestor con agua

El biodigestor se llena luego con agua hasta que las tuberías de entrada y salida estén selladas (cubiertas con agua) desde dentro. El aire que había adentro de la bolsa se quedará retenido en la parte superior.

Se hace un pequeño hueco en el plástico que cubre la tubería de entrada o salida, y a través de este se inserta la manguera del agua. A medida que se va llenando la bolsa, una parte del aire irá saliendo por la válvula de seguridad.

Al final las bolsas de plástico que cubrían las tuberías de entrada y de salida pueden ser retiradas.

Llenar el biodigestor con la materia orgánica

Se acaba de llenar el digestor con la mezcla de estiércol y agua. En la poza de entrada (o en un gran tacho) se mezcla cada balde de estiércol con un balde de agua, hasta obtener una mezcla homogénea. La primera carga puede resultar más diluida de los valores aconsejados para las cargas sucesivas.

Conectar el establo a la entrada del digestor

Si el establo está pavimentado, entonces se aconseja construir un canal que lleve los desechos, mezclados con el agua usada en la limpieza, directamente al digestor. Cuidado a no exagerar en las cantidades de agua utilizadas en la operación.

El digestor completo

El último paso en la construcción del digestor consiste en asegurar su seguridad. Se construye un recinto para que animales y niños no puedan dañar la lamina de plástico. Se cubre el digestor con algún tipo de techado para que no llegue la luz solar directa que disminuye la vida útil del plástico.
Si hay peligro que el agua de la lluvia pueda correr hacia la fosa, hace falta excavar zanjas que la lleven en otro sitio.

El tanque de gas

Es una bolsa plástica grande hecha con la misma manga de lámina de polietileno utilizada para fabricar el biodigestor.
Su volumen debería ser suficiente para acumular el gas producido diariamente. Un tercio del volumen del digestor es una medida razonable.
Una parte de la manga se cierra usando correas de jebe. En el otro extremo se pondrá una te completa con un pedazo de tubo de aprox. 30 cm. Se pone este tubo dentro la manga se asegura con jebe, y lo se conecta al conducto del gas mediante una te.

El tanque cumple una función clave en el funcionamiento del biodigestor y deberá ser ubicado en un lugar conveniente cerca de la cocina. El gas almacenado

estará así cerca del punto de utilización, lo que permitirá que tenga una presión más alta. Por esta razón hay que tener una manera pare incrementar la presión del gas dentro el tanque.
Por ejemplo se coloca una faja alrededor de la parte media del tanque. El aumento de presión se realiza ajustando la faja (por ejemplo: colgando una piedra o ladrillo de uno de los extremos de la faja).
Otra manera sería poner pesos sobre la bolsa, come se ve en al foto, con los pesos que cuelgan desde el techo mediante poleas.

El marco metálico mediante poleas baja encima de la bolsa, aumentando su presión. La presión se puede aumentar apoyando piedras encima del marco.

El tanque va colocado en una zona segura, sin niños, sin animales, limpia, sombreada. No ponerlo en la cocina o en otros espacios cerrados, para evitar que se acumule gas en el caso de fugas.

Además hay que poner dos llaves de paso:
- una antes del quemador: servirá par abrir y cerrar el gas durante la cocción.
- una antes del tanque: será siempre abierta, y solo se cerrará cuando habrá que trabajar en el tramo de tubería entre el digestor y el tanque, para evitar que se pierda el gas contenido dentro el tanque.

Anexo B. Mecanismo de desarrollo limpio en el caso de digestores rurales

Abstract Domestic biogas and CDM financing; perfect match or white elephant

That sustainable energy supply and (agricultural) production methodologies, at any level, will become a critical factor in sustainable development is steadily becoming mainstream global awareness. Biogas technology for rural farming households would have the potential to fit into this picture in a modest but significant manner. To play this role, dissemination of domestic biogas would need up-scaling far beyond what currently is happening in most countries.

For selected countries in Asia, the Netherlands' Asia Biogas Programme aims to support large-scale dissemination of domestic biogas. In view of the significant investment costs (~ € 200 to € 400) for a high-quality biogas plant, one of the challenges the programme faces is the limited purchasing power of otherwise prospective client households and, not unrelated, the limited access for these clients to appropriate credit.

The Clean Development Mechanism could play a role in bridging this financial gap. Domestic biogas plants contribute to the reduction of greenhouse gasses for which –potentially- the CDM offers the opportunity of additional revenue. However, the match between large-scale biogas dissemination projects and the CDM seems a cumbersome one.

In this paper the outline of such a large scale biogas programme (BP II in Vietnam) is discussed in relation with CDM financing. Without claiming to be exhaustive, the paper attempts to explain the "origins" of greenhouse gas reduction by domestic biogas plants and the potential and actual CDM revenue that would result from this. Subsequently, the paper presents the modality to apply this CDM revenue in the biogas programme and its impact on the "finance gap" for the participating households. Finally, the monitoring requirements for the programme, related with the CDM are briefly mentioned.

In summary, the paper concludes that:

- Application of domestic biogas has many economic, environmental, health and social benefits and contributes to sustainable development.
- The GHG reduction potential of domestic biogas plants can be significant (5 tCO_2-eq per plant per year), but that the actual reduction will heavily depend on the local situation related to manure management practices and domestic fuel use.
- The potential CDM revenue for domestic biogas programmes can be equally significant. However, if this revenue is required as a financing mechanism for investment subsidy, the amount will –at least for now- be limited by the duration of the first commitment period of the Kyoto Protocol.
- Although CDM revenue thus will not fully bridge the "finance gap", the paper shows that CDM could reasonably contribute to making the investment more interesting to the household.
- The current CDM methodologies for small-scale projects seem to be inflexible and may hinder the poor from reaping maximally the benefits of CDM, especially with respect to the large scale dissemination of small scale technology.

Paper by:
Felix ter Heegde,
Netherlands Development Organization
CTA Biogas Project Vietnam
Biogas Project Office,
R 104, Bldg 2G, Van Phuc Diplomatic Compound,
298 Kim Ma, Ba Dinh, Ha Noi,
Vietnam.
Email: felix@biogas.org.vn

and:
Ivo Besselink
Netherlands Development Organization
PO Box 9781
Nongbone Road Vientiane
Lao PDR
ibesselink@snvworld.org

1. Introduction

One (not necessarily the only) important stumbling block for large-scale dissemination of domestic biogas, particularly in poorer rural areas, is the combination of the significant upfront investment for the installation with the limited access to financing opportunities for farmers. Subsidy schemes as e.g. practiced by the biogas programmes in Nepal and Vietnam, can only go so far; besides being under constant attack of the "sustainability argument", subsidy schemes still leave some 75% of the investment to be covered by the farmer. And then again, only to a certain extent and often against high transaction costs can this "finance gap" be filled by formal banks, micro-finance institutions and the informal banking sector. As a result, proper quality domestic biogas plants often stay out of reach for the poorer segment of our target group.

The Kyoto Protocol provides the framework under which countries, in particular in the industrialized world, will work to reduce their emission of greenhouse gasses (GHG). The KP's main achievements include the setting of national emission reduction targets for industrialized countries (Annex 1 Parties) and the establishment of three mechanisms -Joint Implementation (JI), the Clean Development Mechanism (CDM) and the International Emission Trading (IET) - by which Parties can trade in emission permits.

Introducing GHG emission reduction trade between Annex 1 Parties (the buyers) and non-Annex 1 Parties (the sellers), the CDM aims to stimulate –on a voluntary basis- to reduce GHG emissions in non non-Annex 1 countries and simultaneously assist these countries in achieving sustainable development.

Domestic biogas in its own right contributes to sustainable development and –by the virtue of conventional fuel substitution and changing traditional manure management practices- reduces the emission of greenhouse gasses.

The biogas project office in Vietnam –not unlike its counterpart in Nepal- explores the opportunities of the **seemingly perfect match** between the **CDM** and large-scale **domestic biogas** dissemination as a solution for the "finance gap".

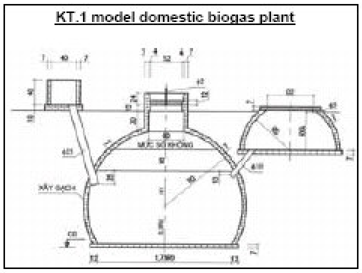
In chapter 2 of this paper the biogas programme in Vietnam is outlined. Chapter 3 elaborates on biogas and the reduction of greenhouse gases while in chapter 4 the other benefits of the biogas programme are outlined. Chapter 5 focuses on carbon–financing biogas programmes. In chapter 6 the present and acute challenges for biogas programmes in relation to CDM are described.

2 Domestic biogas in Vietnam

2.1 The Biogas Project phase I

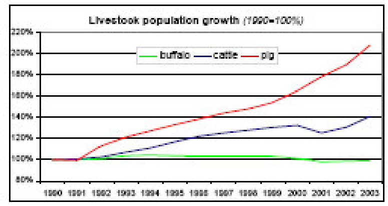
In January 2003, the Vietnamese and Netherlands Governments signed the Memorandum of Understanding for the implementation of a domestic biogas dissemination project in 10 provinces of Vietnam. The project –*"Support Project to the Biogas Programme for the Agricultural Sector in some Provinces in Vietnam"* or "BP I"- uniquely joins Vietnam's technical knowledge on plant design and construction with Netherlands' experience with large-scale dissemination of domestic biogas. The Netherlands' Directorate General for International Cooperation financially supports the project with a grant of –initially- US$ 2 million.

KT.1 model domestic biogas plant



The combination is successful; at an early stage the project expanded to 2 additional provinces and increased its target from 10,000 to 12,000 biogas plants. Even so, many more provinces had to be disappointed when they requested participation in the project. In July 2005, 6 months ahead of schedule, the project reached its numerical goal. In anticipation of a second phase, the Netherlands Government agreed to increase its grant with US$ 486,000 to fund the subsidy component for an additional 6000 installations, thus bringing the project target to 18,000 biogas plants by the end of January 2006.

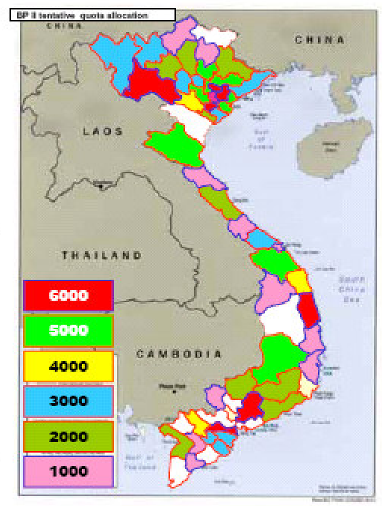
2.2 The potential for domestic biogas in Vietnam



The market potential for domestic biogas in Vietnam is large. Vietnam's animal husbandry sector is vibrant, expanding and for a large part managed in family farms. Farmers and government embrace solutions, including biogas plants, to reduce the environmental load of the sector.

Alternatives to substitute inefficient conventional domestic fuel sources are welcomed, as are opportunities to improve the nutrient management of the fields. With a rural population that –in general- is accessible and well educated, awareness travels fast. Out of the technical potential of 2 million installations, an "active" demand of 1 million domestic biogas plants seems a realistic estimate.

2.3 The Biogas Programme phase II



Encouraged by the results of the project and in view of the potential for domestic biogas in Vietnam, the Department of Agriculture of the Ministry of Agriculture and Rural Development (MARD/DA) and SNV- the Netherlands Development Organization (SNV) agreed on the joint development of a second –nation wide- phase for the biogas project.

In outline, the Biogas Programme phase II (BP II) aims to support construction of 180,000 domestic biogas plants in 58 provinces of Vietnam over a period of 5 years. The programme plans to start in February 2006, accommodating a smooth transfer of phase I.
In preparation of the second phase, the Department of Agriculture of the Ministry of Agriculture and Rural Development (MARD-DA) called for expression of interests for participation of the provinces. By June 2005, 51 out of Vietnam's 64 provinces (including the 12 provinces participating in the current first phase) had submitted their interest. Based on the provincial request and an assessment of the Biogas Programme Office (BPO), tentative production quotas have been allocated. The biogas absorption capacity[1] of provinces varies. Hence, provinces have been divided in six categories, with production targets ranging from 1000 to 6000

[1] Absorption capacity depends on population, livestock holding and holding patterns, accessibility, climate etc.

installations for the programme period.

2.4 BP II main features

The second phase of the programme seeks to ignite a lasting marketing drive and consumer demand for domestic biogas plants and to encourage high quality services to meet this demand.

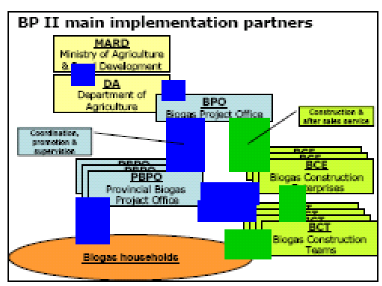
BP II main features include:

- *Building on past successes and lessons*: Using the experiences, structures, relationships and systems of BP I and the Nepal Biogas Programme, BP II will significantly upscale operations to facilitate the construction of 180 000 plants. BP II will also draw on the knowledge resources of a strong international biogas network in the form of SNV's Asia Biogas Programme and through relationships with other programmes in the region.
- *Creating a commercially viable sector*: Ultimately, successful dissemination of domestic biogas will to a large extent rely on the participation of the private sector. Therefore, BP II will place significant emphasis on the strengthening of private enterprise and market development.
- *Jump-starting provinces*: Over a period of 5 years, the programme will assist provinces to establish the full infrastructure necessary to support a market oriented biogas sector. After this period, provinces are expected to carry on biogas development under their own steam, whereby a national support structure will remain available.
- *Decentralized biogas-training centres*: The programme intends to support the establishment of three biogas training and reference centres over the country. These centres will not only train biogas masons and technicians, but will also act as support facilities (after Biogas Construction Enterprises and Biogas Technicians) for participating provinces and enterprises. These centres will be established through the development of partnerships with training and research institutes throughout the country.
- *Maximisation of biogas benefits*: BP II will put a renewed emphasis on the -varied and sometimes under utilised- benefits of biogas. This will be done by continuing research into slurry use, targeting disadvantaged households, improving stoves and other related technology, promoting the intangible (social) benefits, assessing the impact of biogas on women's lives and building on the benefits.
- *Innovative Financing Mechanisms*: There are four key elements to BP II's financing.
  - Anticipated Clean Development Mechanism (CDM) revenue to finance a loan that will -in turn- finance the subsidy scheme and part of the programme support costs at provincial level
  - Targeted subsidy levels to encourage participation and improve access to the programme for poorer people
  - Including direct financial and in-kind contributions from participating provinces
  - Developing biogas credit products to provide participants with accessible finance for building their plants at a competitive rate.

2.5 BP II main implementation partners

BP II, similar to the fist phase of the project, will be a joint venture between the *MARD/DA* and *SNV*[4]. SNV's support, technical and advisory assistance, will take place in the framework of the "Asia Biogas Programme"[iii]. This regional programme, a cooperation of the Netherlands Ministry of Development Cooperation and SNV, seeks to promote commercial deployment of domestic biogas.

The *Biogas Programme Office*, established for BP I, will continue to be responsible for the operational management of the programme. For the second phase, the BPO will obtain a legal status within the Ministry of Agriculture and Rural

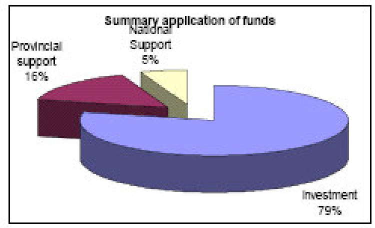


Development to better reflect an institutional set-up complying with the Paris Declaration on aid effectiveness.

At provincial level, the programme works through *"Provincial Biogas Programme Offices"* (PBPO) under the provincial Departments for Agriculture and Rural Development (DARDs). These PBPO's, will be responsible for supervision and coordination of programme activities at provincial level. Currently, over 51 provinces indicated their interest to participate in the programme's second phase.

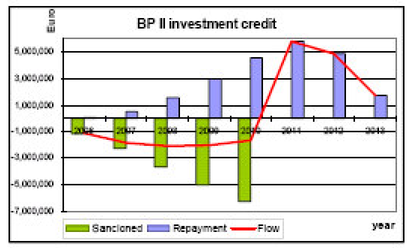
Biogas Construction Enterprises (BCEs), consisting of local *Biogas Construction Teams*[iii] (BCT), construct the biogas plants and provide after sales service. The programme aims to establish 2 BCEs in each district (~ 20 per province). Enterprises and teams will be trained and supported by the programme.

2.6 BP II programme costs.



Total tentative[2] programme costs amount to just over € 64.4 million[iv]. With an average investment of € 250 per plant[3], including accumulated investment financing costs[4], the total investment component results in € 50.8 million. Provincial support cost amount to € 10.2 million and National support costs to € 3.5 million.

The programme will assist farmers with an investment subsidy (average 24% of the total investment[5]). Independent from the size of the plant, the programme will provide three levels of subsidy, higher subsidy levels targeting poorer areas and under-privileged households. Similar to the practice under BP I, after testing and acceptance of the installation, subsidies will be transferred directly to the households through the facilities of Vietnam's national Post Office.



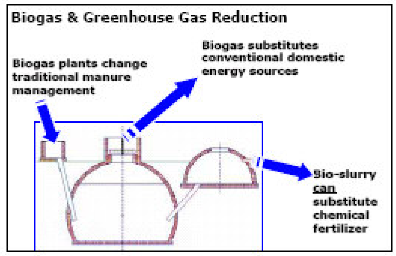
A dedicated biogas investment credit facility is currently under consideration. Experience shows that the programme increasingly would reach poorer households, for whom the remaining investment will proof to high to be paid in cash[6]. The total credit volume results to € 18.4 million. However, taking into consideration repayments the actual required capital is considerably lower (max capital requirement ~ € 2.1 million in the 3rd programme year).

	VND	Euro
Normal	1,000,000	49.50
Medium	1,500,000	74.26
High	2,000,000	99.01
Avg subsidy	**1,238,450**	**61.31**

[2] Although a detailed programme budget is available, adjustments in support scope and resulting costs may occur. Finalization is expected before the end of the year.
[3] Average costs for an 8 m^3 domestic biogas plant, corrected for inflation (5%) over the programme period.
[4] Accumulated financing costs include financing costs for the programme's subsidy component as well as the financing costs for the programme's investment credit component. For the latter, it is assumed that 53% of the households will request investment credit to finance the remaining part (investment minus subsidy) of the plant.
[5] Over the programme period, the investment subsidy will remain constant and uncorrected for inflation. As a result, the actual investment subsidy share will decrease from 27% in the first to 22% in the last programme year.
[6] Calculations assume that the credit requirement will increase from 30% of the households in the first year to 70% in the last.

3 Biogas & GHG reduction

The fermentation of animal dung in domestic biogas digesters, and the subsequent application of biogas and bio-slurry, contributes to the global reduction of greenhouse gasses (GHG). As such, the programme will qualify for the Clean Development Mechanism (CDM) of the UNFCCC[7].

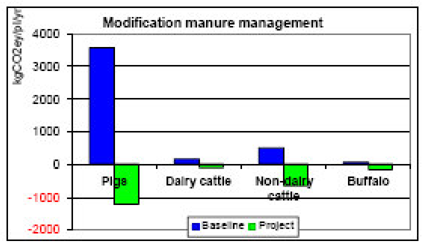


Applying domestic biogas, GHG emissions can be reduced in three ways:

- Modification of the traditional manure management practice;
- Substitution of conventional domestic energy sources, and;
- Substitution of chemical fertilizer.

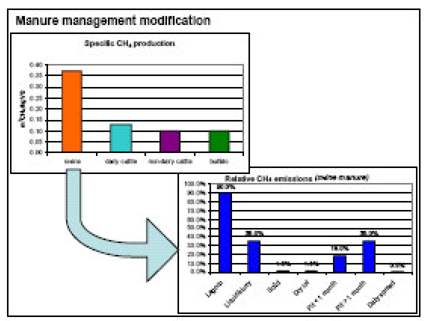
Please note that the actual level of GHG reduction depends to no small extent on the practices in situ.

3.1 Modification of the manure management practice



Depending on the type and handling practice of manure the local manure management practice can become a significant source of GHG. Basically, when manure storage, discharge or application becomes more anaerobic, larger quantities of methane gas will be emitted. Biogas plants paradoxically aim to generate the maximum amount of CH_4 from the manure. But since the biogas is subsequently combusted in the kitchen stove, the generated methane is destroyed.

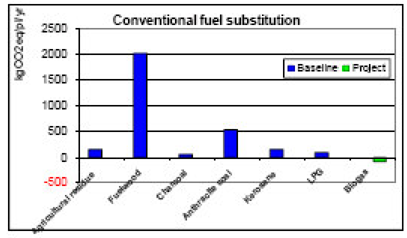
For the exploratory calculations for a typical domestic biogas plant in Vietnam of 8m^3, we assumed the (partial) feeding of the manure of 8 pigs, 1 dairy cattle, 1 non-dairy cattle and 0.5 buffalo and a conservative mix regarding the traditional manure management practices. Based on IPCC[8] default values, these calculations show that as a result of the modification of the traditional manure management, greenhouse gas emissions can be reduced with just over 2,100 kg CO_2-eq per plant per year.



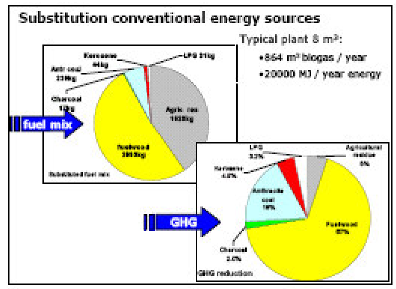
[7] United Nations Framework Convention on Climate Change

[8] Intergovernmental Panel on Climate Change

3.2 Substitution of conventional energy sources.



Burning of biogas releases carbon-dioxide. However, since this amount of CO_2 is absorbed by the re-growth of the agricultural produce, biogas combustion is considered carbon-neutral. Therefore, to the extent that biogas substitutes conventional domestic fuels that are not carbon-neutral (in particular fossil fuels), biogas application contributes to the reduction of GHG emissions.



For the exploratory calculations we took as point of departure the gas production of a typical domestic biogas installation. Taking into account the differences in efficiency of the various combustion devices, the calorific value of the generated biogas was used to calculate how much of the traditional fuel mix[9] could be substituted. Calculations further assume that 50% of the substituted fuelwood is harvested in a non-sustainable way. Based on these calculations, by substituting conventional fuels, domestic biogas plants reduce just of 2,900 kg CO_2.eq per installation per year.

However the SSC WG proposes to revise the simplified baseline and monitoring methodologies for selected small-scale CDM programme activities by deleting references to "non-renewable biomass" as a plausible baseline scenario. This recommendation, if accepted by the Executive Board, will be detrimental to the implementation of Biogas programmes. Since an important source of emission reductions for the biogas program originates from displacing "non-renewable biomass".

3.3 Substitution of chemical fertilizer.

The residue of the anaerobic fermentation process, bio-slurry, is a powerful organic fertilizer and soil conditioner. Field tests confirm a significant increase in agricultural yield through the application of bio-slurry. For farmers, therefore, it is possible (and advisable!) to substitute (part of) their chemical fertilizer application with bio-slurry. Not only from a (sustainable) agriculture point of view, but also for reducing GHG emissions related with the production and application of chemical fertilizer, bio-slurry would have advantages.

Again, exploratory calculations indicate that on a typical farm plot in Vietnam (0.5 ha) the available bio-slurry replacing the nutrient value of chemical fertilizer would reduce GHG emission to the tune of ~ 500 kg CO_2-eq/farm/year.

However, farmers may under or over-utilize chemical fertilizer. They may or may not apply bio-slurry to the full extent or in the most proper way. And the applied bio-slurry may or may not actually replace chemical fertilizer. Clearly, from a baseline and programme monitoring point of view, chemical fertilizer substitution is "nightmarish". It is for this reason that chemical fertilizer substitution is excluded from this programme's GHG reduction claim.

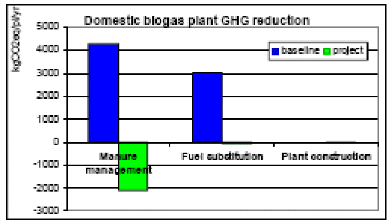
---

9 Establishing the average traditional domestic fuel mix, due to lack of sufficient data, proofs cumbersome. For the calculations we used data from a survey of the Institute of Energy / RWEDP.

3.4 GHG reduction summarized

As stated before, the actual GHG emission reduction by domestic biogas plants depends heavily on the local situation with regard to traditional manure management practices and domestic fuel mix.

However, our rather conservative approach would indicate that plants would reduce greenhouse gas emissions to the tune of ~ 5 tCO_2.eq per plant per year.



4 Benefits of domestic biogas

Besides the reduction of GHG emissions, domestic biogas have multiple benefits. The most obvious benefits are related to the direct outputs of a biogas plant: biogas and slurry.

Biogas
Biogas usually replaces firewood for cooking. End users confirm that cooking with biogas is more comfortable than cooking with firewood and provides a better energy service. A biogas burner hardly needs attention, allows for a better control over the heat source, cooking is generally quicker than with firewood and pots need far less cleaning after use. In practice, this reduces time women spend on cooking. In addition, the availability of biogas may reduce the workload of women and children in rural areas who traditionally depend on firewood for cooking purposes, where the collection of firewood takes significant time and effort.

Slurry
Bio-slurry is a valuable organic fertilizer for crops and trees. However, as many biogas programmes have started for energy and environmental reasons, the use of slurry usually does not receive the attention it deserves. The nutrients in the substrate are not lost during the digestion process. Bio-slurry not-only retains the nutrients, but makes the Nitrogen part better available to plants, pathogens are killed-off or reduced substantially. Moreover, slurry is a powerful composting agent is practically free of the typical odours of manure.

Financial and economic benefits
The financial and –to a lesser extent- economic benefits of a biogas plant for household cooking and lighting may be less obvious. Only when firewood is scarce and the costs are high, the financial benefits of a biogas plant become convincing. However, in many cases firewood is collected at no financial cost to the end-user, except for the time (usually) women and children spend on collection. In Nepal, it was estimated that the time women spend on firewood collection and cooking was reduced with three hours per day on average, once they started to use a biogas plant. Usually only some cash expenditures on kerosene can be avoided when biogas is used for lighting. The increased value of slurry in comparison to the raw feedstock is often not immediately recognized by farmers

Environmental benefits
The environmental benefits of biogas are many-fold. Deforestation and soil erosion, often associated with the use of fuel wood, are reduced. Fossil fuels used for lighting, such as kerosene, can also be replaced by biogas. The use of slurry improves nutrient recycling in agriculture and can substitute chemical fertilizers, thus reducing the related environmental problems.

Health benefits
The health benefits of biogas are mainly related to a substantial reduction of smoke and in-door air pollution compared to a traditional wood fire. This has a positive impact on the health situation of (mainly) women and children: it reduces the incidence of respiratory infections and eye ailments associated with smoke-filled environments. Biogas plants change the traditional livestock keeping and manure treatment modality; animals are

kept more in confined spaces and dung is fed regularly to the plant. As a consequence, hygiene on the farm yard benefits significantly. Where culture allows the connection of the toilet to the plant (at little extra costs), sanitary conditions further improve markedly.

The benefits of domestic biogas are summarized in the 'biogas benefit matrix' below.

	MICRO	MESO	MACRO
Health	Reduced indoor smoke-induced illnesses Reduced poor-sanitation induced illnesses		Reduction of illness-induced production losses Reduced mortality Reduced health system expenses
Environment	Reduced drudgery fuelwood collection Reduction drudgery weeding Reduced soil degradation Reduced pollution of surface and groundwater	Reduced risk of landslides Improved forest quality and quantity Reduced sanitary pollution	Improved biodiversity Reduced global warming effects
Economic	Increased efficient productivity Reduced direct medical costs Reduced fuelwood & kerosene expenditures Increased opportunity for organic agriculture Improved agricultural yields (10-40%) Increased family income (time saving on fuelwood collection) Reduced costs on chemical fertilizer	Improved employment opportunities	Increased agricultural production Increased tax revenues Increased efficient productivity Poverty alleviation
Social	Reduced workload for food-preparation (gender) Improved opportunity for education Cooking biogas more comfortable		Improved human resource base

Sustainable development

In 1987 the generally accepted definition of Sustainable development was published in the Bruntland Report as: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Domestic biogas is compatible with this definition as it contributes (see table above) to household energy and income generation needs; reduces greenhouse gas emissions; reduces reliance on fire wood therefore pressure on forest resources; reduces ground and surface water pollution; reduces reliance on non-renewable energy sources; provides a long term solution to pollution and energy needs and -through proper application of slurry- improves soil health and reduces reliance on chemical fertiliser.

5 Carbon–financing of large-scale biogas programmes

A key feature of the BP II is that the programme seeks to generate revenue from the CDM to:

- finance its subsidy component, and;
- co-finance its provincial support component.

The exploratory calculations indicate that domestic biogas plants reduce GHG emissions to the tune of 5 tCO_2-eq per year. With a conservative price of € 6 per t CO_2-eq, a typical biogas plant would potentially generate € 300 over a crediting period of 10 years. During this crediting period, the total GHG reduction of the programme would amount to over 7700 kt CO_2-eq[10], representing a value of € 46.3 million. However, two "formalities" will – at least initially - reduce the available CDM revenue, namely:

- CDM payment on delivery, and;
- the Kyoto Protocol "First Commitment Period".

5.1 Payment on delivery

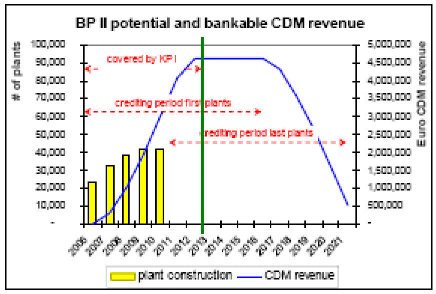
CDM revenue will only be made available "up on delivery". The implication for the programme would be that, assuming an annual verification, farmers would be entitled for their annual CDM revenue amount after the particular verification year. Not only would the resulting financial transactions put a significant load on the programme management, but –more importantly- the CDM revenue in this fashion would not assist the farmer in reducing the up front investment.

For this reason, the programme is in dialogue with the Kreditanstalt fuer Wiederaufbau (KfW). KfW's carbon fund shows serious interest in purchasing the programme's emission reductions to off-set emissions in Europe. At the same time, KfW –through the German Government's "Special Facility for Renewable Energies and Energy Efficiency"- is willing to consider providing the programme, through the Government of Vietnam, a soft loan for which repayments will be made by the programme's CDM revenue.

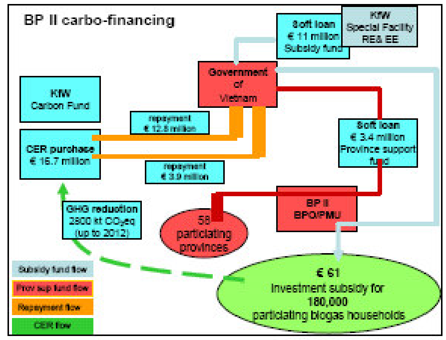
5.2 The "First Commitment Period"

The first commitment period, agreed by the parties to the Kyoto Protocol, terminates at the end of 2012. Greenhouse gas emission reductions after this period will resort under the second commitment period, for which negotiations will only start around 2008.

Although expectations are that after 2012 the mechanism, possibly in an adjusted version, will continue to be operational, GHG reductions after 2012 are not (yet) "bankable" as a source for loan repayment. The effect, as shown in the graph, is that at the moment some 42% of the total potential revenue will be available to debt servicing.



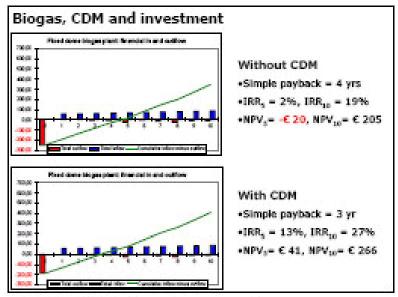
[10] The theoretical GHG reduction by the programme would amount to 9,000 kt CO_2.eq [180,000 plants * 10 years * 5 tCO_2-eq/plant/yr]. However, the calculations assume 10% of the plants are not operational and 5% of the CERs remaining unsold, thus arriving at an effective GHG reduction of ~ 7,700 kt CO_2-eq.



As a result of the above "formalities", a CDM – loan combination would generate €16.7 million. The programme proposes to apply the CDM – loan for two purposes:

- KfW, through the German "Special Facility for RE & EE" would, on request of the Vietnamese Government, consider providing Vietnam with a soft loan to the amount of € 11 million. This amount will suffice to provide an investment subsidy to 180,000 farmers at an average level of € 61.
- The Government of Vietnam will be requested to consider a soft loan to the programme to the amount of € 3.4 million. This amount will suffice to contribute to the provincial programme support costs at an average level of € 13,475 per province per annum for the programme period of 5 years.
- The remaining loan CER revenue, € 2.3 million will cover the financing costs of the above mentioned two loans.

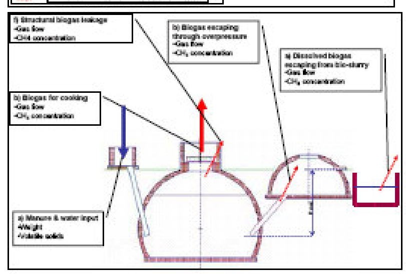
5.3 CDM impact at investor-level



Although CDM may be not a "silver bullet", the graphs indicate that CDM for domestic biogas -even if a loan has to be taken to make the revenue available up-front and even if not the full amount of CERs is available as bankable revenue- can make a reasonable impact:

- The simple repayment period reduces from 4 to 3 years
- The IRR[11] after 5 years improves from 2 to 13%
- The NPV[12] after 5 years improves from minus € 20 to € 41.

5.4 The CDM and programme monitoring requirements



To be eligible for the CDM, programme implementers will have to prove the reduction of greenhouse gasses relative to the situation if the programme would not take place. Simply put, in CDM language, one can distinguish between:

- The baseline situation, accounting for greenhouse gasses emitted without the programme, and;
- The programme situation, taking into account the GHG emission of the programme.

Only the different (baseline minus programme situation) can be claimed as GHG reductions by the programme.

Mitsubishi Securities Co. Ltd[v], a leading consultancy firm in the field of CDM, is currently assisting the programme with the preparation of the official submission of the Project Design Document to the UNFCCC Executive Board. The monitoring methodology they are currently finalizing includes the following.

---

[11] IRR: Internal Rate of Return: Return rate that equalizes the net present value of an investment with the current market price

[12] NPV: Net Present Value: Present value of investment based on future income and payments

Baseline monitoring: For the participating households the current situation will have to be recorded. The minimum information requirement would be:

- Livestock type and population (pigs, dairy / non dairy cattle, buffalo);
- Average weight of livestock;
- Household population;
- Manure management practice;
- Farming pattern (type of crops, number of harvests per year, etc)
- Fuel use (mix of domestic fuels used);
- Local / regional climate.

The proposed baseline monitoring methodology will consist of a:

- one-off census of all participating farming households, and;
- the setting up of a sample group over the period of one year, consisting of at least 10 farms to establish in a detailed manner the baseline emission factors.

Programme monitoring: Domestic biogas systems of the relatively simple "fixed dome" type as used in the programme in Vietnam do not necessarily "destroy" all generated CH_4. "Leakage" can occur due to:

- Structural leakage of biogas as a result of lacking craftsmanship or maintenance.
- Biogas escaping through the compensation tank as a result of over-pressure in the system.
- Dissolved biogas escaping form the compensation tank.

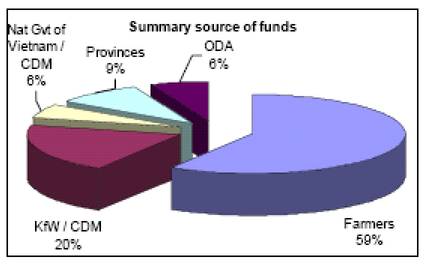
The proposed programme monitoring will consist of:

- The setting-up of a sample group consisting of at least 100 farmers to establish baseline as well as programme emission factors over the period of one year, and;
- An annual census to compile data necessary for determining baseline and programme activity levels, for the duration of the programme.

It will be clear that the required monitoring scope is large and detailed. Clearly, efforts and costs can only be justified if CDM-related monitoring –to a large extent- is integrated with regular programme monitoring and quality management.

5.5 BP II programme financing

Funding sources for the programme are divers[vi] and include farmers (direct investment), the German Kreditanstalt fur Wiederaufbau (loan[13] and CDM[14]), the National Government of Vietnam (loan and CDM), Provincial Governments of Vietnam (contribution to programme support), the Netherlands Directorate General for International Cooperation (ODA – programme support) and SNV (ODA-TA).



Farmers: The total average investment for a typical biogas plant ($8m^3$) amounts to ~ € 250. With an average investment subsidy component of ~ € 60, participating

[13] KfW administers the German Federal Government's "Special Facility for Renewable Energies and Energy Efficiency. The programme would apply for a soft loan from this facility.
[14] KfW's Carbon Fund.

households will contribute ~ € 190. Thus, households will cover the lion share (75%) of the plant investment costs (€ 39 million). The remaining part 24% of the investment costs will be covered by the programme's subsidy component.

KfW Carbon Fund[vii]: KfW's Carbon Fund has been approached for the purchase of the Certified Emission Reductions (CERs) generated by the programme. With the revenue of the CER purchase, the programme will repay the loans as outlined in 4.3 and 4.4 below. During the first commitment period of the Kyoto Protocol (2008 – 2012) the total "bankable" amount of CERs is estimated on € 19.7 million.

The Special Facility for Renewable Energies and Energy Efficiency[viii]: The German Federal Government's Special Facility for Renewable Energy and Energy Efficiency (administered by KfW), has been approached for a soft loan to the amount of € 12.2 million to will finance the programme's subsidy component. The loan will be repaid by the programme's CDM revenue (see chapter 5 hereunder)

Government of Vietnam: The National Government of Vietnam will be requested to participate with a loan in co-financing the programme's provincial support costs to the extent of € 3.9 million. This loan too will be repaid by CDM revenue.

Provincial governments: Participating provincial governments will be requested to contribute on average € 100,000 (€ 20000 per annum) each to participate. In total, provinces will furnish € 5.8 million to the programme budget.

DGIS / the Netherlands Ministry for Development Cooperation: DGIS financially supports the DGIS / SNV Asia Biogas Programme. For the second phase of the Biogas Programme in Vietnam, an ODA grant-contribution of € 3 million for national programme support costs has been committed within the framework of this programme.

SNV / the Netherlands Development Organization: As a partner to the Asia Biogas Programme, SNV has committed itself to an amount of € 0.65 million to finance Technical Assistance expenses at national level.

6. Present challenges for domestic biogas programmes in relation to CDM

Before poor households in Vietnam and other countries can really reap the benefits from CDM, many challenges have to be overcome. The current CDM methodologies for small-scale programmes seem to be inflexible. The present and acute challenges for small-scale programmes, like the biogas programme in Vietnam, are:

I. Limitations of CDM in reducing up-front investments
CDM revenues will be made available "up on delivery", whereas you actually need these revenues for programme development and implementation. The implication for the programme would be that, assuming an annual verification, farmers would be entitled for their annual CDM revenue amount after the particular verification year. Not only would the resulting financial transactions put a significant load on the programme management, but –more importantly- the CDM revenue in this fashion would not assist the farmer in reducing the up front investment.

II Higher transaction costs due to new inflexible bundling rulings
Simplified baseline and monitoring methodologies for small-scale projects have been approved by the Executive Board. Small-scale projects are projects with:

a) a capacity of less than 15 MW(electrical) or;
b) an annual energy production of less than 15 GWh, or;
c) an annual emissions and emission reductions of less than 15 000 tCO_2e.

The aim of these simplified baseline and monitoring methodologies is to reduce the transaction costs of registering a small-scale project. Another possible way to reduce transaction costs is to "bundle" small-scale projects up to the maximum size for a small-scale project for validation, registration and verification. But the benefit of this bundling principle is recently reduced because EB has released new bundling rulings in July 2005, which make it more difficult to meet the requirements for bundling.

The new bundling rulings are:

i) Project activities wishing to be bundled shall indicate as of the request for registration that they will be bundled;
ii) Once a project activity becomes part of a bundle it shall not be de-bundled i.e. project activities that are bundled at the registration should remain part of the bundle;
iii) Composition of bundles shall not change over time (i.e. the submission of projects to be used in a bundle shall be made at the same time i.e. project activities cannot be substituted for one another later on;
iv) All project activities in the bundle shall have the same crediting period.

Those rulings are quite inflexible, and will increase the burden for project developers.

III Restrictive project size

Small-scale projects are projects with a capacity of less than 15 MW(electrical) or an annual energy production of less than 15 GWh, or an annual emissions and emission reductions of less than 15,000 tCO_2e. For biogas programmes the 15 MW limit is normally used.

If the simplified methodologies are followed for a biogas dissemination programme in a particular country, consisting of 180.000 biogas digesters of 2 kW each, at least 24 PDDs have to be prepared (15 MW / 2 kW = maximally 7,500 digesters per PDD. 180,000/7,500 = 24 PDDs). Preparation of a separate PDD for each 'programme area', in which maximally 7,500 biogas digesters are being build, including the correct application of baseline and monitoring methodologies, would cost a lot of effort.

Hence there is urgent need to request the Small Scale Working Group (SS-WG) of the EB to make the simplified small scale methodology more flexible so that either:

i) the total limits could be increased (from 15 MW to 50 or 100 MW) or;
ii) aggregation could be based on larger national, regional or district baseline in order to spread out the transaction cost as proposed in ensuing sectoral policy based approach.

IV Limitations of first commitment period

The first commitment period ends in 2012. CERs generated after 2012 are not yet 'bankable'. More clarity about CDM after 2012 would benefit biogas dissemination programmes greatly.

V Complicated verification and monitoring mechanisms

Monitoring and verification of achieved reduction of emissions of GHG is important because if CERs were awarded in error, emission in annex 1 countries would be 'offset' by non-existent emission abatement, which means that global emission would rise because of the CDM project activity. Therefore the rules for the monitoring of emission reductions are strict, but in practice the requirements sometimes appear to be very complicated. A possible solution might be simplification of the monitoring requirements but meanwhile also reduction of the crediting period to e.g. maximally 5 years. By doing so, the risk of awarding CERs in error would be decreased.

VI Deletion of reference to non-renewable biomass

The SSC WG proposes to revise the simplified baseline and monitoring methodologies for selected small-scale CDM project activities by deleting references to "non-renewable biomass" as a plausible baseline scenario. This recommendation, if accepted by the Executive Board, will be detrimental to the implementation of many biogas programmes. Since an important source of emission reductions from biogas programmes often originates from displacing "non-renewable biomass". Moreover, it will also jeopardize meeting the national developmental goals of countries like improving sustainable energy access and reducing rural poverty through the CDM and undermines many of the brave initiatives undertaken by the pioneering biogas programmes (e.g. Nepal Biogas Umbrella Program). Hence there is an urgent need to request the EB not to implement this recommendation.

Biogas sectoral policy approach

In order to (partly) overcome the above mentioned challenges there is a need to explore the feasibility of developing CDM projects based on sectoral policy approach. Unlike, many large-scale CDM projects (HFC, N_2O), small-scale biogas programmes which have high sustainable development components offers an exciting possibility to test out the sectoral policy approach. A National CDM Biogas Working Group could be set up to develop sectoral policy based CDM for maximized SD integrity.

A policy based approach is a government-driven mechanism that enables non-annex 1 countries to develop national or local policy initiatives that discernibly lower GHG emissions in a particular sector e.g. small scale biogas digesters, agro-industrial waste or municipal waste. The CERs flow directly to the host government that will thus be compensated for its efforts and may choose to pass some of the benefits on to industry and households affected by the measures in the form of tax incentives, subsidies or other fiscal instruments. This provides an innovative tool for government to finance climate-friendly policy measures.

References

Bhardwaj, N., Partan, B., de Coninck, H.C., Roos, C., van der Linden, N.H., Green, J and Mariyappan, J. 2004. Realising the potential of small scale CDM projects in India. IT-Power-ECN report for EU-Synergy Programme.

Yapp, J, 2005. Development of Sectoral CDM Project: A Case Study for Small Scale Biogas Project. In 'Proceedings of the International Biogas Technology for Poverty Reduction and Sustainable Development.' 18 to 20 October 2005, Beijing.

Endnotes

i **Involvement of SNV in domestic biogas**

Fifteen years ago, SNV – the Netherlands Development Organization started in cooperation with national partners the biogas activities in Nepal. In 2003, the programme was extended to Vietnam. In the past decade, SNV further developed the use of the technology as well as a sector wide approach to stimulate the emergence of a national biogas industry. Working simultaneously with government agencies, private enterprises, NGOs, credit agencies and research institutions, all key aspects of the biogas sector received managerial and advisory support from SNV. The success of the programme in Nepal and since a few years in Vietnam can be attributed to the comprehensive market-driven approach, the strong partnerships between international development agencies and national organisations and the long-term commitment of the partners involved. Application of smart consumer subsidies coupled with strict quality standards for producers played a key role in the acceleration of demand for biogas plants by individual farmers. Worldwide, about two billion people lack clean and safe cooking fuel. To improve their lives, they need access to sustainable energy services. SNV has demonstrated in Nepal and Vietnam that domestic biogas is very well able to fulfil in the basic energy needs for cooking and lighting in rural areas. About 790,000 people benefit from biogas plants installed in the period July 1992 up to December 2004. Multiple benefits are achieved at household, local, national and global level. The current programmes in Nepal (Biogas Support Programme phase IV up to 2009) and Vietnam (Biogas Project phase I up to 2005) are set to reach another 1.15 million people and to achieve even larger benefits.

ii **The Asian Biogas Programme**

To up-scale its domestic biogas activities, SNV sought additional support from the Netherlands Directorate for International Cooperation (DGIS) for the implementation of the Asia Biogas Programme covering Vietnam (phase II), Bangladesh, Cambodia and Lao PDR. In addition, SNV requested assistance in setting up strategic biogas partnerships and a regional biogas network in Asia. It is estimated that an additional 1.3 million people will be reached through this Programme in the period from 2005 up to 2010. In addition, viable biogas markets will be established with good prospects for continued deployment of biogas plants after the Programme period, being after 2009 for Bangladesh, Cambodia and Lao PDR and after 2010 for Vietnam. SNV requested DGIS for a grant of € 12.9 million. A Memorandum of Understanding on the Asia Biogas Programme was signed between DGIS and SNV on the 14th of December 2004. The grant document covering the first two years of the Programme (2005 and 2006) was issued by DGIS on the 17th of May 2005, with the commitment that an agreement for the rest of the programme period will be reached in due course.

iii **Involvement of the private sector.**

BCTs, as established under BP I, are proto-commercial biogas construction entities. To manage the demand, each district will need minimally 2 BCTs, resulting in –on average- at least 20 BCTs per province. BCTs typically consist of 3 or 4 local masons, selected from the commune for biogas construction. During BP II, more attention will be directed towards guiding these BCTs towards proper private enterprises. To this extent, following the successful model in Dak Lak province, BCTs will be encouraged to merge into Biogas Construction Enterprises (BCEs) that work on a more provincial level. Per province BP II foresees establishment of at least 2 BCEs.

iv **BP II Application of Funds.**

MSCL is a globally leading organization in the field of Clean Development Mechanism consultancy. MSCL, in the framework of its "Social Responsibility Policy" offered to MARD / Department of Agriculture to develop Project Design Document, Baseline Methodology and Monitoring Methodology for BP II free of charge. These documents are crucial for approval of the CDM component of the BP II by the UNFCCC Executive Board, and thus are key to mobilizing the potential CDM revenue for the programme.

[vii] **KfW Carbon Fund**
From KfW's website: "KfW Banking Group has set up a carbon fund in cooperation with the Federal German Government to purchase emission credits from JI and CDM projects. As recipients of these emission credits mainly German and European companies are to be considered who are expecting reduction obligations and wish to use project-based Kyoto mechanisms. At an early stage they can assure this way obtaining valuable emission credits at favourable prices for the 2nd phase of the ETS."

[viii] **The Special Facility for Renewable Energies and Energy Efficiency.**
From KfW's website: "In the period 2005 – 2009 KfW Entwicklungsbank will make up to € 500 million available in the form of low-interest loans for investment in renewable energies and energy efficiency in developing countries. Up to 50 investment projects in natural resources conservation and environmental protection with an average volume of € 10 million each can be co-financed through the Special Facility, thereby mobilizing a much greater overall investment volume. KfW applies the funds on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). On the occasion of the international "Renewables 2004" conference the German federal government announced to make funds of up to € 500 million available to developing countries to spread the use of renewable energies and improve energy efficiency. The programme module "Renewable Energies" promotes investment in wind farms, biomass use and biogas plants, photovoltaic systems and solar thermal energy, geothermal power plants or hydro power plants. This supports the partner countries in an energy management that conserves natural resources and preserves the environment."