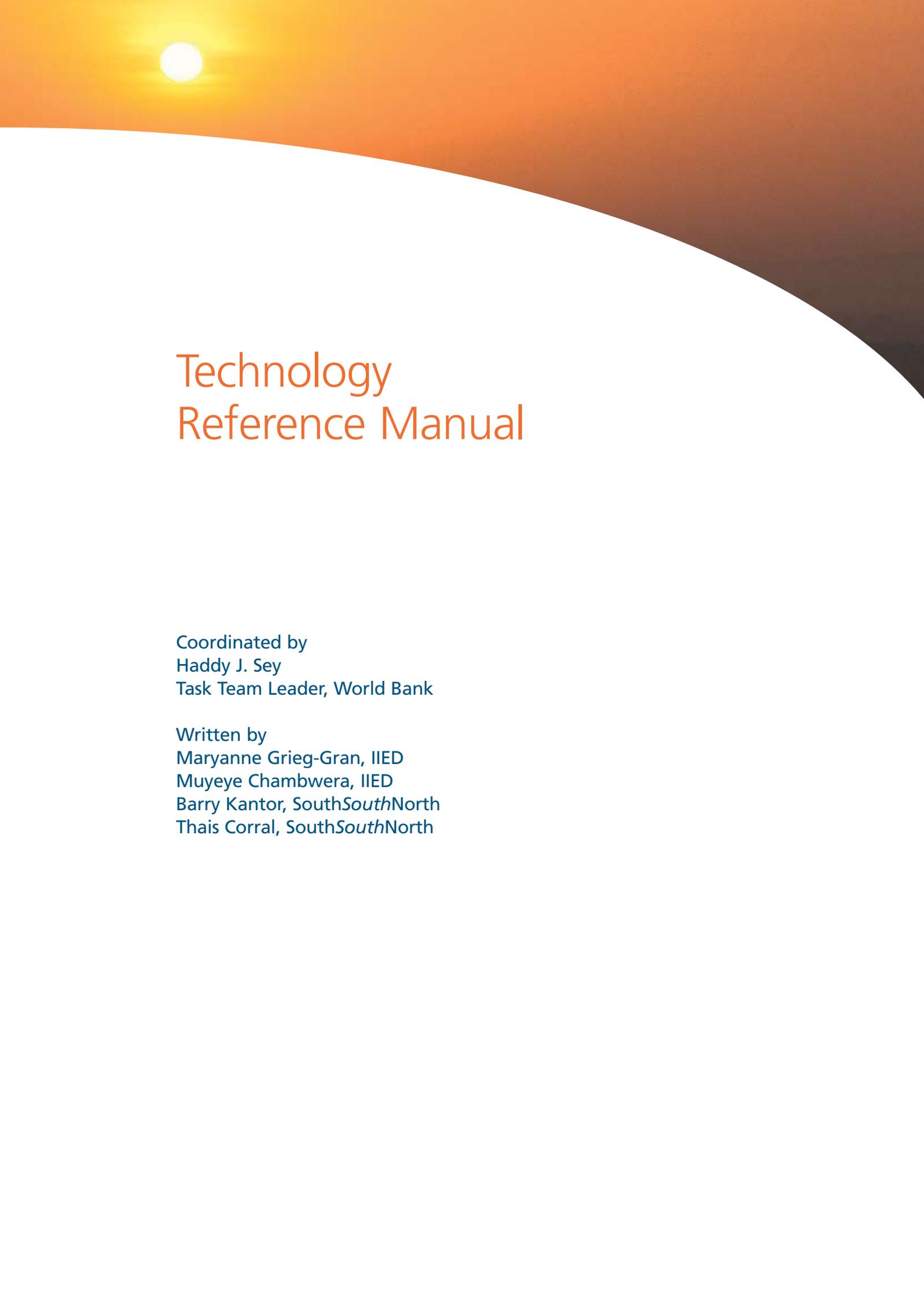


# Technology Reference Manual

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# Knowing what technology can do for us

- Technology can help save money
- Technology can help prevent global warming
- Technology can benefit communities

Because of these benefits, it is possible to get help with the funding for these technologies!

The Kyoto Protocol gives people in developing countries the opportunity to take inventive approaches to reducing emissions. Types of approaches include:

## 1. Switching fuels

- Switching to fuel that does not harm the atmosphere e.g. sustainable firewood.
- Switching to fuel that is less harmful to the atmosphere than conventional fuels, e.g. from kerosene to gas. Although gas is a fossil-derived fuel it is less harmful to the atmosphere than kerosene.

## 2. Efficient use of energy by saving heat:

- Using technology that produces energy without losing much heat is obviously more energy efficient than a technology that does e.g. using a closed oven instead of an open fire will be much more efficient and will reduce emissions.
- Using technology that makes use of the heat emitted while running, to create more energy. This is called co-generation, because it creates heat and power together.

## 3. Using technology based on renewable energy sources, for example:

- Renewable firewood.
- Hydropower – using the energy in flowing water to produce electricity.
- Solar power – using the sun's heat and light to produce heat or electricity.

These and other renewable energy technologies (described further in the following pages) are valuable for the following reasons:

- Each has been tried and tested in Clean Development Mechanism (CDM) projects.
- They cause no harm to the environment, relative to other technologies.
- As they all are based on renewable energy sources, these technologies offer realistic solutions to provide energy to people.
- They tend to be environmentally and economically sustainable, and thus benefit small communities. They can provide energy to people who would otherwise not have electricity, and new jobs to people involved in building and installing the new technology. Often they reduce the cost of and effort involved in producing energy. For these reasons, communities do not lose out financially by using them.
- They can work as small-scale projects. This means they have a simpler procedure to follow under the CDM rules and are therefore cheaper.

Small-scale projects, however, may still struggle to cover initial costs of development. This problem may be overcome by:

- i. bundling several small-scale projects together into a bigger project, which multiplies the benefits and shares the costs over a wider base.
- ii. developing a 'program of project activities'. This means grouping several similar projects under one project design document. This saves time and costs on various formal requirements, such as project validation, which only needs to be done once for the group, reducing costs proportionally.

It is important to be creative, flexible, and inventive when considering possible approaches for using renewable energy and for using energy more efficiently.

We deal with the following technologies in this section:

Technology	Application	Examples
Biomass.	Burning biomass to produce heat and energy.	Guyana: using biomass in the Skeldon sugar modernisation project (CDCF).
	Burning biomass for heating.	Moldova: Biomass heating in rural communities (CDCF).
Landfills.	Methane from landfill/waste water.	Argentina: Olavarría landfill gas recovery (CDCF).
		Bolivia: Urban wastewater methane gas capture (CDCF).
Biodigesters.	Local biogas digester plants.	Nepal: Methane from manure, biogas support program.
Solar water heaters.	Thermal solar water heaters.	South Africa, Kuyasa: low cost housing interventions.
Solar home systems.	Photovoltaic (PV) solar home systems.	Bangladesh: Grameen Shakti program (CDCF).
Micro-hydro.	Micro-hydropower.	Peru, Santa Rosa: Micro-hydropower (CDCF).
		Nepal: Micro-hydropower (CDCF).

## Biomass technologies

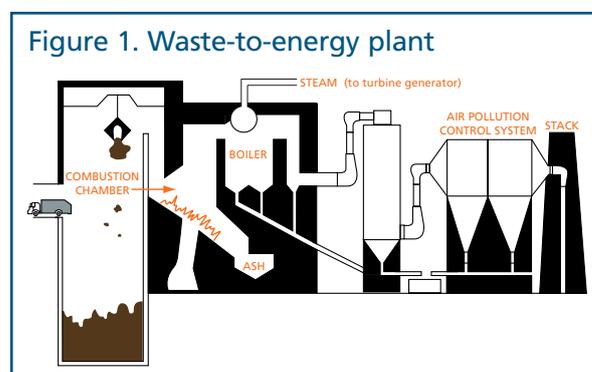
Burning biomass (wood or other vegetable matter) provides energy for cooking or heating. It can also be burned in a furnace to create steam for energy. Changing from one technology to another, for example from kerosene to wood, can reduce the amount of carbon dioxide emissions released into the atmosphere, and can form the basis of an emission reduction project.

A reduction in emissions only occurs when the replacement biomass fuel comes from a renewable and sustainable source. For example, firewood biomass should be harvested from a forest that can be easily regrown so that any wood used is replenished.

The 'waste' from harvests is a particularly valuable source of biomass. This waste matter – for example, the rice husks left after the kernel has been removed, or sugarcane bagasse that remains after the stalks are crushed to extract their juice – is not useful as food and, if left to rot, emits methane, a very harmful greenhouse gas. However, if harvested, this 'waste' can be used for heating or to produce electricity. To give an idea of how much energy harvest 'waste' contains, 4 kilograms of rice husks is roughly equivalent to 1 kilogram of diesel petroleum oil.

### How does the technology work?

1. A furnace burns plant biomass to generate heat energy, which is converted into mechanical energy by turning the turbine of a generator, which then produces electrical energy. Such power stations can help generate off-grid electricity in remote areas.
2. Waste-to-energy plants work on a larger scale, using municipal rubbish (solid waste) to fire an industrial boiler. The same steps are used to make electricity in a waste-to-energy plant as in a coal-fired power plant:
  - a) The fuel is burned, releasing heat.
  - b) The heat turns water into steam.
  - c) The high-pressure steam turns the blades of a turbine generator to produce electricity.
  - d) A utility company sends the electricity along power lines to homes, schools, and businesses.



Note that it is important to avoid releasing harmful chemicals into the atmosphere when burning rubbish produced from materials like plastic and certain metals.

### Advantages of biomass

- Biomass is cheap and locally available in many places, such as remote areas where electricity is not available.
- Once biomass has been burned, it produces ash which is mineral rich and can be used as a fertilizer.
- As the technology involved in building and running a furnace is fairly simple, it need not be

acquired from far away and may provide business opportunities for local enterprises.

- Likewise, efficient stoves and heaters are relatively simple technologies that can be manufactured locally, creating jobs.
- If efficient biomass technologies are used, the amount of biomass required is reduced, which reduces the cost of energy and reduces the amount of labor involved in collecting fuel, freeing up time for local communities to engage in more productive pursuits. This often benefits women, who are responsible for this activity in many societies.

### Disadvantages of biomass

- Biomass is also used for compost, building materials and to make certain biodegradable plastics and paper, and these industries compete for use of available biomass.
- Where biomass is deliberately grown, it may place a strain on available water.
- Where forests are used unsustainably, biomass will not be a renewable energy source and will not successfully lead to a reduction in emissions.
- Where sustainable forests are planted on sensitive or indigenous land, or where growth will negatively impact local biodiversity, the project will not lead to sustainable development and local stakeholders will likely object to the project. Care should be taken not to grow biomass on land that is more suitable for food production.
- Burning in the open air produces local air pollution, which can cause serious respiratory disease. For this reason, it is preferable to use more efficient technologies for burning biomass. Other forms of renewable energy that do not cause disease, such as solar or wind energy should also be considered.

### When biomass is most suitable

Using biomass technologies is useful where there is an abundance of biomass available in the same place. For example:

- using 'waste' biomass to power the processing of the 'food' part of the same harvest, for example using bagasse to power a sugar mill.
- using biomass to produce heating or energy for residential and institutional users living close by to biomass available locally.

If biomass is not particularly abundant locally, efficient technologies can help reduce the amount needed to produce enough energy.

### Examples of biomass projects helped by CDCF funds

#### Skeldon sugar modernization project in Guyana

This is a large industrial project that uses bagasse in a power plant to produce heat and electricity (co-generation) for a sugar mill and for the national grid, displacing the use of light fuel oil in diesel generators. Bagasse is a by-product of sugarcane processing that would otherwise be wasted and rot. Part of the carbon revenue from this CDM project is being used to support a number of community benefits such as assistance to a local hospital, improvements to a community center, and urban landscaping in public areas. New jobs will be created during construction and operation, both in the new sugar mill and in local farms, which will expand sugar cultivation. The community will also benefit from improved electrical services in the region.

#### Biomass heating in rural communities in Moldova

This is a small-scale project that uses biomass to heat public buildings in rural communities. The heating systems, which run on compressed straw bales, will be installed in schools, hospitals and public service buildings on a grant basis and local agricultural enterprises will supply the biomass under long-term contracts. This project will benefit the community by decreasing the cost of heating. It will also increase the number of days per year that public buildings are heated, which will allow people to work longer and earn more. Children will also be able to study for longer. Aside from improved levels of comfort, improved heating will reduce the incidence of illnesses that result from living in cold conditions, particularly for children, the elderly and the disabled.

## Landfill technologies

Methane is a harmful greenhouse gas that escapes from rotting vegetable or animal matter, often in landfill sites, into the atmosphere or into ground water. Methane is 21 times more harmful than carbon dioxide.

Methane emissions can be reduced by extracting and flaring (burning) the gas from landfill sites. In this case, the reduction in emissions is the amount of methane that would have escaped into the atmosphere less the amount of carbon dioxide emitted from burning.

However, rather than simply flaring the methane, the gas can be captured and burned as fuel. Biogases such as methane can provide a clean, easily-controlled energy alternative to firewood or fossil fuels, such as kerosene and diesel, and replacing them reduces global greenhouse gas emissions. Because biogas is a renewable fuel, it can be used in CDM projects.

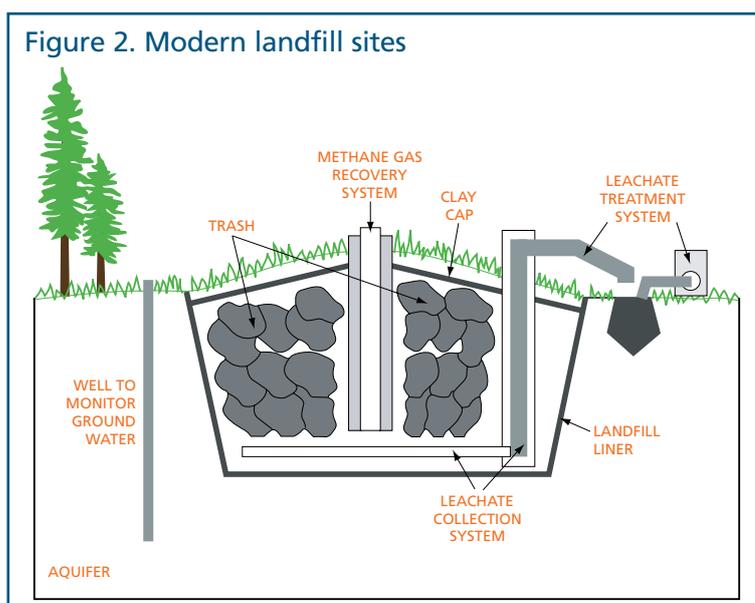
Producing energy from biogas requires only a small amount of labor, and the energy can be used to produce electricity, heat buildings or water. It can be used as fuel in gas-powered engines to run pumps and equipment (called process heating). Compressed methane can be used instead of compressed natural gas to fuel internal combustion engines or fuel cells.

### How does the technology work?

Methane can be captured from landfill sites, or from rotting, stagnant ponds and marshes.

Biogas produced by the rotting rubbish in landfills can be captured by covering the rubbish site, for example with clay and a layer of earth, draining it of any excess liquid, and piping the methane out. The gas can then be used to provide energy to local industry or to produce electricity for the grid.

Today's landfills are very different from the open dumps of the past. Modern landfills are situated where clay deposits and other land features act as natural buffers between the rubbish and the surrounding environment. Safety measures are used to keep groundwater clean and pure. Modern landfill sites are designed to ensure that children cannot play among the rubbish.



To protect the environment, the landfill is divided into a series of individual working areas or 'cells' and only a few of these are filled with rubbish at any one time. This helps protect the site from wind and rain and at the end of each day a layer of earth is added which helps reduce odour and control vermin. Full cells are filled and capped with a layer of clay and earth, and are then seeded with native grasses.

Landfills do not permanently scar the environment, and may in time be landscaped to provide parks and other recreational areas, such as sports fields.

### Advantages of landfill sites

- Biogas costs little and is renewable – people and animals will always produce waste.
- Well-managed landfills are environmentally-friendly and efficient.
- Landfills generate energy more reliably than the wind or the sun.
- Using biogas to produce energy reduces the amount of greenhouse gases emitted into the atmosphere.
- Collecting landfill gases reduces unpleasant smells from the rubbish dump and improves the growth of plants near the site.

### Disadvantages of landfill sites

- Landfills can smell and attract vermin.
- Compared to fossil fuels, much greater quantities of landfill gases are required to create electricity.

### When landfill sites are most likely to be suitable

Large, municipal landfills in urban areas are the best candidates for collecting biogas for energy production. Because they produce renewable energy, as well as reducing methane emissions, they are a financially attractive option for developing countries.

Landfills are best situated where clay deposits and other land features act as natural buffers between the rubbish and the surrounding environment.

The positioning of a landfill site is important. It should not be too close to residential areas, but also not too far away so that transport is needed, which increases the costs and emissions.

### Examples of landfill/stagnant pool biogas projects helped by CDCF funds

#### The Olavarría landfill gas recovery in Argentina

This project collects biogas from a landfill. The set-up includes gas extraction wells, collection piping, mechanical blowers, collection of landfill gas condensate and flare systems to reduce landfill gas emissions.

Initially, the local community did not receive any direct benefit from the project. To rectify this, extensive consultations were held between the project and community leaders. They identified that the community of Espigas needed potable (drinking) water. As part of their community benefits plan, the project will provide water to about 150 households, a kindergarten, an elementary school, a high school, a hospital, a social and sports club, and a cultural center.

#### Urban wastewater methane gas capture in Bolivia

This project captures and flares methane produced by anaerobic lagoons at wastewater treatment facilities. The methane-rich biogas is captured using high-density polyethylene (HDPE) covers.

## Biogas digester plants

Capturing methane from a landfill (previous section) is not the most effective way to harvest biogas because the rubbish gets in the way of the extraction process. A better method is to separate the biomass from the rubbish before it rots and to collect the biogas separately. This approach works for both large-scale municipal projects and small-scale projects run by communities or farmers.

In India, an estimated 2 million rural households produce biogas from manure using small-scale anaerobic digestion facilities. Because it is simple to implement and uses cheap raw materials, it is one of the most environmentally-sound approaches to producing energy.

### How does the technology work?

Farm waste such as manure, energy crops such as maize silage, or biodegradable wastes such as sewage sludge and food waste are put into an anaerobic 'digester' tank, also known as a biogas plant. The biogas plant consists of two components: a digester (or fermentation tank) and a gas holder.

The digester is a waterproof, airtight, circular pit made of concrete. The fermentable mixture is put into the pit along with the

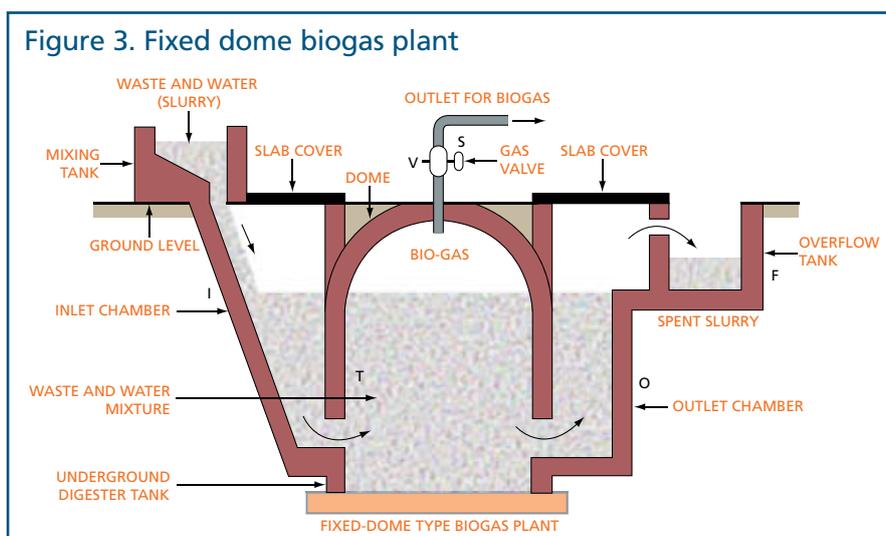
appropriate quantity of wastewater to aid the digestion process (this is not done in landfills). The digester is provided with an overflow pipe to lead the sludge out into a drainage pit.

The gas holder is an airtight steel container that, by floating like a ball on top of the fermentation mix, cuts off air to the digester and collects the gas generated. Usually, the gas holder is equipped with a gas outlet that can be connected to the kitchen. The combustion of the biogas produced in this way produces very little odour or smoke.

### Advantages of biogas plants

- According to the Alternative Energy Promotion Center (AEPC), one biogas plant helps to save 2 tons of wood, 0.8 tons of agricultural waste, 0.45 tons<sup>1</sup> of dung cake and 50 litres of kerosene per household on average.

1. A metric ton is used here to describe 1000 kilograms



- Biogas produces less carbon dioxide than fossil fuels.
- Collecting biogas reduces the emissions from rotting farm waste.
- Biogas reduces labor by at least three hours per day per household, which would have otherwise been spent chopping down trees and building cooking fires.
- Biogas improves health, because:
  - It does not produce smoke and so reduces the chance of eye/respiratory irritation.
  - It does not dirty pots as much as wood fuel, so makes cleaning pots easier and more hygienic.
  - Using biogas to cook removes the danger posed by open wood fires.
  - The plants treat waste, which reduces the risk of disease.
- Sludge, a by-product of the digestion process, is a better fertilizer than manure or synthetic fertilisers, and is cheaper than manufactured products.
- Biogas is renewable – people and animals will always produce waste.
- Biogas reduces the amount of waste that needs to be transported to, and put into landfills.
- Digesters are simple to build and use materials that are often available locally. Demand for digesters provides opportunities for local enterprises.
- Biogas is a more reliable generator of electricity than the wind or the sun.

### Disadvantages of biogas plants

- Because digester plants require a lot of water to function, they are only appropriate where there is an abundance of natural water so that they do not compete with the needs of the local community.
- Methane can explode if care is not taken. However, with a small amount of training, local communities can learn how to handle biogas safely.

### When biogas plants are most likely to be suitable

Digesters are useful for abattoirs, dairy farms, or to treat wastewater sludge because it reduces the volume and mass of the input material. Some designs are also appropriate for community use. The energy from small-scale units should be used on-site if possible (for cooking, heating, lighting and absorption refrigeration), because compressing the gas for storage or use in vehicles uses a large amount of energy.

### Example of biogas plant projects helped by the CDCF

#### Methane from manure – biogas support program in Nepal

This project helps to support poor, rural households to install small biogas plants which they would otherwise not be able to afford. The plants run on animal and human waste, generating gas that can be used for cooking, replacing traditional sources of energy, namely fuelwood, kerosene and agricultural waste.

Punyadumari Sanjel, a 55 year-old woman involved in the project, says, “Initially we built the biogas plant without toilets attached, and there was not enough gas to cook for the entire household. We had to resort to using traditional ways of cooking. Later on, a biogas entrepreneur showed us how to build and connect toilets to generate more gas for the plant and to improve sanitation. Now we use the plant to make enough meals for the entire household and our health and surroundings have significantly improved as a result.”

The use of biogas has decreased the amount of smoke in kitchens, reducing the incidence of respiratory disease among household members. The latrines, installed to feed into the biogas plants, have improved health and cleanliness (before people would defecate in the open). The women no longer have to collect firewood and have more time for other tasks. The community is using the slurry from the plants to increase fish production. In addition, the project has improved social cohesion and created local jobs.

## Solar thermal water heaters, cookers and driers

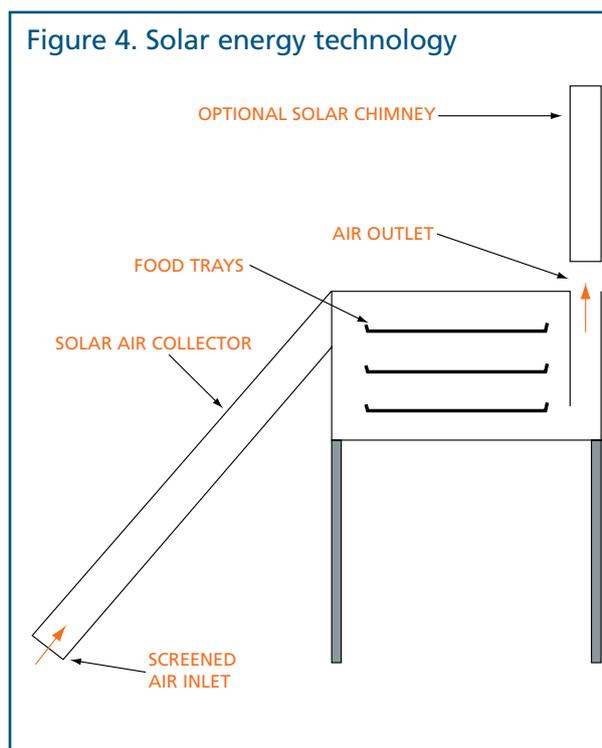
Solar energy technologies harness the sun's energy and can be used to heat houses or water, for cooking, or for drying. Although there is no shortage of sun on the earth, its availability is affected by the time of day, the seasons and the weather. The sun's energy far exceeds our energy needs, but methods for tapping it are only in their infancy.

Solar energy is renewable. Apart from the emissions involved in building solar technologies, they come free of any greenhouse gas emissions. When solar energy replaces other sources of energy such as firewood or fossil fuels, it reduces emissions.

### How does the technology work?

Building houses to face the sun is a simple example of using the sun's energy. Other examples include:

1. **Solar cookers:** these cookers use reflectors to concentrate the sun's rays on to a cooking container. The reflectors track the sun's movement during the day, and their shape helps amplify the rays to heat the cooker to a high temperature. Solar cookers also trap heat, and many are black to absorb the heat from the sun. The simplest design requires only cardboard, aluminium foil, and a plastic bag. Solar cookers are usually quite large, but portable models have also been developed.
2. **Solar driers:** these are used for drying fruit and fish to give the products a longer shelf life and make them easier to transport and sell. The driers use a combination of heat and air movement to remove 80 to 90 per cent of the moisture from the food. Typical drying times range from one to three days, depending on the sun, air movement, humidity, and the type of food. The temperature in the dryer ranges from 100 to 160°C, which kills bacteria and inactivates enzymes.
3. **Solar thermal heaters:** these heaters collect solar energy, and use air or water to transfer the heat to where it is needed. 'Low temperature' collectors are flat plates that can be used to heat swimming pools or the inside of buildings. 'Medium temperature' collectors are also usually flat plates and are used to heat water for residential and commercial use. Governments in many countries offer a subsidy or tax incentive for installing this kind of water heater.



## Advantages of solar cookers, heaters and driers

- Communities and households with access to these technologies can reduce the time and cost involved in collecting or purchasing firewood or other fuels, and the cost of electricity where it is available.
- Hot water can improve hygiene and increase comfort.
- Drying foodstuffs increases their shelf-life and therefore can also be sold for income.
  
- The solar technologies mentioned above are cheap, simple and easy to build. For example, the solar cooker is cheap to produce and costs nothing to run, requires little skill to operate and reduces the amount of time needed to tend an open fire, which is a great benefit for the cook (usually a woman).

Other advantages include:

- Clean (no greenhouse gas emissions after set-up) and non-polluting.
- Renewable.
- Lowers household power bills.
- Solar will become more attractive as the cost of installation gets cheaper.
- Silent operation.
- High reliability.
- Low maintenance.
- No fuel dependence.
- Can be used in any location, provided there is enough sunlight.
- Protects forests, which many communities rely on to make a living.

## Disadvantages of solar cookers, heaters and driers

- Because solar power doesn't work at night, solar cookers are only suitable for cooking during the day.
- These technologies do not work as well during winter and when there is cloud cover. They are only reliable in a sunny climate.
- They have not been particularly popular, in part because they are so different to conventional cooking methods. They also take longer and provide a much less intense heating source.

## When solar cookers, heaters and driers are most likely to be suitable

These solar technologies can be installed anywhere, and across many households and institutions. They are useful for providing small amounts of heat energy, particularly in remote areas without access to the national grid. These technologies are useful for poverty reduction purposes and for this reason are applied in programs across poor and remote regions of the developing world, such as in Africa.

## Example of a solar water heater and insulation project

### The Kuyasa low cost housing interventions project

This is facilitated by the non-governmental organization (NGO) SouthSouthNorth. It is a small-scale CDM project that reduces emissions in low-income housing units. The project installs solar water heaters and ceiling insulation to reduce the need for heating. Many of these poorly-built houses lack ceilings altogether, with only a corrugated iron sheet for a roof. The project helps people save on the cost of household energy and improves their health by reducing dust and the need for paraffin stoves, which are a fire hazard and can cause respiratory disease.



Households benefit from ceiling insulation and solar water heaters

© SouthSouthNorth

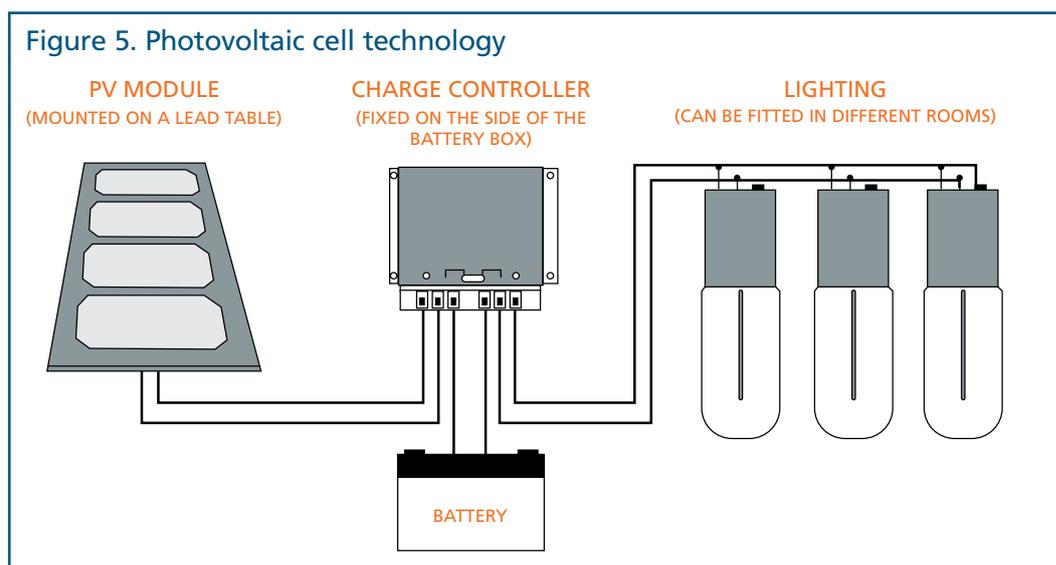
The project was the first Gold Standard project in the world because of its overwhelmingly positive contribution to sustainable development.

## Solar-powered home systems

Solar energy, as we have seen in the previous section, is a renewable source of energy. Photovoltaic cells (PV) are a more sophisticated form of solar technology and can be used in both small- and large-scale projects, such as a PV power plant.

As in other solar technologies, PV is emission-free – almost. Batteries are used to store the captured energy and require regular replacement. Their manufacture is likely to use energy from fossil fuels, and this should be factored in when assessing the greenhouse gas reductions involved in a project.

### How does the technology work?



A typical, stand-alone solar PV home system is made up of a PV module for charging the battery, a solar deep cycle battery for storage, a charge controller to charge and discharge the battery, light sources and provision for connecting other loads (radio, tape recorder, portable TV, etc.) as well as a complete set of installation hardware.

The battery and module rating are selected depending on individual requirements. The performance will vary depending on solar levels, and the use of energy-efficient practices, such as the correct orientation of the solar panel.

### Advantages of solar home systems

- This source of off-grid electricity enables the use of small appliances, lighting and communication and entertainment systems. It helps run small offices and businesses, and

enables children to study in the evening. Listening to a radio or watching television often provides educational and social advantages to poor isolated communities, who are otherwise denied all access to modern technologies.

- Communal spaces can also be lit and stimulate local organizational development.
- Enabling access to micro-credit to buy these systems is likely to stimulate community engagement and cooperation.
- Small enterprises may benefit from selling, installing and maintaining this technology.

See the previous section on solar technology for further benefits.

### Disadvantages of solar home systems

- The cost of buying and installing solar panels remains the biggest obstacle to wide-scale use. Unless there are credit facilities available, the technology is unaffordable for most people.
- Solar cells cost a great deal of money compared to the amount of electricity they produce in their lifetime, but are cheap when the costs involved in reducing emissions and the costs caused by the impacts of climate change are considered.
- Storing the captured energy also creates challenges. Energy can be stored in the form of heat, but batteries are still the most effective form of storage. However batteries do not last forever and are a cost to the buyer and to the environment.

### When solar home systems are most likely to be suitable

Because it provides small amounts of energy, solar power is most useful in the home or small offices and businesses, and in rural areas without access to the national grid. As mentioned above, this technology is most useful where the sun shines reliably.

Because solar home systems are expensive, they are most likely to be useful in situations where micro credit is available to people to purchase and install the systems, for example in Bangladesh and India where the Grameen Shakti Bank operates.

### Example of solar home systems helped by the CDCF

#### The Grameen Shakti solar home systems project in Bangladesh

This project helps poor rural households not connected to the grid to access renewable solar electricity. The project reduces emissions by replacing kerosene used for lighting and diesel used for off-grid electricity generation.

The target households have no electricity and use diesel generators to produce electricity. Grameen has initiated a project to offer micro-finance to these households so that they can access electricity and increase their economic activity.



Local women employed on the solar home systems project

#### Benefits

- A total of 198,978 households will be supplied with electricity from solar energy.
- Kerosene and diesel consumption will be replaced by renewable energy.
- The program will generate short- and long-term employment resulting from the installation and maintenance of solar home systems.
- Rural businesses, enterprises, schools, health centers, mosques, and temples will also be supplied with solar energy.
- The use of modern technologies, such as television, computers, and radios, will increase throughout the community.

## Micro-hydro technology

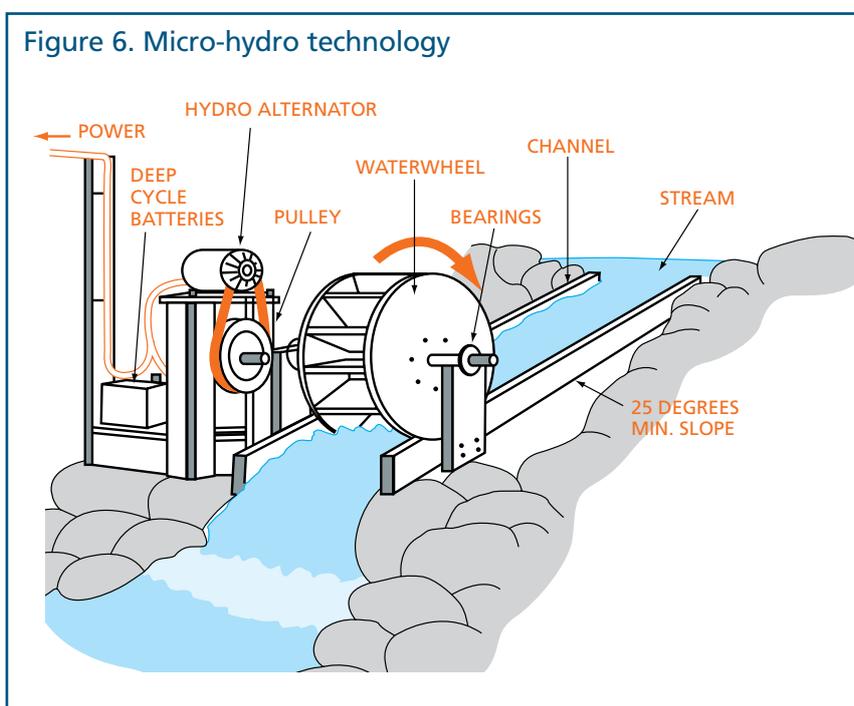
Flowing rivers have built-in energy that can be collected and used as the water flows downhill. Flowing water is a renewable source of energy and has been used for thousands of years, for example to turn paddle wheels to grind grain.

Micro-hydropower plants are relatively cheap to build and once running are relatively easy to maintain. Once built, these plants provide electricity without emitting any greenhouse gases and are eligible for the CDM.

### How does the technology work?

Electricity is produced by using the flow of water to turn the blades of a turbine (generator). In large storage plants, a dam is built across a river so that the water flow through the turbines can be controlled and increased when needed. When electricity is not required, the stored energy can be used to pump water back up to the dam for later use. These large-scale hydro-electric plants are controversial, but small-scale, micro-hydro plants are considered an ideal way to produce electricity in remote areas, or as an adjunct to the national grid.

Small-scale run-of-river plants use little, if any, stored water to provide water flow through the turbines. Although some plants store a day or week's worth of water, weather changes – especially seasonal changes – cause run-of-river plants to experience significant fluctuations in power output.



### Advantages of micro-hydropower

- Micro-hydropower provides a cheap, sustainable, and generally reliable supply of electricity and serves small grid connections in remote areas. No water is polluted in the process.
- Hydropower plants may be used as an adjunct to the grid, reducing reliance on fossil fuels and

ensuring the reliability of energy in areas where peak demand is frequently over run. Having a reliable source of electricity often makes the difference in a community developing and advancing financially.

- Building, running and maintaining micro-hydro plants provides job opportunities.

### Disadvantages of micro-hydropower

- Large storage plants can cause problems for the local environment and the people who live near them. For example, changing the flow of a river will affect the water supply to land nearer the sea. This may cause problems for farmers irrigating their crops.
- A good site for a hydroelectric scheme, such as a mountainous region, is not always near towns. It is possible to transmit electricity over long distances, but a loss of energy is inevitable and increases in proportion to the distance the energy has to travel.
- The building of large dams floods large areas and causes damage to existing habitats. Because of this, run-of-river plants may be more environmentally and socially acceptable.

### When micro-hydro plants are most likely to be suitable

This technology is most suitable in places where rivers flow continually and offer a constant source of energy. Hydroelectric power schemes exist in many countries. They can be built in areas where there are fast-flowing rivers. These are often hilly or mountainous regions where rivers flow down steep slopes.

On flatter land, rivers flow more slowly, so very large artificial dams have to be built to create reservoirs. The reservoir then provides a 'head' of water that can be directed through a turbine.

Most people live on flatter land, so most hydroelectric schemes require large dams and flood a lot of land. Large hydropower plants can significantly impact the surrounding area. Reservoirs can cover towns, scenic locations and farmland, as well as affect fish and wildlife habitats. To mitigate the impact on migration patterns and wildlife habitats, dams maintain a steady stream flow and can be designed with special pathways to allow fish to migrate upstream.

Less often used than solar or wind energy, micro-hydro has the potential to produce the most power. It is more reliable than solar or wind power if the right site is found.

### Example of micro-hydro plants helped by the CDCF

#### The Santa Rosa micro-hydropower in Peru

This project is a bundle of run-of-river hydropower plants that feed into the national grid and help reduce the area's reliance on fuel-diesel, coal- and gas-fired power plants therefore reducing the emission of carbon dioxide into the atmosphere. The project uses the existing irrigation infrastructure as its source of water flow. It is the first small-scale CDM project to be developed in Peru.

The project provides sustainable development benefits such as creating jobs during installation and operation. Thanks to a community benefits plan, revenue from the project will be used to improve local infrastructure. There



A canal and spillway at the Santa Rosa hydro project. The canal is cleaned regularly as part of the community benefits plan.

are plans to build a community center, renovate a school building and provide free electricity to a local orphanage.

### The Nepal micro-hydro, with assistance from the Alternative Energy Promotion Center (AEP) in Nepal

This project is developing and installing micro-hydropower plants ranging from 5 to 500 kilowatts, with a cumulative capacity of 15 megawatts. These projects will be bundled together to reduce energy waste. While 80 per cent of Nepal's population relies on agriculture for their livelihoods, only 10 per cent of households are connected to the power grid. Most energy comes from traditional fuel such as wood and animal dung. This dependence on wood has contributed greatly to deforestation, resulting in wood scarcity and widespread erosion. Fossil fuel such as kerosene is too expensive for many rural people. The villagers, in particular women, often spend hours each day collecting wood to cook meals and will benefit from the provision of power through the project activities.



Improved lighting is one benefit from the Nepal micro-hydro project

This new source of power will also reduce the use of dry cells used to operate radios and flashlights. As it will eliminate the need to charge lead acid cell batteries, there will be no need for the continuous transport of the batteries from houses to charging stations. This will reduce the amount of chemical pollution in the local environment and reduce the risk exposure and contact with these chemicals.



The Community Development Carbon Fund (CDCF) provides carbon finance to projects in the poorer areas of the developing world. The Fund, a public/private initiative designed in cooperation with the International Emissions Trading Association and the United Nations Framework Convention on Climate Change, became operational in March 2003. The first tranche of the CDCF is capitalized at \$128.6 million with nine governments and 16 corporations/organizations participating in it and is closed to further subscriptions. The CDCF supports projects that combine community development attributes with emission reductions to create “development plus carbon” credits, and will significantly improve the lives of the poor and their local environment.



The World Bank Carbon Finance Unit's (CFU) initiatives are part of the larger global effort to combat climate change, and go hand in hand with the World Bank and its Environment Department's mission to reduce poverty and improve living standards in the developing world. The CFU uses money contributed by governments and companies in OECD (Organization for Economic Co-operation and Development) countries to purchase project-based greenhouse gas emission reductions in developing countries and countries with economies in transition.



The International Institute for Environment and Development (IIED) is one of the world's top policy research organisations focusing on sustainable development. With partners on five continents, IIED is helping to tackle 21st-century challenges ranging from climate change and cities to the pressures on natural resources and the forces shaping global markets. The institute works with some of the world's most vulnerable people to ensure they have a say in the policy arenas that most closely affect them – from village councils to international conventions.



SouthSouthNorth (SSN) is a network-based non-profit organisation sharing two decades of experience in the fields of climate change and social development. SSN directly pursue structural poverty reduction in Sub Saharan Africa, Asia and Latin America by building Southern capacity and delivering community based mitigation and adaptation projects.