Sun, Wind, Water and More

Renewable Energy in WWF Field Projects

David Harper, Jean-Philippe Denruyter and Judy Oglethorpe

Credits

Research for this report was undertaken for WWF's Renewable Energy Centre and People and Conservation Program by David Harper, intern at WWF-US in 2009, under the supervision of Jean-Philippe Denruyter, Manager, Global Renewable Energy Policy, WWF-International and Judy Oglethorpe, Managing Director, People and Conservation, WWF-US.

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Cover photos: **top left**: Jari Maya at her household biogas inlet, Terai, Nepal, © WWF Nepal / Trishna GURUNG; **middle left**: power station in northern Hungary that burns biomass from an invasive plant, © WWF International / Jean-Philippe DENRUYTER; **bottom left**: solar cooker, Nepal, © WWF Nepal / Ugan MANANDHAR; **right**: wind and solar power in WWF/Kenya Wildlife Service camp in Kiunga Marine National Reserve, Kenya. © WWF-US / Judy OGLETHORPE.

Please address any questions to Jean-Philippe Denruyter
Email: jpdenruyter@wwf.panda.org
Phone: +32 2 740 09 27

WWF-International
Av. du Mont-Blanc
CH-1196 Gland
Switzerland
Phone. +41 22 364 9111
Fax. +41 22 364 0640
www.panda.org

WWF-US
1250 24th St. NW
Washington, DC 20037-1193
USA
Phone. +1 202 293 4800
Fax. +1 202 293 9211
www.worldwildlife.org

Executive Summary

This report presents results of a project that reviewed WWF renewable energy field projects around the globe to learn lessons and provide a source of inspiration and information for future WWF renewable energy ventures and to create a network of WWF staff involved in renewable energy projects for future action.

WWF offices and projects have undertaken a number of unrelated renewable energy projects whose purposes and benefits have included slowing of habitat degradation; promoting habitat restoration; reducing greenhouse gas emissions; improving community livelihoods, health, education, and women's empowerment; increasing efficiency of WWF operations; generating messages for global climate change communication; and providing practical demonstration of renewable energy approaches.

The review focused on 10 case studies, which are presented at the end of the report. In Vientiane, Laos, and Kiunga, Kenya, WWF offices were outfitted with wind and solar technologies to provide a reliable and sustainable source of electricity. In Madagascar, Democratic Republic of Congo, Tanzania, and Nepal, efficient woodstoves, solar cookers, biogas, small-scale hydro, and/or wood production chains were used to reduce deforestation practices and improve the well-being of local people. In Hungary, biomass energy was at the core of a plan to rehabilitate habitats. And in Tanzania solar power was implemented to improve the lives of children and others in a rural village. Findings and recommendations of the review are summarized below.

Need for Renewable Energy and Choice of Technology
Identification of need is extremely important when starting to plan a renewable energy project. What need will it meet, and what are the drivers/threats that justify it? Then, sound choice of renewable energy technology is extremely important for project success. Each technology functions best under specific conditions. A long-term, well thought-through renewable energy system management plan is crucial for success, and awareness raising and education are critical.

Solar photovoltaic panels can be used almost anywhere for any size of infrastructure project. They have a long lifespan, produce no pollution or noise, require no fuel, and can save time and work for local people, particularly women. Drawbacks include high initial cost, performance fluctuating with weather conditions, energy storage requirement, the need for reasonable knowledge of electrical systems, and risk of theft.

Wind energy systems tap into a free source of energy, have a long lifespan, do not require fuel, and save communities time and work. Disadvantages are similar to some of those listed for photovoltaic solar panels. Photovoltaic/wind hybrid systems with batteries help to overcome some of these disadvantages. It is crucial to plan for battery replacement.

Bioenergy projects include use of crops and solid biomass to generate electricity, heat, and liquid biofuels; use of animal dung and human excreta to produce biogas; and more efficient use of biomass, e.g. fuel-efficient stoves. Advantages include no net carbon emissions if well managed; provision of a stable energy supply compared to wind and solar energy; creation of local employment; and, in some cases, saving women time and work. Drawbacks include cultural resistance; the need for an adequate supply of resources; risk of competition with other land uses; relatively long time associated with production/processing; and climate limitations, e.g. for biogas viability. Alternatives often struggle if firewood remains readily available locally.

Micro-hydro provides a more steady energy supply compared to solar and wind power and can be adapted for many different situations. Disadvantages include the need for suitable stream characteristics, high initial investment cost, and fluctuations in electricity supply if the streamflow fluctuates. It is also difficult to expand capacity of an initial installation - it is easier to add a solar module to an existing solar installation or a wind turbine to a small wind park. But all small electrical systems are designed for very specific needs and if demand exceeds the need that was foreseen when the system was built, the installation can wear out rapidly.

Solar cookers do not burn food, cause no health problems from smoke, save work, can be made cheaply and locally, and can last for many years. Drawbacks include long cooking times, dependence on direct sunshine, and sometimes incompatibility with culture and work practices.

Community Involvement
There are multiple benefits in helping communities access renewable energy. These include improving livelihoods, health and education; empowering women; reducing pressure on natural systems; and improving community attitudes toward conservation. In many of the case studies, despite cultural attachment to traditional energy uses, communities were willing to adopt new approaches if they could see clear benefits. Community participation and ownership of renewable energy systems and processes are keys to success. Systems should be affordable and easy for communities to maintain; they should not incur opportunity costs such as loss of agricultural land. When a local economy can be created around the renewable energy supply, the likelihood of success increases. In developing countries, projects should aim to help reduce poverty and benefit women, the poor, and less-privileged members of the community. Where WWF is installing a renewable energy system for its own operations in a remote area, extending benefits to local communities improves neighborly relationships.

Funding of Renewable Energy Projects
In community projects, ideally communities should contribute in-kind to the cost of renewable energy systems so that they value them. Strong community participation and buy-in is important from the start to help ensure that the communities maintain the system in the future. Maintenance should be cheap and, if possible, undertaken locally. To make projects replicable and to scale them up, it is important to develop models that are economically viable for government authorities, businesses, local communities, and other stakeholders. Such models include profitable environmental protection and restoration solutions where profit is made while protecting the environment (for example, harvesting an invasive tree species to fuel a power station in Hungary and restore floodplains) and micro-credit solutions where renewable energy is made affordable for households.

Carbon markets are a growing area for financing renewable energy projects. To ensure project quality, any project seeking certification should look for Gold Standard accreditation. However, many of WWF's case study projects are too small for carbon markets due to high transaction costs, with the exception of the Terai household biogas project in Nepal which bundles several small-scale projects. Another way to cover several similar small-scale projects is the Programme of Activities concept, where project activities can be registered as a single clean development mechanism project; here it is possible to add new CDM Programme Activities (CPAs) to a PoA without undertaking the validation process afresh, or charging registration fees to new CPAs.

Given the high up-front costs for submitting carbon project proposals, only larger-scale projects should be considered (e.g. WWF- Switzerland's Gold Standard work sets a project minimum of 20,000 tons a year of greenhouse gas emission savings). For future projects that are on a large enough scale, carbon markets can increase project viability and profitability of renewable energy and energy-efficiency projects. Carbon markets can also help WWF to introduce renewable energy technologies in new places and provide good demonstration pilots to help support national policy development for renewable energy.

Project Monitoring

Most of the projects in this review were successful in building renewable energy infrastructure and making it work. However, monitoring was often inadequate to measure conservation impact. (Admittedly, some were too young to show impact.) This is an area to focus on improving in the future so as to produce strong demonstration models with quantifiable results.

Replicating and Scaling up Approaches

Single, small-scale renewable energy projects will not solve the huge environmental problems we are facing. For this reason, it is important to prioritize projects that have good potential for broader replication by WWF and others and for use in demonstration, communication, advocacy, and policy work at local, national, regional, and/or global levels.[1]

Future of Renewable Energy in WWF Network

The current renewable energy field projects portfolio is scattered and uncoordinated, resulting from local-level innovation. To date there has been no centralized, concerted effort to promote renewable energy approaches in our own operations or those of our partners. In light of WWF's ambitious climate program and the multiple benefits of renewable energy, we recommend that WWF leadership give much greater focus to the potential of renewable energy through—

- **WWF operations:** starting with energy audits in offices where these have not already been done, with feasibility studies of renewable energy options
- **Field programs:** introduction and expansion of renewable energy approaches
- **Communication and advocacy:** broader use of renewable energy projects for demonstration and communication on climate change issues
- **Scaling up:** replicating and scaling up successful approaches in our own programs and through partners, with support of policy initiatives as needed.

To do this, WWF requires the capacity to provide technical assistance and help to seek funding for renewable energy activities. It also needs to ensure better access to renewable energy information and networking, including its own experiences and lessons, for WWF staff and partners. This project has made a start by initiating a network of WWF staff working on renewable energy.

[1] This is less the case for projects where WWF seeks to secure a reliable energy supply for its own operations, although it is still relevant.

Contents

List of Abbreviations and Acronyms

CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CEFR	Regional Forest Energy Commission
CFUG	Community forest user group
CNRIT	Center for Natural Resource Information Technology
CPAs	CDM Programme activities
DGF	Forestry Department
DNPWC	Department of National Parks and Wildlife Conservation (Nepal)
DRC	Democratic Republic of Congo
DRFT	Regional Forestry and Tourism Department
EARPO	WWF Eastern Africa Regional Programme Office
ESMAP	Energy Sector Management Assistance Program
FEC	Forest Energy Commission
GDP	Gross domestic product
GHG	Greenhouse gas
ha	Hectare
IDP	Internally displaced person
KAAA	Kadoorie Agricultural Aid Association
KMNR	Kiunga Marine National Reserve
MW	Megawatt
OEMN	"One Europe, More Nature"
PEVi	Virunga Environmental Program
PHE	Population, health, and environment
PoA	Program of Activities
PPO	Pure plant oil
PV	Photovoltaic
RES	Renewable energy system
SCAFP	Sagarmatha Community Agro-Forestry Project
SEESO	Synergie Energie Environnement dans le Sud Ouest de Madagascar
SEI	Solar Energy International
TAL	Terai Arc Landscape
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNHCR	United Nations High Commissioner for Refugees
UNIDO	United Nations Industrial Development Organization
VDC	Chaurikharka Village Development Committee

1 Introduction

There are many advantages to conservation organizations of adopting renewable energy approaches. Such approaches can help reduce deforestation and promote reforestation, reduce environmental impacts of energy infrastructure, reduce greenhouse gas emissions from energy or agriculture systems, and improve conservation organizations' logistical operations. Positive social and economic impacts for local communities can go hand in hand with environmental benefits, improving health and livelihoods, providing reliable energy sources, and helping to alleviate poverty in the developing world. As conservation organizations expand the scope of their operations across different scales and sectors to embrace the major threats facing biodiversity today, a range of renewable energy practices can help reduce threats at many levels from local to global.

In light of the serious climate changes affecting some of WWF's priority places and the need to promote mitigation and adaptation techniques for the future of people and ecosystems, WWF needs to be at the forefront of the renewable energy debate. Our ability to embrace a more holistic approach to environmental problems, including livelihoods and the need for mitigation and adaptation, will greatly affect our efficiency in tackling environmental issues.

Therefore, a Renewable Energy Centre was created at WWF-International. The centre seeks to promote renewable energy in both industrialized and developing countries, thereby supporting WWF in its conservation work on both climate change and biodiversity. These efforts include—

- Development of a better understanding of how renewables can be deployed in different regions, especially in regions where WWF seeks to promote transformational projects in order to achieve WWF's Climate and Energy Vision by 2050.
- Advocacy on electric grid issues, promoting a grid that can absorb large quantities of renewable electricity, mainly in Europe and the United States.
- Advocacy for a right framework for a large-scale solar power development, mainly in North Africa.
- Support for the development of an enabling framework for geothermal energy, mainly in South East Asia.
- Assistance to WWF's business partners in purchasing credible green power around the world
- Help in solving tensions between local environmental objectives and renewable energy development, for example through mapping of biodiversity and renewable energy potentials around the world
- Promotion, in "renewables-scarce" countries, of renewable energy pilot projects that have a high replication potential and can stimulate governments to support renewable energy through policies over the longer term, mainly in developing countries.
- Informing, encouragement, and support of the WWF Network to mainstream and use increasingly affordable renewable energy sources.

As part of these activities and more specifically to support pilot projects and colleagues who wish to use more renewable energy in their projects, the centre developed a project with the People and Conservation Program in WWF-US to review WWF renewable energy projects in field offices and programs around the globe to learn lessons and provide a source of inspiration and information for future WWF renewable energy ventures and to create a network of WWF staff involved in renewable energy projects for future action.

The project had the following objectives:

- to gather information on existing and completed WWF renewable energy projects around the world and prepare case studies on selected projects
- to create a network of WWF staff engaged in renewable energy projects
- to increase WWF's understanding of renewable energy and to encourage greater integration of renewable energy activities in WWF programs in the future

This report reviews several renewable energy practices adopted in the WWF Network as a safe, alternative, and smart choice for the future through 10 representative case studies. The main report extracts the essence of the stories and lessons learned, and the case studies are presented at the end. In Vientiane, Laos, and Kiunga, Kenya, WWF offices were outfitted with wind and solar technologies to provide a reliable and sustainable source of electricity. In Madagascar, Democratic Republic of Congo, Tanzania, and Nepal, efficient woodstoves, solar cookers, biogas, small-scale hydro, and/or wood production chains were used to offset deforestation practices that are occurring in critically important ecosystems and to improve the wellbeing of local people. In Hungary, biomass energy was at the core of a plan to rehabilitate habitats. And in Tanzania, solar power was implemented to improve the lives of children and residents in a small rural village. These examples are only a few of the many renewable energy projects in which WWF is involved around the globe.[2] They were selected on the basis of relevance and available information.

We hope that this report will encourage more WWF staff to develop renewable energy projects by highlighting results from pilot projects and providing guidance on appropriate technologies and models, costs, and opportunities to scale up initiatives. Although the report is meant primarily for an internal audience, we hope it will be shared with donors and partners and may also help other conservation organizations to increase their renewable energy involvement.

We wish you happy reading!

[2] A list of all the projects can be found in Annex 1

2 Project Analysis

There are several ways to use renewable energy. Each approach has benefits and drawbacks, and some important choices need to be made at the beginning of the project. Which technology is most appropriate for the context of my project? Can I buy the technology in-country? Is expertise available to maintain the installation, or can it be built up locally? What are the costs involved? Is the technology acceptable to the local community? Are there opportunities to replicate and scale up successful approaches?

Section 2.1 provides information on different renewable energy technologies and some very brief examples, and section 2.2 looks at reported successes and challenges in projects. The case studies in the second part of this report highlight in more detail the experiences of selected WWF renewable energy projects.

2.1 Pros and Cons of Different Technologies

2.1.1 Solar Photovoltaic Panels

Photovoltaics (PV) convert sunlight directly into electricity. PV cells are made of special materials called semiconductors such as silicon, which is currently the most commonly used. When light strikes the cell, a certain portion of it is absorbed within the semiconductor material, and hence energy from the absorbed light is transferred to the semiconductor. The energy knocks electrons loose, allowing them to flow freely. PV cells all have one or more electric fields that act to force electrons freed by light absorption to flow in a certain direction, producing an electrical current. By placing metal contacts on the top and bottom of the PV cell, the current is drawn off to use externally. This current, together with the cell's voltage (which is a result of its built-in electric field or fields), defines the power (or wattage) that the solar cell can produce. [3]

Due to the PV system's modular design and technological advancement, it can be applied in almost any location to fit nearly every need, generating power from very small to very large quantities. The many sizes and scales of the system enable it to have considerably low criteria to warrant site exclusion,[4] and it can easily complement other renewable energy systems (RES). The unique ability to be used as a stand-alone off-grid or grid-connected system has made PVs a great renewable energy resource for many applications worldwide.[5] According to UNEP (United Nations Environment Programme), economically solar photovoltaic systems are very competitive with fossil fuel generation in the case of small, isolated, and dispersed off-grid communities and villages.[6] The low maintenance needs of the system make it appropriate for villages where education levels are low, and villagers could not handle the maintenance of a complicated system.

[3] http://science.howstuffworks.com/solar-cell1.htm
[4] Even the Belgian Antarctic station, Princess Elisabeth, uses solar PV panels - http://www.antarcticstation.org
[5] Current Status of Renewable Energies in the Middle East – North African Region, United Nations Environment Programme, June 2007.
[6] Current Status of Renewable Energies in the Middle East – North African Region, United Nations Environment Programme, June 2007.

PV systems have a lifespan of more than 20 years and produce no noise or greenhouse gas emissions (except during the initial production and transport of the PV cells and parts). The payback time to replace the energy used during production is around 1.5 to 3.5 years for a PV system.[7] There are no additional costs for fuel as no fuel is required for operating the system, and PV systems are thus not subject to fluctuations in fuel prices, unlike fossil energy. Of course, fossil energy sources are directly competing with solar, and fuel prices will affect the PV system's economic competitiveness.

Although PV systems can be outfitted to fit nearly any scale or size of project as required, high initial investment costs must be taken into account. Other disadvantages of PV systems include energy storage issues when the sun is not shining, fluctuations in performance based on weather conditions and sunshine levels, the potential use of toxic materials for PV production, and the need for disposal of PV battery parts in an environmentally safe manner.

Electricity storage should not be underestimated. The battery system has to be replaced every five to eight years, depending on the technology's quality, which adds to the cost of the installation. Well-planned financial management that sets aside the necessary funds for battery replacement (as well as some small components such as inverters) is paramount for the project's survival. Neglecting the future need for battery replacement is one of the main reasons for project failure.

For all types of small-scale renewable electricity systems, the users' awareness and education regarding energy savings will also play an important role. Small systems are designed for very specific needs, and if demand exceeds the need that was foreseen when the system was built, the installation can wear out rapidly.

WWF has used a solar PV system with a battery at a local secondary school in a remote rural village of Miguruwe, Tanzania, to help supply light to the school. A PV system was chosen because of the high average incidence of sunlight the village receives, the minimal maintenance requirements of the system, and the lack of additional costs associated with fuels or delivery challenges. The WWF office in Laos chose to install PV panels on top of its building to supply electricity more reliably than the main grid and to showcase the technology. It was easy to place solar panels on the existing roof.

[7] Alsema, E.A.; Wild - Scholten, M.J. de; Fthenakis, V.M. Environmental impacts of PV electricity generation - a critical comparison of energy supply options, September 2006.

Solar lamps

In the Terai Arc, Nepal, WWF introduced cheap solar lamps to communities that traditionally used kerosene lamps for light in the evening. Along with smoke from cooking fires, kerosene contributes to indoor air pollution that is a major cause of acute respiratory infection. Kerosene is a fossil fuel that poor households often struggle to pay for. In this renewable energy system, a small solar panel charges two lamps. The solar lamps enable children to study in the evening and women to see when cooking and looking after children. Each household set costs US$54 (2007 exchange rate). The Khata Community Forest Coordination Committee used a revolving fund (with seed funding from Johnson & Johnson through WWF) to give microcredit loans to households to purchase solar lamp systems. This scheme was extremely popular with local villages, with a 100 percent repayment rate of loans in 2007. The solar lamps are made in eastern Nepal. The panels last for more than 10 years; batteries have to be replaced after two years.

Local communities report the following advantages of solar lamps:

- *Cost lower than kerosene*
- *Can provide light all night for no additional cost*
- *Do not produce smoke, so more comfortable and healthy for children studying*
- *Can be used as a battery to operate radio*
- *Can be used out of doors in wind and rain when kerosene lamp would not function*
- *Easy and safe to handle, with no fire risk*
- *Helps people avoid snakebites when going out to fields at night*

Source: Dhan Rai, WWF Nepal, personal communication 2007

Table 1. Advantages and Disadvantages of a PV System

Advantages	Disadvantages
Few criteria for site exclusion	High initial investment costs
Systems are flexible and can fit any size or scale of infrastructure project; new modules can be added as electricity consumption increases	Fluctuations in performance based on weather conditions, sunlight
Produce no greenhouse gas, pollution, or noise	Energy storage required when sunlight is not available, unless connected to the grid
Long expected lifespan (usually over 20 years)	Need to dispose of battery in environmentally safe manner
No fuel requirements	Some PV materials may contain toxic substances
No need for grid connection but grid connection possible	Reasonable knowledge of electrical systems is needed for maintenance
Can be outfitted to buildings when space is unavailable nearby	Risk of theft (panels)
Saves women time and work, which they can spend on child care, income-generating activities, community activities, and natural resource management.	

2.1.2 Wind Energy

Wind turbines produce electricity by converting kinetic energy in air movements into mechanical energy. Wind force acts on rotator blades that can directly power mechanical devices, such as water pumps, or can be connected to a generator to create electricity. Similar to other renewable energy systems, wind turbines create no greenhouse gases or other pollution[8] during their use. Large-scale production of wind turbines has risen in the past couple of decades as the costs of wind-generated electricity have fallen.[9] Heavily researched in the early 1970s when petroleum prices around the world spiked rapidly, wind turbine technology has been developed, improved, and fine-tuned for many decades. Wind energy has become one of the lowest cost types of renewable energy today, together with hydropower.[10] For developing countries, electricity from diesel generators often costs more than US$0.25 per kilowatt hour[11] in remote or rural areas, while large-scale production of wind energy can produce electricity at costs as little as US$0.04 per kilowatt hour to US$0.06 per kilowatt hour in the United States.[12] Even though small-scale electricity produced by wind power costs more than large scale wind projects, there are clear financial benefits of using wind energy to generate electricity. Other advantages of wind energy systems are that wind turbines use an infinitely sustainable source of energy (wind), require no fuel once installed, are automatically operated, call for little maintenance during their lifespan, and have lifetimes of more than 15 years with little or no major running costs during that time.

Wind energy systems are quite site specific in terms of their use. Largely affected by wind speed, the energy produced from wind turbines is also subject to barometric pressure, altitude, and air temperature in the surrounding environment. The high initial investment costs of the equipment make this RES difficult to acquire in developing countries, even though once built, it is economically viable for remote and rural areas. Dependent on a fluctuating energy source, wind energy systems experience variations in the amount of energy produced at times, which calls for a backup system or battery to store electricity when the wind is not blowing. UNIDO's training report suggests that wind will be successful if the potential markets are large enough to support the expertise and experience that are needed to develop and maintain wind energy systems.[13]

[8] Except maybe visual pollution and some noise, although this is a very subjective matter.
[9] Hara, Nobuyuki. Renewable Energy: RD & D Priorities, Insights from IEA Technology Programmes, International Energy Agency, 2006.
[10] Current Status of Renewable Energies in the Middle East – North African Region, United Nations Environment Programme, June 2007.
[11] Current Status of Renewable Energies in the Middle East – North African Region, United Nations Environment Programme, June 2007.
[12] Hara, Nobuyuki. Renewable Energy: RD & D Priorities, Insights from IEA Technology Programmes, International Energy Agency, 2006.
[13] Training Manual on Sustainable Energy Regulation and Policymaking for Africa, United Nations Industrial Development Organization.

Table 2. Advantages and Disadvantages of Wind Energy Systems

Advantages	Disadvantages
Infinitely free source of energy	Largely affected by wind speed, as well as barometric pressure, altitude, and air temperature
Does not emit greenhouse gases or any pollutants	High initial investment costs
Lifetime span of over 15 years	Site specific technology
Little to no maintenance required and automatically operated	Fluctuations in energy produced, which calls for backup system or battery to store electricity, unless the system is connected to the grid
No fuel required	Large-scale farms may have environmental impacts, including bird and bat mortality
Can be used in conjunction with other renewable energy technologies	Reasonable knowledge of electrical systems is needed for maintenance
Not necessary for grid connection but connection possible	
Saves women time and work, which they can spend on child care, income-generating activities, community activities, and natural resource management	

2.1.3 Bioenergy

Bioenergy refers to the production of energy from biomass. The term *biomass* includes animal wastes and residues, human wastes, wood and agricultural products and byproducts, and forest wastes. The production of energy from biomass can be done by physical, chemical, or thermal means and can produce fuel in a gaseous, liquid, or solid form.[14]

Chemical energy in biomass comes originally from the sun during the process of photosynthesis by plants in the presence of sunlight. Biomass is considered a renewable source of energy because plant matter is renewed constantly by photosynthesis in a quick regrowth cycle.[15] Biomass also has the benefit that it can be stored over long periods of time, compared to wind and solar renewable energy. As such, biomass can supply baseload energy to meet minimum expected consumer requirements.[16] Theoretically, if biomass is harvested and replanted in a sustainable way, use of biomass energy does not increase the atmospheric concentration of carbon dioxide because the carbon released during burning was originally absorbed by plant material; hence no new greenhouse gases are emitted into the atmosphere. However, this will depend on the biomass production process, transport, and use. Land-use change, such as felling of forests for biomass plantations, use of artificial fertilizers (whose production requires much energy), pesticides, etc., will affect the greenhouse gas balance of bioenergy as well as its benefits for the environment. Bioenergy can have a positive impact on local economies, spurring job creation in the growing, harvesting, and production of biomass for use as an energy source.

[14] Hara, Nobuyuki. Renewable Energy: RD & D Priorities, Insights from IEA Technology Programmes, International Energy Agency, 2006.
[15] Current Status of Renewable Energies in the Middle East – North African Region, United Nations Environment Programme, June 2007.
[16] Hara, Nobuyuki. Renewable Energy: RD & D Priorities, Insights from IEA Technology Programmes, International Energy Agency, 2006.

A difficulty encountered when using biomass is that it is often not readily available, meaning the production of materials may require long processes such as sowing, planting, harvesting, drying, storing, fuel conversions, mechanical conversions, and transportation.[17] High transportation costs are often associated with biomass, as it has a relatively low energy density before conversion when compared to fossil fuels.[18] However, a large proportion of the developing world currently uses fuelwood from forests, and the use of a better managed biomass resource will still represent a huge improvement.

Biomass technologies need a stable biomass supply chain, and this can create competition among land uses, including food production, when large areas of land are needed for production. Biomass production can be uneven throughout the year depending on climatic/weather conditions. And the smoke from biomass burning in homes, particularly wood products, can cause acute respiratory infections, usually among women and young children.

Culture can be a major hurdle when promoting fuelwood consumption reduction or switching to alternative or more efficient energy sources. For example, gathering organic sources of biomass, including animal and human excreta, is not necessarily acceptable in certain societies. There may also be resistance to moving away from traditional cooking methods. For example, indigenous villagers in the Khata area of the Terai, Nepal, commented that the design of an improved cook stove they had been given did not fit well with their work pattern. Members of an extended family would all work together in the fields and come home to eat quickly before returning to the fields. For this, they cooked communally using large pots, which did not fit on the improved cook stoves. Much awareness-raising and education is needed, as well as adaptation of technologies to local needs.

Alternative technologies struggle to gain markets as long as firewood remains readily available. Again, awareness-raising and education are keys. Also, it is important to combine alternatives, together with more traditional firewood management. It takes time to obtain results. In the end, if a project fails, often it is not due to the technology but to the human component.

The bioenergy technologies and sources described in this report are mostly rural and rather small-scale applications. For a more thorough discussion of bioenergy, including large-scale operations, please refer to WWF's position paper on bioenergy from June 2008.[19]

Solid Biomass

Solid biomass comprises organic material such as wood, dung, and industrial wastes that can be used to generate electricity, heat, and other forms of energy. The energy stored is released through several processes.

[17] Hara, Nobuyuki. Renewable Energy: RD & D Priorities, Insights from IEA Technology Programmes, International Energy Agency, 2006.
[18] Hara, Nobuyuki. Renewable Energy: RD & D Priorities, Insights from IEA Technology Programmes, International Energy Agency, 2006.
[19] www.panda.org/renewables

In Tiszatarján village in Hungary, the woody shrub *Amorpha fructicosa* is cut down and sold to a local power company to help restore the natural floodplains of the area. *Amorpha* is an invasive species that had come to dominate the natural vegetation of the landscape. The cleared land has now reverted to floodplain grassland with some areas dedicated to the planting of willow to ensure a sustainable supply of biomass for the future. The extraction of biomass has created local jobs for the surrounding villages as well as many seasonal employment opportunities from the planting and harvesting of willow seedlings.

In Madagascar, WWF sought to curb deforestation in the Spiny Forest by introducing a wood energy production management chain nearby the town of Toliara. The project planted energy-useful tree species as a biomass source for cooking needs. Local charcoal manufacturers and traders were trained on new carbonization techniques to produce better and more efficient charcoal from the solid biomass produced.

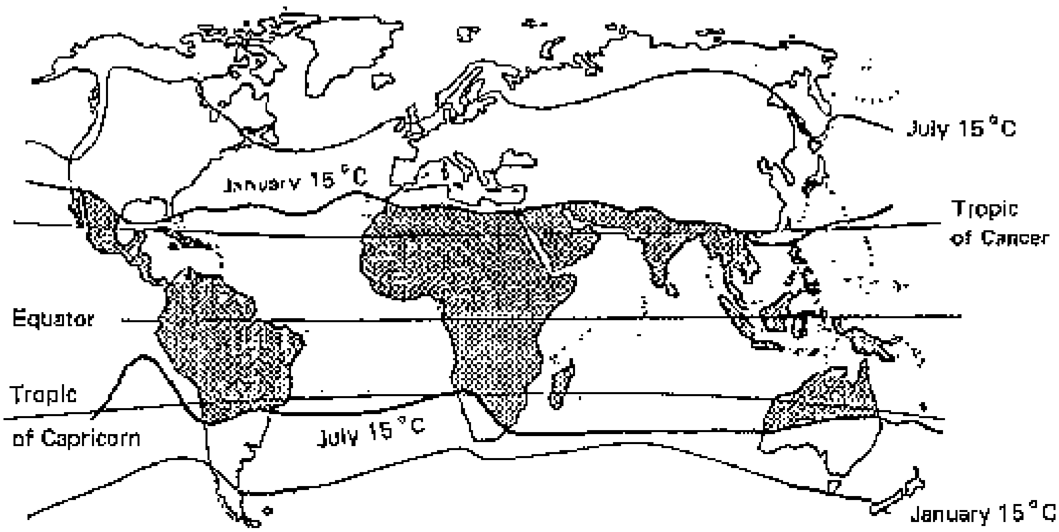
Biogas

Biogas refers to a chemical process where animal dung, human excreta, or other organic materials are broken down in anaerobic conditions to produce methane gas. Biogas technology is relatively simple and has been in existence for decades. Biogas is very advantageous for rural communities in developing countries to use because it demands only local resources for inputs. Overall, the simplistic nature and interchangeable parts of the system, as well as the range of uses for the biogas system, make this technology well suited for small-scale applications, including at the household level.[20] During the anaerobic process, organic material such as human excreta or cow dung, and water combine and decompose to form methane gas. This gas can then be used for lighting, cooking, or heating through combustion. The combustion re-emits carbon that was captured initially by plants, so the carbon balance is neutral. In addition to reducing pressure on forests and enabling forest restoration by reducing fuelwood consumption, biogas reduces indoor air pollution and hence acute respiratory infections in women and children and saves women much time and work from collecting firewood. Another advantage to using biogas technology is that the remaining solid waste produced from the chemical process is slurry rich in nutrients and valuable as a fertilizer. Biogas technologies are often used to avoid the collection of firewood with all its social and environmental impacts.

For biogas technology to provide a reliable source of methane gas, certain criteria must be met. Biogas options are affected by temperature, climate, altitude: *"A minimum temperature of 15 °C is required for anaerobic fermentation of organic material. Since simple biogas plants are unheated, they can only be used in climatic zones in which the minimum temperature is not fallen short of for any substantial length of time. In general, this is true of the area located between the two tropics, i.e. in the geographic region referred to as the "Tropics." This basic zonal breakdown, though, is altered in several ways by other climatic factors such as wind, elevation and ocean currents. Consequently, the climatic zones serve only as a basis for rough orientation with regard to the climatic evaluation of potential sites for biogas plants. The locally prevailing climatic conditions are decisive and must be ascertained on the spot."*[21]

[20] Technical and Economic Assessment of Off-grid, Mini-grid, and Electrification Techniques. Energy Sector Management Program, December 2007.
[21] Biogas Plants in Animal Husbandry, GTZ 1989

Figure 1. Global 15ºC isotherms for January and July, indicating the low-tech biogas-plant conductive temperature zone



(Source: OEKOTOP)

Table 3. Climatic Zones and Their Suitability for Biogas Plants (Source: OEKOTOP)

Climatic zone	**Factors of relevance for biogas generation**	**As biogas zone:**
Tropical rain forest	Annual rainfall > 1500 mm; this can lead to high groundwater levels, causing problems in construction and operation of biogas plants.	unfavorable
	temperature fairly constant at 25-28 °C; little animal husbandry due to various diseases, i.e. scarcity of dung; vegetable waste possible from permacultures and gardening	
Wet savanna	Water usually available all year (rainfall: 800-1500 mm) ; livestock farming on the increase, with mixed farms (crop farming + livestock)	favorable
Dry savanna	Short rainy season, long dry season; most livestock pastured extensively, but some mixed farming and cattle kept near to homesteads/farm buildings	possible
Thornbush steppe	Short rainy season (rainfall: 200400 mm) ; extensive-type pasturing (nomads, cattle farmers) so dung uncollectable; shortage of water	unsuitable
Dry hot desert	- - -	unsuitable

Another limiting factor is the livestock available to produce the necessary organic matter, although two to three head of cattle or pigs are often sufficient to produce enough dung for the mixing chamber. This amount will vary, depending on the circumstances. But the method is not normally appropriate for poor households who do not have livestock or land. (Space is needed for the biogas chamber.)

WWF's project work in the Terai region of southern Nepal has supported the installation of 3,578 biogas plants in local communities near to protected areas and critical forest corridors where firewood collection was a major cause of forest degradation and fragmentation. The low-lying Terai region has a warm climate and hosts more than 9.3 million head of cattle. The application of small-scale biogas technology in this region is very appropriate.

Liquid Biofuel

Bioenergy in the form of biofuels is the only RES that can currently significantly replace conventional transportation fuels, either fully or in blended percentages.[22] In developing countries, the mixture of biofuels with conventional fossil fuels is often necessary during the initial stages of biofuel implementation, as biofuel production can take a matter of years to reach its full potential capacity. Biofuels can also serve as a substitute for kerosene in cooking or lighting devices.

Due to the expense of petroleum for rural and small villages away from major cities, biofuels can certainly be an option as fuel for transportation devices, mainly boats, vehicles, and tractors. In these areas, consumption of fuel for transportation is quite low, so local producers can often supply quantities demanded.

In the village of Ngarambe in rural Tanzania, WWF began working with biofuels as they were a convenient way to replace conventional fossil fuels use in the village's existing generator with vegetable oil produced around the village. The longer-term aim is to use *Jatropha* as a feedstock for biofuel.

Fuel-efficient cooking stoves[23]

Fuel-efficient cooking stoves help cut down on fine particulate emissions, reduce fuelwood use, and promote better health practices. In developing countries where fuelwood is the main energy source for cooking, heating, and lighting needs, improved and more efficient fuelwood-burning cooking stoves help decrease incomes spent on wood or charcoal, curb deforestation, and cut down on women's time and labor associated with collecting wood. Fuel-efficient cooking stoves can also lead to increased safety for women, especially in areas of insecurity. Fuel-efficient cooking stoves can be made from porcelain, steel, cast iron, and even recycled metal barrels. As with other renewable energy systems, user practices can affect the efficiency and gains made with the system. The environmental conditions as well as the food preferences of the local inhabitants should be examined to help maximize efficiency and the benefits of improved cooking stoves.

[22] Hara, Nobuyuki. Renewable Energy: RD & D Priorities, Insights from IEA Technology Programmes, International Energy Agency, 2006, p

[23] http://eetd.lbl.gov/l2m2/stoves.html

Table 4. Advantages and Disadvantages of Bioenergy

Advantages	Disadvantages
Positive impacts on local economies and community well-being, creating jobs from harvesting, planting, cutting. Saves women time and work, which they can spend on child care, income-generating activities, community activities, and natural resource management	Long processes associated with the production of materials for biomass conversion to energy (except for firewood)
Renewable source of energy because of (direct or indirect) plant matter used	Require adequate supply of resources, causing potential competition in land use
Different types of conversions (physical, chemical, or thermal) leading to fuel in gaseous, liquid, or solid form	Production can be uneven throughout the year depending on climatic/weather conditions
If well managed, no new net increase in carbon dioxide emissions	Burning of traditional biomass can cause severe health problems
The only RES that can directly replace fossil fuels in existing installations and vehicles; can provide stable energy supply, compared to wind or solar	Certain site-specific characteristics associated with biogas production, including climate, availability of land, and source of organic material
Secondary slurry from biogas use can be used as fertilizer	Requires cautious assessment of environmental and social impacts of biomass production
	Reasonable knowledge of electrical systems is needed for maintenance of biomass-based electric systems

2.1.4 Micro-Hydropower

Around the world, hydropower remains the single largest source of renewable electricity. Most hydropower is generated by large hydropower plants; yet, as the technology of hydropower has become more readily available and used around the world, small hydro, micro-hydro, and pico hydro power plants have become increasingly common. To date, only 5 percent of the global hydropower potential has been exploited through small-scale sites.[24] Micro-hydro power facilities are simple to build; can be constructed at relatively low cost; and have a large diversity of blueprints, designs, material types, and structural components that make building each micro-hydro power system unique.

Micro-hydro systems are a great choice for developing countries because these systems provide a relatively cheap, reliable, and fairly constant stream of electricity, compared to other renewable energy systems. The low costs associated with implementation, coupled with an efficiency potential of over 90 percent, have given micro-hydropower systems greater accessibility for rural and remote areas needing electricity.[25] Micro-hydropower requires no fuel and does not emit greenhouse gases, has low maintenance requirements, and has a lifespan of more than 30 years. However, water is diverted away from a portion of the stream, and caution must be exercised to ensure that there will be no damaging impact on the local ecology or civil infrastructure. Further information on environmental impacts from hydropower, including dams, can be found on http://www.panda.org/what_we_do/footprint/dams_initiative/problems/.

[24] Hara, Nobuyuki. Renewable Energy: RD & D Priorities, Insights from IEA Technology Programmes, International Energy Agency, 2006.
[25] Current Status of Renewable Energies in the Middle East – North African Region, United Nations Environment Programme, June 2007.

For a micro-hydropower system to be fully functional, efficient, and effective, certain site characteristics must be met. These include a watercourse that has sufficient stream discharge[26] and water drop that is located relatively close to where the energy is needed. Unfortunately, these conditions are not always met for rural villages and communities looking to implement micro-hydro technology. Once operational, micro-hydro systems cannot easily be expanded, if at all, to accommodate an increase in energy demand, as the systems are tailored to the stream. If the population of the area expands or per capita consumption increases, the community must look to other sources for increased electricity supply.

Although micro-hydro technology delivers a constant electricity supply over longer periods than wind or solar systems, fluctuations in the amount of electricity delivered do still occur during the year. This depends on patterns in precipitation, streamflow and water depth. Before installing micro-hydro technology in a stream, the climatic conditions of the region and annual streamflow patterns, as well as variability between years, need to be taken into consideration.

If climate change continues unabated into the future, there will be severe consequences for micro-hydro in many areas. With rising temperatures, glacial melt, and changes in precipitation patterns, streamflow is already changing in many areas, and micro-hydropower plants that depend on smaller streams and mostly don't include dams could see a large variability in the amount of electricity they can produce. Seasonal fluctuations could increase greatly, so engineers and implementers of this technology must be able to extrapolate water levels and conditions into the future to determine if hydropower systems are viable.

In Chaurikharka Village, Nepal, WWF became involved with a project to bring electricity to local communities from micro-hydro technology to decrease deforestation, since hydroelectricity offers a substitute for firewood. The Ghatte stream was selected for implementation because it exhibited appropriate site characteristics, mainly good stream discharge, velocity, and head of water.

Table 5. Advantages and Disadvantages of Hydropower

Advantages	Disadvantages
Can be built at relatively low cost	Specific site characteristics
Large diversity of sizes, shapes, designs, and blueprints for differing project needs	Micro hydro systems cannot easily, if at all, be expanded to meet increased energy needs
Provide a less variable source of energy compared to solar or wind energy on a daily basis, although fluctuations do happen over the year	Fluctuations in the amount of electricity provided throughout the year (dependent on climatic conditions)
Saves women time and work, which they can spend on child care, income-generating activities, community activities, and natural resource management.	
Over 90 percent efficiency potential	High initial investment costs
Low maintenance requirements with a lifespan of over 30 years	High level of engineering knowledge for implementation of the system
No fuel required	Potential environmental impacts
No pollutants emitted	Reasonable knowledge of electrical systems is needed for maintenance

[26] Volume rate of water flow.

2.1.5 Solar Cookers

A solar cooker is a relatively cheap and efficient way to prepare a meal via a renewable energy source, the sun. Food can be cooked at a temperature of 250 degrees Fahrenheit[27] (121 degrees Celsius) to successfully kill pathogens. Solar cookers can also be used to boil or pasteurize water.[28] Solar cookers do not use wood to cook food and thus significantly cut down on health problems in developing countries where woodstoves are used. The cookers emit no harmful pollutants and no greenhouse gases. They are ideal for local manufacturing, as the materials are simple and easy to assemble. Used in conjunction with improved cooking stoves, solar cookers can significantly cut down on firewood consumption in developing countries.

Their relatively low temperature makes for prolonged cooking times. This is a disadvantage in cases when food needs to be cooked and served quickly or when those cooking could better spend their time on income-generating activities. However, solar cookers cook food at temperatures that do not cause burning, reducing the level of attention needed by the cooks.

Solar cookers also require certain climatic and socioeconomic characteristics to be efficient and effective. Ample amounts of direct sunlight are necessary. Compatibility with the daily work pattern of households is key: In some situations, local people in rural communities have to work throughout the day while the sun is shining to generate income or grow subsistence crops and cannot start cooking until after the sun has gone down when solar cookers will not work. In other regions, long rainy seasons can affect the effectiveness of solar cookers. Extended families' pots may be too big for some types of solar cookers. These socioeconomic and climatic characteristics must be assessed before introducing solar cookers.

In northern and southern Nepal, WWF embarked on a project to bring solar cookers to local village residents in the Terai Arc Landscape, the Kanchenjunga Conservation Area, and Langtang National Park of Nepal. In these areas, most residents relied on fuelwood for household cooking and heating needs. Solar cookers worked well because most villagers had at least one family member who did not work up until dusk, so food could be prepared before sunset. This is a key requirement of all projects that hope to implement solar cooking technology. The work patterns of communities and climate factors must be fully assessed to see if the site characteristics meet the requirements for solar cookers. For example, in Nepal the summer solstice days are good for efficient cooking, but during winter solstice days, it takes much more time to cook.

[27] http://www.she-inc.org/cooking.php
[28] http://www.solarcooking.org/

Table 6. Advantages and Disadvantages of Solar Cookers

Advantages	Disadvantages
No pollutants or greenhouse gases emitted	Certain site- and culture-specific characteristics
Food does not burn	Long cooking times
Replaces fuelwood with renewable energy source, cutting down on health problems and deforestation. **Under certain circumstances**, saves women time and work, which they can spend on child care, income-generating activities, community activities, and natural resource management	Variations on effectiveness due to climatic conditions such as sunlight, rainy seasons
Can be manufactured locally	In some instances, one solar cooker is not enough to feed a large family
Relatively cheap initial costs	
Last for many years (depending on model and maintenance)	

2.1.6 PV-Wind Hybrid Systems

Combined solar photovoltaic and wind energy systems are beneficial because two renewable energy resources complement one another, and raise the overall capacity and energy production. The PV system produces electricity when the sun shines during the day but not at night; the wind system produces energy when the wind blows. Energy from both systems may be stored by charging batteries, to provide power at times when neither is producing. These hybrid systems are very useful for small rural villages in developing countries because the technology can either be connected to a country's main energy grid or can work off-grid. Although initial investment is typically high, PV-wind hybrid systems have a lifespan of around 20 years with little maintenance required after installation. According to ESMAP (Energy Sector Management Assistance Program) PV-wind hybrid systems have been successfully implemented on island mini-grids, small buildings, and hospitals.[29]

PV-wind hybrid energy systems and stand-alone wind or solar systems were installed on small buildings and health care centers in five locations within the Kiunga National Marine Reserve of the Lamu Seascape, Kenya. The hybrid systems were particularly suited to this region due to the large amounts of sunlight and wind off the Indian Ocean that the Kiunga National Marine Reserve receives yearly. (The onshore breeze builds up during the afternoon and blows well into the evening, after the sun has set.) The systems work off-grid and should be viable for more than 20 years with little maintenance except for minor upgrades every several years.

[29] Technical and Economic Assessment of Off-grid, Mini-grid and Electrification Techniques. Energy Sector Management Program, December 2007.

Table 7. Advantages and Disadvantages of PV-Wind Hybrid Systems

Advantages	Disadvantages
Two different renewable energy technologies complement and supplement one another, increasing capacity and making use of a wider range of climatic features	High initial investment and capital costs
Applications for small villages and remote project field stations as well as for larger projects	Site-specific technology
Lifespan of around 20 years	Reasonable knowledge of electrical systems is needed for maintenance
Little maintenance required	Risk of theft of panels, turbines
Work on and off-grid	
Saves women time and work, which they can spend on child care, income-generating activities, community activities, and natural resource management	

2.1.7 Solar Heating Systems

Existing commercially for more than 30 years, solar heating technology can be used for solar water heating, solar space heating, agricultural process heating, and passive solar cooling.[30] In the past several years, water and space heating combination systems have been on the market.[31]

Using solar collectors, solar heating systems use the sun's radiation to transform energy into heat. This process can either be done actively with integrated pumps and rotary elements or passively, using gravity, circulation, and pressure. All solar water heating systems essentially have two main elements: a collector and a storage tank. The collector is made of tubes through which water is circulated and heated, and typical examples of collectors include the plastic collector, flat plate collector, and evacuated tube collector, all of which perform similar functions to heat water. For developing countries where no frost occurs, very simple and cheap systems can be installed using passive technologies.

As with most other renewable energy systems, solar heating systems have environmental and social benefits. The reduced demand for fuelwood for hot water needs helps curb deforestation while at the same time decreasing the time and labor spent on collecting wood. Particulates and smoke from wood burning can be decreased. In addition to displacing fuelwood use, solar heating technologies are rational and valuable replacements to the fossil fuels currently employed for water heating purposes.[32] Some projects, such as the WWF-Netherlands office building in Zeist, Netherlands, (http://www.wnf.nl/nl/overwnf/huisvesting/veelgestelde_vragen/duurzaamheidvragen_over_het_nieuwe_kantoorpand/index.cfm) or the WWF-France project in Marais du Vigueirat, France, (http://www.life-promesse.org/les_actions_concretes/energie/chaleur), use solar heating systems. Unfortunately, these projects are not part of the 10 case studies included in this report.

[30] Hara, Nobuyuki. Renewable Energy: RD & D Priorities, Insights from IEA Technology Programmes, International Energy Agency, 2006.
[31] Idem
[32] Hara, Nobuyuki. Renewable Energy: RD & D Priorities, Insights from IEA Technology Programmes, International Energy Agency, 2006.

Table 8. Advantages and Disadvantages of Solar Heating Technology

Advantages	Disadvantages
Mature technology, commercially viable for over 30 years	Not suitable for all climates. The hottest climates, where solar thermal heating works best, are not the places where hot water is most needed. Solar cooling is an option but is more complex to implement.
Able to meet several different needs, i.e. heating, cooling, drying, etc.	
Many designs and configurations	
Cheap and simple systems	
Saves women time and work, which they can spend on child care, income-generating activities, community activities, and natural resource management	

In addition to this technology and the other renewable energy systems mentioned in this section, there are several additional technologies appropriate for developing countries. These include solar and wind pumps, solar lamps, solar photovoltaic pumps, and many others. Additional reading can be found in publications from the UNEP, UNDP, UNIDO, and other organizations.[33]

[33] See for example,
http://www.unido.org/fileadmin/user_media/Publications/Pub_free/training_manual_on_sustainable_energy_regulation_and_policymaking_for_Africa.pdf
http://www.iea.org/textbase/nppdf/free/2006/renewenergy.pdf
http://siteresources.worldbank.org/INTENERGY/Resources/MiniGridElectrificationTechnicalReport61207.pdf
http://www.unep.org.bh/Newsroom/pdf/Renewable%20Energy%20_JUNE18_.pdf

2.2 Results, Successes, and Challenges

The WWF projects highlighted in this review use a range of renewable energy systems for many different purposes in a variety of projects and WWF infrastructure. **Four main objectives are pursued in our projects.** Some projects use renewable energy sources and systems to simply acquire **steady, reliable electrical power** from a clean energy source for WWF infrastructure or local communities. Other projects aim to **curb deforestation** by introducing solar cooking techniques, biogas technologies, plantations, and better charcoal carbonization methods. Another project introduced biomass energy as a way to **restore ecosystems** in areas ravaged by invasive plant species. Some projects that are not discussed in the case studies are aiming to **reduce greenhouse gas emissions and bringing sustainable energy technologies** to countries where such technologies are still seriously lacking. Whatever the main goal is, all these projects make a contribution to reducing global carbon emissions through the use of renewable energy and provide demonstration projects in their countries.

This section briefly introduces different project models, and highlights goals, successes, failures, and overall outcomes of various types of projects.

2.2.1 Providing Reliable Sustainable Energy for WWF Offices & Rural Communities

Operating in diverse and often remote areas throughout the world, WWF offices and projects are frequently confronted with unreliable electricity grids or with no access at all. The lack of electricity or power shortages, blackouts, and other minor disturbances limit information technology options and other services based on electricity and sometimes pose serious barriers to WWF operations. To build reliable energy sources, some WWF offices have embarked on using renewable energy sources. In some cases, the energy supply to WWF operations can also serve local communities, thereby improving local livelihoods and well-being, and increasing community goodwill for our work. And in some cases, WWF helps local communities to access sustainable energy, independently of its own energy needs. Reasons for this include the increased acceptance of WWF's operations in the area; the contribution to local development that in turn supports conservation objectives through synergies with alternative livelihoods, improved health, education, awareness-raising, and improved communications; and opportunities to scale up our work.

WWF Offices in Vientiane and Kiunga

WWF-Austria helped WWF-Laos to reduce dependence on the electric grid by installing solar PV panels on the office's roof. WWF involved Fronius, an internationally renowned company from Austria, as the technical partner for this project. A formal agreement between relevant parties was reached in 2008 for the office to be outfitted with a solar photovoltaic (PV) system on top of the east, south, and west roofs of the building. The project is currently being completed (in 2009). The solar PV system, rated at 7.3 kWp[34] with more than 90 modules, now generates 81 watts of energy per thin layer module and provides a reliable, steady stream of electricity for computer and IT-related electrical office needs. This solar PV system, which is also connected to

[34] kilowatts peak

the grid, also provides a nice example and communication tool, as it is the first grid-connected PV system in Vientiane.

In **Kiunga, Kenya**, WWF offices and projects were lacking power. The sites were the WWF/Kenya Wildlife Service (KWS) camp in Mkokoni, the WWF office in Kiunga Village, the turtle outpost on Mongo Sharif Island, the Mkokoni village dispensary, and the health center in Kiunga village. In this remote area, there is no access to the national grid. WWF cooperated with Southwest Windpower, a U.S. company with experience in combined wind-solar energy systems, to install PV-wind hybrid systems in early 2009. The system comprised Skystream 3.7 and Airbreeze wind systems, as well as 205 or 80-EX solar panels and various inverters. Some locations were equipped with a hybrid wind-solar system and some with one technology only depending on needs and micro-climate conditions in the individual sites.

The provision of electricity to support the local community's livelihoods through the fish freezer, and health through powering the health facilities has been part of broader WWF support to community livelihoods, health, and education. This support has significantly changed community attitudes toward the Kiunga Marine National Reserve and secured community buy-in to natural resource management, significantly contributing to success of the conservation program.

A guard had to be recruited to ensure security of the installation in the WWF/KWS camp, but a side business was set up for local villagers to charge cell phones at the camp for a small fee, which helped to cover the guard's salary.

In the end, both projects were successful in providing reliable electricity for WWF operations, while providing side benefits such as better acceptance of WWF operations, better livelihoods for local communities, and a good demonstration pilot to encourage replication.

Communities in Tanzania

Miguruwe, Tanzania

This WWF project sought to provide power for local rural communities lacking electricity in order to increase educational opportunities, small business opportunities, and overall chances for people to increase their standard of living. WWF partnered with a local businessman to provide electricity to a secondary school. The school was given photovoltaic solar panels to provide light for studying, reading, and completing homework assignments during evening hours. Since March 2009, the Miguruwe Secondary School has been using the system during the evening hours to light classrooms and teacher's blocks and to power a personal computer.

This project was WWF's symbolic way in Coastal East Africa of sending an Earth Hour message to politicians globally who will be negotiating the new global climate deal in Copenhagen later this year, and supported communities close to the Selous Game Reserve. Several conservation projects are occurring near to the village, which has faced human-wildlife conflicts in the past. The project demonstrates to the communities that WWF cares about people as well as wildlife and helps improve relations between WWF and its neighbors.

WWF is considering scaling up the project for 20 schools as a first step, working with Chinese investors and in active cooperation with WWF-China and the "China for a Shift" Network

Initiative. This new project could take place by March next year for Earth Hour. The ultimate aim is to find different ways to scale up such initiatives to a higher level.

Ngarambe, Tanzania

WWF and its partner ABB[35] were looking for activities that both parties found meaningful. ABB was conducting an access-to-electricity" program, to demonstrate the positive impact of electricity on poverty reduction and improvement of livelihoods. The company suggested an access-to-electricity project within the ABB-WWF collaboration. WWF had been working with conservation and development projects in the Selous Game Reserve. It had collaborated well with the Ngarambe village over several years and identified it as a site for a first project within this access-to-electricity initiative.

It seems that the project was not a strategic part of the WWF conservation plan, and there is no direct link to biodiversity conservation. The project was considered a nice add-on, as it would provide benefits for communities supporting conservation work. Linking livelihood benefits and conservation certainly makes WWF's objectives more attractive to local communities, and fostering community buy-in can be a very important element in achieving conservation.

WWF and ABB started the rural electrification program in the village of Ngarambe by introducing a diesel generator for electricity generation. To date, the generator has increased both the number of villagers attending classes and the number of educational courses available. Whereas 250 villagers attended courses before 2004, now more than 350 villagers are present at sessions held during the day and evenings. The generator in the village can run for four hours past dusk, which allows local businesses to sell their products and services during evening hours. Ngarambe's local dispensary has installed a new refrigerator so medicines for patients can be stored locally, while a water pump and sawmill have been installed to reduce the amount of time required by women to gather water and fuelwood.

To further the program, WWF and ABB began conversion of the generator in Ngarambe to run on biofuels, specifically pure plant oil, in 2006. This project hoped to replace conventional fuels and cut down on expenses involved with the purchase and transportation of expensive fossil fuels. It was planned as a showcase for the region. Hoping to use the seeds of *Jatropha*, a nonedible and drought-resistant plant, in the longer term for pure plant oil production, the village began sowing, harvesting, and producing several different plant species to replace conventional petroleum. Because the production of *Jatropha* seeds takes two to three years, sesame seeds and sunflower seeds were planted to help start biofuel conversion during the initial years of production.

A particular challenge when using biofuels for an electricity generator is that a constant supply of feedstock must be secured. Since *Jatropha* was a little-known crop, the constant supply of feedstock over the year could be problematic.

Another potential issue with biofuels is competition with food production in terms of land and labor forces. Although *Jatropha* is not edible, is does not mean that it would not compete for land or for labor forces. Caution is required. Unfortunately it is too early to draw conclusions from this

[35] ABB company – automation and power technologies (http://www.abb.com)

project. The conversion has not currently taken place, mainly because an oil pressing machine has not been installed in the village, but measures to support this process are underway. Officials in charge of the project have been unable to estimate how much oil will be produced per kilogram of seeds due to temporary stoppage of the generator for major service, further halting the conversion of the generator to run on pure plant oil.

2.2.2 Curbing Deforestation

In many developing countries, fuelwood is the largest source of energy for heating, cooking, and lighting. Whether it is from protected areas, community-managed forests, communal lands or unprotected natural forests, wood is often consumed at an unsustainable rate. WWF hopes to curb deforestation and reduce the consumption of fuelwood by introducing more sustainable energy systems. These include the installation of biogas plants, management of wood energy production chains, setting up of micro-hydro plants, and the introduction of solar cooking stoves and improved cooking stoves. Whatever the system, the goal is to halt deforestation and forest degradation and promote restoration of natural habitats. An added benefit is often the contribution to poverty reduction and improvement of human health.

Toliara, Madagascar
In Madagascar, WWF sought to curb deforestation of the Spiny Forest in the Atsimo Andrefana region of Southwest Madagascar where local communities and towns use wood from the forest for fuel. In 2008, WWF began a plan to introduce a wood energy production management chain in the town of Toliara. Planting energy-useful tree species on designated land with help from villagers, communes, and private operators and introducing better carbonization techniques to charcoal producers were the project's means to reduce deforestation.

To combat inefficient carbonization techniques, consultants in the area are being selected to teach the community and local charcoal makers better carbonization methods. Coordination and energy management contracts between parties involved in the project have been streamlined with the founding of the Regional Forest Energy Commission (CEFR), an entity that oversees coordination between state governing bodies and local communities for all sustainable wood management activities in the southwest of the country. Through the CEFR, unnecessary competition is avoided, and a good coordination between projects is ensured in the region.

Near the town of Toliara, more than 28 villages and 212 individuals participated in the reforesting program with help from the RM5 military company as well. These individuals have planted more than 135,000 trees on 12 different nursery sites distributed among 4 communes.

However, although more than 135 hectares of land in the Toliara II district have been planted with energy-useful tree species, it is only a portion of the 550 hectares that were originally planned to be planted. The success of the reforestation depends on local weather conditions, and it was particularly bad for this year, leading to the loss of many seedlings.

A monitoring system of the reforestation activities has been put in place, enabling an inventory of experiences and lessons to prepare the next campaign. Indicators, such as the number of households earning a living based on the sustainable wood business and the yield (in tons) of charcoal from the plantations, will help to measure project success. It is still too early to draw conclusions about impacts on natural forests; measuring reduction of deforestation in targeted forests will only be available over a longer period of time.

It is worth mentioning that some political and legislative aspects of the project are slowed down by the difficult political context in the country in 2009 and by the sensitiveness of the biomass to energy topic in a period of food price hikes and land-grabbing.

Goma, Democratic Republic of Congo

In 2008, WWF launched a program to combat deforestation in the region near Goma, Democratic Republic of Congo (DRC). The Goma area has seen several influxes of Rwandan refugees and internally displaced persons (IDPs) during the last two decades, greatly increasing the need for fuelwood in the area. Some settled inside Virunga National Park and others on its border where they extracted firewood from the forest with large local impacts. The project looked to improved cooking stoves as a means to achieve its goals as part of a broader exercise in which development and conservation organizations collaborate with UNHCR.

WWF promoted improved cooking stoves made by local manufacturers from recycled metal barrels. More than 7,500 stoves have been manufactured since November 2008, and 350 have been tested in their households by the members of women's associations. The majority of the stoves have been distributed to IDP camps. Another 1,130 stoves are now being sold through the women associations to Goma citizens for $5 per stove.

WWF has also been working with the communities to establish plantations of fast-growing trees to provide fuelwood, and these are now mature and being sold as fuel for IDPs. More than 1,665 hectares have been planted, and it is hoped that 4,000 hectares will be planted by the end of the project in 2012.

The change from old woodstoves to fuel-efficient ones not only has helped to minimize the illegal cutting of wood, but also has provided new income for a sector of the local economy. As a result of training of local craftsmen in the production of improved woodstoves, 159 local incomes now come from producing new efficient stoves. Women’s associations are also being trained in maintenance, management, and selling of the woodstoves. These skills could lead to a source of income for these women, which would help raise the standard of living for their families.

The production and distribution of cook stoves and the plantation program are running well. However, it is too early to measure the full success of this initiative with respect to reduced deforestation in Virunga National Park.

One constant challenge has been to ensure the quality of the stoves while producing them at a large scale.

Terai Arc Landscape, Nepal

In the Terai Arc Landscape of southern Nepal, forests are being degraded and fragmented due to cattle grazing and firewood collection by local people. With funding from USAID and Johnson & Johnson, WWF worked to reduce deforestation by introducing biogas technology to rural communities, in conjunction with improved cooking stoves for households too poor to install biogas. The project has also helped to reduce acute respiratory infections and women’s work and time to collect firewood. Latrines installed alongside the biogas plants, along with improved water supplies and hygiene, helped to decrease instances of diarrheal disease.

Apart from being a good substitute for fuelwood, the biogas plant requires cattle to be kept closer to the homestead. This has helped to remove cattle from the forest because another cause of forest degradation was trampling and browsing by cattle. Households now have milk from stall-fed cattle, which improves children’s nutrition and provides household income from the sale of excess milk.

A revolving fund helps households cover the initial cost of biogas installation. Using community forest user groups to recommend credit and assess the feasibility of biogas and repayment credit plans, microfinancing procedures were established to help the project achieve its goal of implementing biogas technology in the region and to reduce deforestation.

The project is showing good results: The amount of firewood saved through biogas plants was estimated at 1,206 metric ton in 2008, saving several hectares of forests and reducing carbon dioxide emissions. A single biogas plant reduces CO_2 emission by 4 tons and saves more than 4.5 metric tons of fuelwood per year. From January 2007 to August 2009, more than 3,628 biogas plants have been constructed and are operational in buffer zones and corridors across the Terai. The fact that the project gained a certain scale, as well as the feasibility of measuring the greenhouse gas savings quite accurately, led the project to apply for carbon finance with Gold Standard accreditation. In the end the project hopes to eliminate as much as 148,000 tons of carbon dioxide emissions over its lifetime.

One major project challenge is training and retaining project staff.

Chaurikharka Village, Nepal

In 2006, WWF introduced a micro-hydro system close to Chaurikharka Village in the buffer zone of Sagarmatha National Park. Many residents were using fuelwood for cooking and heating needs. This, coupled with the high tourism-related demand for wood fuel in the area, led to deforestation in the region. WWF initiated the 70 kilowatt Ghatte Micro-Hydro Project to bring electricity as a substitute for fuelwood. Introducing sustainable biomass management was not possible due to the cold climate, so micro-hydro was selected. The environmental impacts of the plant are negligible. Water is diverted from a stream, runs a generator, and then flows back to the stream.

The project has been successful in that, today, villagers use electricity for cook stoves, microwaves, rice cookers, refrigerators, and room heaters. The project benefited 108 households in 6 villages. Due to the success of the Ghatte project, several other micro-hydro sites have been surveyed and are functional. The 35 kilowatt Ghuna micro-hydro project in Ghunsa, the 35 kilowatt Chaalgadh micro-hydro project in Tripurakot, the 50 kilowatt Mahadev line extension project in Mahavev, and the Chuserma micro-hydro project in Sagarmatha have all reduced forest pressure for fuelwood in their respective areas. A 35 kilowatt micro-hydro system can help conserve 500 tons of fuel wood annually. More than 480 total households in these communities now use hydropower for their electrical and energy needs.

Solar Cooking in Nepal

In January 2008, WWF-Nepal began a pilot project to bring solar cooking technology to residents of the Terai Arc Landscape (TAL), the Kanchenjunga Conservation Area, and Langtang National Park. More than 60 percent of residents in this region use fuelwood for household energy and cooking needs. The aim of the project was to reduce pressure from fuelwood consumption on nearby forests. With funding from the Alcoa Foundation, more than 40 households in the Terai and 500 households in the Kanchenjunga Conservation Area and Langtang National Park area have received solar cookers. The project took little under a year and concluded in December 2008. The recipients of the solar cookers have been trained in the use, maintenance, and repair of the solar cookers.

Unfortunately for this pilot project, WWF has not been able to quantify the amount of fuel wood saved so as to judge its success. What is certain is that the devices can only be used when there is a good amount of sunshine. In Nepal, summer days are good for efficient cooking, but during winter it takes much more time to cook.

2.2.3 Using Biomass as an Economic Incentive for Ecosystem Restoration

Biomass energy production with an economic value can make ecosystem conservation or restoration attractive for business. Using invasive plant species as a biomass source is one means by which WWF projects can restore native ecosystems. In a different context, the sustainable harvesting of biomass sources in important ecosystems can add economic value to these ecosystems and prevent land conversion for other purposes.

Tiszatarján, Hungary

The main goal of the WWF project in the Tiszatarján village of Hungary was to restore the area's natural floodplains. This was made possible by producing local renewable energy while increasing and diversifying local income streams. The invasive plant species *Amorpha fructicosa* is growing wildly in the floodplains of the Tisza river, along which the village is located. To reduce the invasive species, WWF worked with a new company, set up within the project framework by the Tiszatarján municipality, and a local farmer. Local people were paid to cut *Amorpha* bushes, which were dried and shipped to a large power plant nearby to produce green electricity. To ensure a continuous biomass supply to the plant, willow seedlings were planted in some areas formerly covered by *Amorpha* and in former arable lands. The willows will serve as a feedstock once the *Amorpha* is exhausted. Water buffalo have been reintroduced in the region, while Hungarian long-horned grey cattle, beavers, and wild horses are also being considered to help restore the floodplains and grasslands to their former species-rich glory.

The project was successful in removing the invasive species from much of the area's natural floodplains as well as creating a source of green energy by planting willow seedlings in designated areas. It has so far led to the restoration of 50 hectares of wetlands and grasslands and generated 400 tons of biomass. The potential for replication is huge as several villages in the region face similar problems with *Amorpha*. Although there are long processes associated with the harvesting of willow, the fact that the power company was already functional meant that there were no requirements for fuel or mechanical conversions to existing machinery for the biomass energy production.

However, the project is still fragile with regard to the viability of willow plantations in the future. It is not certain that the income from willow-biomass sales to the power plant will be economically viable over the long run.

2.2.4 Reducing Greenhouse Gas Emissions and Tapping Carbon Markets

Although the projects described in this report all reduce greenhouse gas emissions, often this is not their main purpose. The emissions avoided are very small, compared to the scale of global emissions, although such projects do have potential for replication and can serve as demonstration projects for future policies. The biogas project in Nepal is an exception to the rule. This does not preclude that future WWF field projects may have a main goal to reduce greenhouse gas emissions on a large scale.

Carbon Markets[36]

Due to their size, most of the projects described would not be able to benefit from the carbon market. Even though special rules apply for small-scale projects, transaction costs associated with completing the CDM (Clean Development Mechanism) project cycle represent a common hurdle facing many project developers. This is because transaction costs are incurred up front, while CDM revenue is only generated once the project's methodology has been approved, the project registered, and credits issued. The table below shows a breakdown of representative transaction costs for large- and small-scale CDM projects.

[36] More information on http://www.cdmrulebook.org/pageid/452

Table 9. Representative transaction costs for large- and small-scale CDM projects

Activity	Cost (large-scale, USD)	Cost (small-scale, USD)	Type of cost
Initial feasibility study, i.e. Project Idea Note (PIN)	5,000-30,000	2,000-7,500	Consultancy fee or internal
Project Design Document (PDD)	15,000-100,000	10,000-25,000	Consultancy fee or internal
New methodology (if required)	20,000-100,000 (incl. US$1,000 UN registration fee)	20,000-50,000	Consultancy fee or internal
Validation	8,000-30,000	6,500-10,000	DOE fee
Project Registration Fee	10,500-350,000[31]	0-24,500[32]	EB fee
UN Adaptation Fund Fee	2% of CERs	2% of CERs	EB fee
Initial verification (incl. system check)	5,000-30,000	5,000-15,000	DOE fee
Ongoing verification (periodically)	5,000-25,000	5,000-10,000	DOE fee
Share of Proceeds to cover administration expenses (SOP-Admin)	The fee paid at registration is effectively an advance that will be 'trued up' against actual CERs issued over the crediting period (if different to emission reductions projected at registration). SOP-Admin is not capped.		EB fee

Source: Guidebook to Financing a CDM Project, UNEP Publications, March 2007

***31** US$0.10/CER for the first 15,000 CERs per year and US$0.20/CER for any CERs above 15,000 CERs per year (max US$350,000). The minimum shown here has been calculated as 15,000 CERs/year over a single seven-year crediting period.*

***32** As for large scale projects, unless total annual average emission reductions over the crediting period are below 15,000 tCO2-e, in which case no fee is payable. Maximum calculated as 25,000 CERs/year over a seven-year crediting period.*

Some emission reductions buyers, especially large institutional or national carbon funds, have been offering different types of advance payments to project developers to help overcome the burden of transaction costs. One model involves offering this advance payment as a grant, separate from the funds used by the buyer to purchase emissions reductions. Another model is to pay part of the price for the purchased carbon emission reductions (CERs) in advance before the project's inception.

It is possible to bundle several small-scale projects together, such as in Nepal. However, there are limits to small-scale projects and bundling. Attention may need to be paid to address issues relating to building of the bundles—homogeneity, redundancy risk, time scaling, size, and ownership. Legal and taxation issues may also be relevant in country-specific contexts.

One possible way to apply for several similar small-scale projects is to use the program of activities (PoA) concept. A local/regional/national policy or standard cannot be considered as a clean development mechanism project activity, but project activities under a PoA can be registered as a single clean development mechanism project activity.[37] A PoA is distinct from a bundle of small-scale projects, because it is possible to add new CDM program activities (CPAs) to a PoA without undertaking the validation process afresh. No registration fee is payable on CPAs, which are added subsequently to validation. Another advantage is that the projects are related to a broader policy to promote sustainable energy, which makes them more relevant. This tool would be very interesting should WWF wish to scale up some of its renewable energy activities in developing countries. As of today, no projects are registered under the PoA system. Two PoAs are going through the validation process: improved cooking stoves in Bangladesh and the promotion of biomass-based heat generation systems in India.

Another problem for a WWF project that wishes to benefit from carbon credits is to ensure the quality of the project. The Gold Standard, a quality standard for carbon projects, has been created for this purpose and is supported by WWF. More information about the Gold Standard can be found at www.cdmgoldstandard.org.

WWF-Switzerland's Promotion of Gold Standard Carbon Projects

To get sustainable energy projects started in developing countries where there is a real lack of investments and where sustainable energy policies are still rare, WWF-Switzerland has started a Gold Standard project support program. The market share of Gold Standard projects within both the compliance and voluntary markets is still very small and will need a big boost to have a noticeable impact on the carbon market as a whole. There is very high interest from companies to work with WWF in developing carbon offset projects. The WWF Network has the potential to establish new Gold Standard projects that are aligned with WWF's environmental goals.

When developing Gold Standard projects, WWF-Switzerland limits its role to being the project developer (with the aid of local planners and engineers) on the one hand, and the gatekeeper between the certificates and a selected group of partner companies on the other hand. It delegates to a third party the task of taking the projects through the Gold Standard registration process and formulates exclusion criteria for the use of credits from WWF projects. A list of projects that are currently considered can be found at the end of Annex 1.

As this project is in its infancy, it is too early to draw conclusions. However, the carbon market has demonstrated in the past that a few good renewable energy projects in a country, such as Turkey, have encouraged policy makers to support such projects more systematically.

[37] provided that approved baseline and monitoring methodologies are used that, *inter alia*, define the appropriate boundary, avoid double counting, and account for leakage, thereby ensuring that the net anthropogenic removals by sinks and emission reductions are real, measurable, verifiable, and additional to any that would occur in the absence of the project activity.

3 Conclusions and Recommendations

This section presents conclusions drawn from the assessment and recommendations for the WWF Network on use and promotion of renewable energy in the future. We hope that this section may also be of interest to donors and other conservation organizations interested in learning about WWF's experiences with integrating renewable energy into its conservation activities and scaling up these approaches.

3.1 Future of Field-Based Renewable Energy in the WWF Network

Around the world, WWF offices and projects have undertaken a number of unrelated field-based renewable energy projects. Purposes and benefits have included—

- slowing habitat degradation;
- promoting habitat restoration;
- reducing greenhouse gas emissions;
- improving community livelihoods, health, education, and women's empowerment;
- increasing efficiency of WWF operations;
- generating messages for global climate change communication; and
- providing practical demonstration of renewable energy approaches.

WWF has used a variety of technologies and energy sources and worked mostly at the local level, with a few projects either scaling up or reaching much broader audiences. This scattered and uncoordinated portfolio has come about through the innovation and hard work of field and country teams and support staff at the cutting edge of these approaches who had the vision and determination to carry them out. These "thousand flowers" have bloomed to provide us with valuable pilot projects from which much can be learned.

To date, there has been no centralized, concerted effort to promote renewable energy approaches in our own operations, our field programs, or those of our partners. In light of WWF's ambitious climate program, the multiple benefits of renewable energy, and the results of this assessment, we recommend that the WWF leadership give much greater focus to the potential of renewable energy. This includes focus on—

- **WWF operations,** starting with energy audits in offices and related operations where these have not already been done, accompanied by a feasibility study of options for introducing or increasing renewable energy. WWF should also put energy efficient or renewable energy appliances for sale in WWF online shops.
- **Field programs,** including introduction or expansion of renewable energy approaches in our field programs
- **Communication and advocacy** through broader use of our renewable energy projects as demonstration models and incorporation of their results in broader communication on climate change issues
- **Scaling up** through replicating and scaling up successful approaches in our own programs and through partners, including governments, development and conservation NGOs, and community-based organizations, with support to policy initiatives as needed.

As part of this increased activity, WWF requires the capacity to provide technical assistance and help to seek funding for renewable energy activities. It also needs to ensure better access to renewable energy information and networks for WWF staff and partners, including its own experiences and lessons.

More specific recommendations and conclusions from the review are outlined below.

3.2 Identification of Need and Choice of Technology

It is critical to first identify the energy need. What are the drivers or threats that justify a renewable energy project? In some field projects, the main goal of the project was not clearly stated. We struggled to understand whether projects were contributing to WWF's core mission. (For more about this, see Section 3.5.)

Once the need is identified, the most appropriate renewable energy technology should be selected (solar PV, solar thermal, wind, combined wind-solar, biogas, biomass, etc.) for each situation. Each of these technologies has a vast array of options that, in turn, need specific conditions to perform optimally.

Any choice must be driven by a long-term and thought-through RES management plan. For instance, electricity storage should not be underestimated, as mentioned in section 2.1.1. Lack of fund allocation for battery replacement is one of the main reasons for failure of solar and wind-based renewable energy projects.

Some technologies require certain climatic conditions or natural resource characteristics. Micro-hydro can be a solution in climates too harsh for biomass or biogas use. Solar PV can work in regions where freshwater is scarce. However, if it is too warm, polycrystalline cells (one PV technology) can drop more than 30 percent in efficiency, and thin-film (another PV technology) can become a better option. Some technologies will be better adapted to the local culture or will be more viable economically. Such choices are not straightforward, and it is critical to consult experts and involve local communities when planning a renewable energy project.

For all types of small-scale renewable electricity systems, the users' awareness and education regarding energy savings will also play an important role. Small systems are designed for very specific needs, and if demand exceeds what was foreseen when the system was built, the installation can wear out rapidly. A similar comment can be made for the rational use of fuelwood.

Some tools can help. For instance, the free RETScreen (http://www.retscreen.net/) software can be used worldwide to evaluate the energy production and savings, costs, emission reductions, financial viability, and risk for various types of renewable energy and energy-efficient technologies. The software (available in multiple languages) also includes product, project, hydrology, and climate databases, a detailed user manual, and a case study based college/university-level training course, including an engineering e-textbook.
Some NGOs and other organizations also provide practical training on renewable energy technologies. For instance, Solar Energy International (SEI) (http://www.solarenergy.org/) is a U.S. nonprofit organization whose mission is to help others use renewable energy and

environmental building technologies through education. SEI teaches how to design, install, and maintain renewable energy systems and how to design and build efficient, sustainable homes. SEI offers trainings online and in 22 locations around the world.

Finally, success will very much depend on the use of simple, locally available technologies or the development of a local economy through renewable energy. Importing expensive or complex technologies will not always generate success. Local people will not pay for repairs to a system they cannot afford.

3.3 Community Involvement

There are multiple benefits in helping communities to access renewable energy and/or use it more efficiently. These include:

- improving livelihoods, health, and education
- empowering women by reducing workloads and increasing time available for other purposes, including child care and improved management of natural resources used by women
- reducing pressure on natural systems, e.g. from fuelwood collection and cattle grazing (cattle can be removed from forests and kept near homesteads to fuel biogas plants)
- reducing carbon emissions, both by reducing use of fossil fuel and increasing carbon storage in forests
- building community and ecosystem resilience to climate change, for example by reducing human pressure on forests, and helping to reduce poverty
- improving community attitudes toward conservation, once they understand that WWF cares about the community as well as biodiversity; this can tremendously accelerate progress in conservation projects. Renewable energy projects can provide an entry point for working with communities or be incorporated as an integral part of community conservation programs.

In many of the examples in this review, communities demonstrated that they are very open to new forms of energy that improve their livelihoods, even though they were used to other forms of energy before. For instance, Nepalese villagers started using hydropower for cooking instead of fuelwood. Although people are culturally attached to traditional energy uses, they are willing to take up new approaches if they can see clear benefits. But such support is not guaranteed. Culture can be a major hurdle to a reduction of fuelwood consumption or to a switch to alternative or more efficient energy sources. As already mentioned, gathering organic sources of biomass, including animal and human excreta, is not necessarily acceptable in certain societies. A lot of awareness-raising and education are needed, and design of individual renewable energy projects should be tailored to local needs.

Often, alternative energy schemes struggle to gain markets as long as firewood remains readily available. Again, awareness-raising and education are keys. Also, it is important to combine alternatives together with more traditional firewood management. It takes time to obtain results. In the end, if a project fails, very often it is not due to the technology but the human component.

Fostering community involvement and ownership is extremely important in community renewable energy projects and should be a major part in determining the most appropriate technology. Local people should understand the basics of the technology. They must accept, take ownership of, and receive benefits from the project. Ideally, the community should incorporate the project into its existing governance system (for example, maintaining a micro-hydro system or operating a revolving fund so that households can install solar energy). Creating a local economy around the renewable energy supply will also increase chances of success in the long term. And the cost and level of maintenance of the system must be appropriate for the community's capacity to pay for and maintain it. The system should not involve the community incurring opportunity costs that could ultimately affect its well-being and people's livelihoods; in developing countries projects should aim to help reduce poverty. They should benefit women and the poor and less privileged members of the community, as well as richer members.

Where WWF is installing a renewable energy system for its own operations in a remote area, it is good for relationships with the community if local people can also benefit in some way (for example, supporting the health and fishermen's facilities and providing an opportunity to charge cell phones in Kiunga). This helps to build community relations and avoids creating the impression that WWF only looks after itself.

3.4 Funding of Renewable Energy Projects

Payment for Energy Services

When energy services are provided, ideally local communities should contribute toward payment in cash or in kind (for example, by providing labor or land). When services come for free, people do not tend to value them as much as when they have to make an effort to obtain them. Firm community buy-in will help to ensure that communities maintain the system in the coming years. Also, distributing systems for free or through new channels could curtail local businesses that were distributing alternative energy systems previously. Repair costs can be kept down by using local technicians—an approach that also provides local employment. Failure to do this can lead to high maintenance fees for communities that have little annual income. The biofuel project in Tanzania, the wood energy production chain in Madagascar, the biomass project in Hungary, the biogas project in Nepal, and the fuel-efficient woodstove project in Goma, DRC, were particularly successful in integrating projects in the local economy. This helps ensure economic sustainability of the project once the recipients assume full management of it.

Employing Appropriate Financial Models

To make projects replicable and to scale them up, it is important to develop models that are economically viable for government authorities, businesses, local communities, and other stakeholders. Such models include profitable environmental protection and restoration solutions, where profit is made while protecting the environment, micro credit solutions where renewable energy is made affordable for local communities while still being viable for authorities, or carbon markets.

Micro Credit

In critical forest areas of the TAL of southern Nepal, WWF worked with community forest coordination committees (CFCCs), entities comprising community forest user groups, to recommend credit, assess the feasibility of biogas and repayment credit plans, and support biogas programs for households. The CFCCs worked with microfinance institutions to release loans to the beneficiaries, while the beneficiaries provided labor, such as digging and hauling rocks, and supplied natural materials. The microfinancing loans were vital in helping WWF and partners to achieve the goal of implementing biogas technology in the region and reducing deforestation.

Carbon Credits

Carbon-saving projects of a certain scale can help make conservation projects financially interesting when taking advantage of either the voluntary or the compliance (CDM) carbon markets. These projects can also help WWF promote renewable energy technologies in countries where such technologies are hard to find and where getting the right support policies in place will need good demonstration pilots to start with. Given the high up-front costs when submitting a carbon project proposal, it is recommended that this option only be considered when a minimum estimated amount of greenhouse gas emissions will be saved. For instance, our colleagues at WWF-Switzerland (see section 2.2.4) focus their efforts on projects that save more than 20,000 tons a year in order to keep transaction costs down.

In order to ensure project quality, WWF projects should always look for Gold Standard accreditation (see section 2.2.4). Further recommendations and advice can be obtained from WWF-Switzerland, which is helping WWF offices around the world to set up Gold Standard projects.

Profitable Environmental Protection and Restoration

Making environmental protection profitable is a very pragmatic and efficient way to get people and businesses to buy into conservation. Several non-energy-related examples exist, such as the communal conservancies in Namibia, sustainable trophy hunting in Pakistan, and the “One Europe More Nature” projects throughout Europe (www.panda.org/europe/oemn/). Renewable energy production can often be profitable, as well as replacing polluting forms of energy, and can be valuable components of larger conservation programs. Bioenergy is a very interesting product as it can be derived from waste or from various biomass products coming from important ecosystems. The challenge is to make the biomass harvesting profitable.

The One Europe More Nature program has taken up this challenge by making the removal of invasive species profitable. This could be an example for several future projects. For example, it could be a model for the Mondi Wetlands project in South Africa where WWF works with Mondi to remove invasive eucalyptus trees. There are millions of hectares of invasive juniper bush in the western United States. What other programs could incorporate renewable energy projects and create win-win situations?

3.5 Monitoring Renewable Energy Projects

Several projects in this review were successful in building renewable energy infrastructure and making it work. However, in some field projects, the main goal of the project was not clearly stated, and indicators were inadequate to measure success. We struggled in a few cases to understand whether projects were contributing to WWF’s core mission, for example, by reducing deforestation, protecting biodiversity, restoring ecosystems, substantially reducing greenhouse gas emissions, or helping people to live in better harmony with nature. Improving livelihoods is an important component of many projects in order to reduce poverty and simultaneously achieve conservation goals through very interdependent linkages. But in a small number of cases, those linkages were not clearly articulated. WWF needs to demonstrate in all cases that renewable energy, better livelihoods, and conservation are a winning combination.

Several field projects did not seem to have benefited from application of the WWF standards, which would have ensured clearly stated goals and targets, identification of threats and opportunities, and development of results chains articulating the linkages between actions and threat reduction/opportunity-taking. The projects would also have had measurable indicators and would have been better able to demonstrate success, including conservation impact. We found plenty of evidence of project output indicators—for example, number of stoves distributed and plantations established—but relatively little evidence of conservation impact. Admittedly some projects had not been running long enough to demonstrate this.

3.6 Replicating and Scaling Up Approaches

Single, small-scale projects will not solve the huge environmental problems we are facing. For this reason, it is very important to be strategic about future renewable energy project development in WWF. We should give priority to renewable energy field projects and programs that have good potential for broader replication by WWF and others and for use in demonstration, communication, advocacy, and policy work at local, national, regional and/or global levels.[38] To make a project really successful, this potential should be considered from the start. For instance, Turkey has launched a nationwide support scheme for wind energy to promote the rapid and large-scale growth of this technology. Many believe that the successful voluntary carbon market-sponsored wind projects in the country have shown the benefits of this technology and have led the government to decide on a national support scheme.

Among the case studies, the Nepal biogas project is the only one that is scaling up significantly. Key enabling conditions for scaling up include the national forest policy enabling community forest management, the government-approved landscape-scale strategy for the TAL, the existence of community-based organizational capacity, the availability of donor funding for testing approaches and establishing revolving funds, and support from the government and NGOs. Now these are being combined with the opportunity to tap into the carbon market—a great set of conditions to scale up this approach.

As we move forward, it will be very important to further define and refine enabling conditions for scaling up renewable energy approaches. Here are a few ideas that WWF could adopt for scaling up:

- Through various projects WWF has developed expertise in various financial mechanisms for renewable energy. Other mechanisms could possibly be applied, such as credit guarantees. It would be interesting to analyze further such schemes, compare WWF activities with other organizations, and see whether WWF could become a centre of expertise to provide financial support mechanisms for renewable energy. It is interesting to note that few green micro-finance systems exist.

[38] This is less the case for projects where WWF seeks to secure a reliable energy supply for its own operations, although it is still relevant.

- WWF has relationships with several donors for renewable energy funding: foundations, companies, private donors... There are many ways to obtain funding for renewable energy projects. It would be more efficient for WWF to pool these funds for use in the various financial mechanisms mentioned in the point above.

- WWF could advocate on behalf of those lacking access to energy, and are disproportionately the most vulnerable and affected by climate change: for example, it could make the "Elimination of Kerosene Based Lighting by 2025" a central campaign/project (global cost: less than the AIG bailout).

- WWF could establish 3-4 very strong renewable energy programs on islands in priority places in different parts of the world and make them self-sufficient in renewable energy, independent of fossil fuels, as pilot demonstrations.

- WWF could overlay maps of its priority places with maps of renewable energy potential (solar, wind, biogas, microhydro, etc) to identify high priority areas for future energy projects.

- WWF could identify people's energy needs in place-based NIs. Such a survey, that we can develop with field based offices in order to better understand local needs, such as villages needing electrification, pressure on forests for fuelwood, population growth etc. would help us identify which energy solutions to bring to place-based NIs in order to improve livelihoods, reduce environmental degradation and promote habitat restoration. For this survey to be successful, we need to:
    - Develop criteria for prioritizing the right technologies in the right places at the right time (with help from 3TIER, for example)
    - Understand how such energy services will support WWF in its conservation mission

- WWF could select the countries where it would have the greatest impact (after the mapping exercise), and identify policy opportunities and constraints. These could include, for example, import duties, lack of incentives for renewables, or funding for renewables even if there is zero potential (for example, wind energy installations) which gets the sector a bad reputation. It could work to improve regional and national level policies, leveraging existing information (including maps of renewable energy potential) and pilot demonstrations.

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- **http://www.cdmrulebook.org/pageid/452**

Annex 1 – List of WWF Renewable Energy Projects

Case Studies

- Goma, Congo – Efficient Woodstoves Energy-Saving Project
- Ngarambe Village, Tanzania – Biodiesel and Pure Plant Oil Production
- Toliara, Madagascar – Wood Energy in Southwest Madagascar
- Hungary, Tisza Floodplains – Planting Energy for Wetland Conservation
- Tanzania, Miguruwe Secondary School – Installation of a Solar PV system for Lighting
- Kiunga Marine National Reserve, Kenya – Wind-Solar Systems
- Vientiane, Laos – Building a Solar PV System on the WWF Office
- Terai Arc Landscape, Nepal – Biogas Technology
- Chaurikharka, Nepal – 70 Kilowatt Ghatte Micro-Hydro Project
- Terai Arc Landscape, Nepal – Solar Cookers

Other WWF Renewable Energy Field Projects

Other WWF renewable energy projects that we know of are listed below. Unfortunately it was not possible to write a story for each project.

- Brazil – A Study on Biodiesel in the City of Apiacás, Municipality of Apiacás, in the State of Mato Grosso.
- China – Solar Photovoltaic on the Panda Observation Center in Wolong.
- China – Panda Forests: Biogas and Energy-Saving Stoves in Villages Located in Buffer Zones
- France – Retrofitting of Site with Small-Scale Renewables in the Marais du Vigueirat, Camargue. http://www.life-promesse.org
- India – Household Biogas and Improved Cookstoves (Terai)
- Nepal – Solar Lighting
- Nepal – 35 Kilowatt Ghuna Micro-Hydro Project
- Nepal – 35 Kilowatt Chaalgadh Micro-Hydro Project
- Nepal – 50 Kilowatt Mahadev Line Extension Project
- Nepal – Chuserma Micro-Hydro Project
- Nepal – 100 Percent Solar Electrification in Upper Dolpa
- Nepal – Improved Cooking Stoves
- Nepal – Biofuel Study: Feasibility of Ethanol Extraction from *Saccharum spontanium*
- Madagascar – Solar, Wind or Hydro, or a Mix in the Nosy Hara Archipelago
- Coastal East Africa – Sustainable Development of Charcoal Small-Scale Enterprises for Sale in Urban Centers, Tree Plantation
- Borneo (Kalimantan) – Installation of Solar Panels on Two Islands
- United States Northern Great Plains – Solar Panels on Webcams, Collars of Curlews, and on APF Electric Fence
- Galapagos - partnership with Toyota to develop Energy Blueprint for the Galapagos Islands; education campaign for high school teachers and students; and Solar project in Floriana
- WWF-Netherlands Head Office

Projects under Consideration by WWF-Switzerland's Initiative to Promote Gold Standard Carbon Projects (2009)

- Argentina – Greening Growing Cities: Buenos Aires
- Cambodia – Biogas from Dung
- China – Upscaling Existing Pilot Biogas Project
- Georgia – Using Waste Wood for Electricity Generation
- Ghana – Biogas from Household Waste in Accra and Tema
- Honduras – Capturing Methane from Wastewater Ponds on Palm Oil Plantation
- Indonesia – Greening Growing Cities: Jakarta
- Laos – Improved Cookstoves
- Madagascar – Solar Cookers
- Madagascar – CFL Distribution in Seven Cities
- Paraguay – Capturing Methane from Wastewater Ponds at Ethanol Plants
- Peru – Using Waste Wood for Electricity Generation
- PNG – Capturing Methane from Wastewater Ponds on Palm Oil Plantation
- Senegal – Greening Growing Cities: Dakar
- Nepal - The Nepal Biogas Project (presented as a case study)

Annex 2 - Case studies

A. Goma, Congo – Efficient Woodstoves Energy-Saving Project

The illegal cutting of wood in the Virunga National Park in the Democratic Republic of Congo (DRC) has become a serious problem in the past several years, in part because many households in the region use firewood and charcoal to meet nearly all of their daily household energy needs. The reliance on firewood for energy consumption, coupled with an explosion in population in Goma due to the arrival of internally displaced people in response to internal unrest and civil wars in the country, is putting severe strain on the Virunga National Park ecosystem. To reduce the illegal deforestation, the WWF-supported Virunga Environmental Program (PEVi) began a new venture called the Efficient Woodstoves Energy-Saving Project in 2008. The main goal of the project was to introduce efficient woodstoves to the city of Goma.

Testing woodstoves with women's associations in Goma © WWF-PEVi

Location: City of Goma in the Democratic Republic of Congo.
Goals: To reduce threats to Virunga National Park from the destruction of forest for household energy needs and to reduce carbon dioxide emissions.
Technology: Energy-efficient woodstoves.
Partners: WWF-PEVi, WWF-Belgium, WWF-United Kingdom, WWF-Sweden, WWF-Germany, WWF-Netherlands, WWF-International, 50 women's associations of Goma, craftsmen associations.
Time Frame: Production: Since the project began in 2008, 7,635 stoves have been produced. Distribution: 350 stoves have been used by the members of the women's associations for testing in their households. The other 7,285 have been distributed to internally displaced persons (IDP) camps. Today, 750 stoves are ready for distribution to women in a displaced camp. Those women have been raped while collecting wood in the forest. Another 1,130 stoves are now being sold, through the women's associations, to Goma citizens. The project ends in 2011 unless new funds are available.
Carbon Market: None.
Potential for Replication: In other regions where destruction of forest is occurring at an unsustainable rate due to the need for firewood and charcoal.
Project Funding: WWF-Sweden + Swedish International Development Agency, WWF-Germany.
Cost of the project: US$350,000.

1. Context

Location

The project is located in Goma, a town on the eastern border of the DRC. The town is situated next to Lake Kivu and is only shortly due south of the Nyiragongo Volcano.

Significant Landscapes, Species, and Habitats

Located to the west of the Great Rift Valley in Africa, Goma is uniquely situated between two precarious natural landscape features. To the south of the town is Lake Kivu. Almost 1,040 square miles in area, this great lake of Africa poses the threat of a limnic eruption, or a huge release of carbon dioxide and methane gas, which can be fatal to nearby humans. Located slightly to the north of Goma is the Nyiragongo Volcano. Erupting in 2002, this still-active volcano has caused massive damage to Goma and surrounding villages. Quite possibly the most important natural feature located near Goma in the DRC is the Virunga National Park. In 1925, Virunga became Africa's first national park, encompassing more than 3,000 square miles of forest, marshland, and plains. The park is home to endangered mountain gorillas, okapi, hippos, elephants, lions, and numerous other species.

Human Presence

The DRC has a population of 66 million, with more than 600,000 living in the city of Goma. At the time of colonization, North-Kivu was known for its enormous coffee and pyrethrum plantations. The region was also known for its mining richness, which was more exploited after the colonialists' departure. Being next to the border with Rwanda and not far from Uganda, Goma has often been home to refugees during humanitarian crises, especially during the Rwandese genocide. It is also home to people displaced during the wars and conflict in Eastern Congo. Those refugees and IDPs are looking for a more secure place to live, and they find it somehow in the city. Most citizens of Goma are involved in informal activities, which yield little income.

Economic Status

Years of war and mismanagement in the country have weakened the DRC's GDP and per capita income, which now sits at $300 annually for DRC citizens and even less for Goma citizens. Although the country has a vast wealth of natural resources, such as timber, gems, coltan, copper, and gold, political strife and corruption have led to serious inflationary problems and a lack of investment in the private sector and infrastructure. Mining in the region still represents the largest source of direct foreign investment and accounts for around 10 percent of the DRC's total export revenue.

Agriculture constitutes a large percentage of national GDP, yet there is little commercial agriculture production. Most agricultural practices are dominated by subsistence farming in the region, leading to most people living in rural areas. Farming products include rice, maize, groundnuts, and plantains. Many people remain displaced due to political unrest over the last few decades, and hunting of bushmeat by people moving deep into the forests of the DRC is seriously depleting wildlife stocks in some areas.

In Goma and North Kivu, the Virunga National Park plays a large and vital role in the local economy, as more than 50,000 people directly and indirectly benefit from fishing activities inside the national park and related commercial activities. Tourism revenue, during periods of peace, from the selling of permits for gorilla visits in the Virunga National Park could generate up to 1.5 million euros a year.

2. Problem

The widespread use of charcoal by Goma residents for daily energy needs, along with a population explosion of refugees from the Rwanda genocides and IDPs from the country's own tumultuous civil wars, have caused illegal deforestation from the Virunga National Park to increase significantly over the last 15 years. Today, there is absolutely no balance between the demand for charcoal (because of this population explosion) and its supply.

In 2007, only 3 percent of households had access to semireliable electricity and only occasionally needed to supply themselves with wood. Due to this fact, Goma residents burn wood and charcoal in energy-inefficient woodstoves for nearly all their household energy needs. These activities consume large amounts of firewood and result in the release of pollutants and greenhouse gases directly into homes and into the atmosphere. The firewood burned in homes is most often acquired by the illegal deforestation of the nearby Virunga National Park. Small traders bring wood and charcoal extracted from the park into town on their backs or by using their bikes, trucks, or vans. The quantity of construction wood (rafters and planks) used in Goma is equivalent to 60,000 eucalyptus trees per year. The amount of firewood carried into town ranges from a couple of 30-kilogram bags to up to 250 such bags of charcoal in a single truckload. Goma's total consumption of charcoal in the area is 1,335,000 sacks of charcoal per year, the equivalent of 47,525 tons. A sanctuary for many endangered animals, the Virunga National Park is under pressure from widespread deforestation.

3. Solution

WWF's main goal is to curtail the illegal cutting down of trees in the Virunga National Park by introducing efficient woodstoves to the nearby village of Goma and establishing plantations to supply fuelwood.

Efficient Woodstoves Introduced

WWF-PEVi's initial step in the project was to assess the energy situation in Goma regarding firewood consumption as well as to determine how many efficient woodstoves were being used throughout the city. This information was significant in determining the impact of the project for Goma residents. Through a survey of 18 neighborhoods, it was revealed that only 7 percent of households in Goma use efficient woodstoves even though, on average, a household spends between 10 to 30 percent of its budget on charcoal. For the second step, WWF-PEVi worked to determine which efficient woodstove was best suited for Goma residents' future use. To gather this information, WWF-PEVi sought the help of local Congolese citizens. Working with 350 housewives drawn from 50 women's associations, WWF-PEVi tested different woodstoves using qualitative and quantitative measures (ease of starting stoves, cooking speed, smoke emitted, energy consumption) and asked the local housewives to give their opinions and recommendations. From the seven initial candidates, one woodstove was determined to be the best all-around improved woodstove. WWF-PEVi next trained residents of Goma on the use and production of these efficient stoves. Seven craftsmen associations have received training on production methods for the woodstoves. (WWF established quality norms and is closely following up the production. The production of the stoves depends on the availability of recycled materials of good quality and the capacity of production). In the meantime, the 50 women's associations who participated in the initial steps of the project have also been given further training in areas such as selling techniques, use of stoves, management, and maintenance.


Woodstove production – quality check © WWF-PEVi

In conjunction with this project, an EcoMakala program has begun in Goma that addresses the wood-energy supply side of the equation and seeks to create an alternative to illegal and nonsustainable deforestation of natural forests in the park. For several years, WWF has worked with local communities to plant forestry plantations on their land to produce fuelwood and save the Virungas. These communities are already benefiting from sale of fuelwood to Goma and to the IDPs, although transportation has been a problem as roads have been closed during the unrest. The project hopes to create plantations as well as to implement a test system of rotating capital to support reforesting activities into the future. The project is spread over five years, from 2007 to 2012. Since 2007, 1,665 hectares have been planted. At the end of the project, it is hoped that 4,000 hectares of plantations will be established. If everything runs smoothly, WWF hopes to plant 2,000 hectares more.

Job-Generating Sector

The conversion from old woodstoves to efficient ones not only helps minimize the illegal cutting down of wood, but also provides new income for a sector of the local economy. Following the training of local citizens to produce the improved woodstoves, 159 local incomes now come from producing new efficient woodstoves. Craftsmen producing the stoves use recycled metallic barrels and clay, which enables the stoves to last up to four years for those made of metal and two years for the type using clay. This new income, coupled with the savings from using improved stoves, represents a large increase in daily budgetary earnings for producers in Goma. Women's associations are also being trained on maintenance, management, and selling techniques for the woodstoves. These skills could possibly lead to a source of income for these women, which would help raise the standard of living for their families.

Reducing Impacts on the Environment

The Virunga National Park is home to the endangered mountain gorilla, the okapi, hippos, and many different bird species. The violent and tumultuous history of the DRC and its neighbor Rwanda, coupled with the lack of infrastructure in the country capable of supplying energy to outlying rural areas, is causing deforestation and a sharp decline in habitat for these endemic animals. The diminution of deforestation from improved woodstove use in cities near the park will help these creatures to thrive without disturbance from human activity. Improved woodstoves also cut down on the release of greenhouse gases—specifically carbon dioxide, which is major contributor to global warming. The improved stoves are made from recycled metallic barrels. Five stoves can be made from one metallic barrel.

4. **Outcomes and Hurdles**

Since the project began in 2008, 7,635 stoves have been produced, and 350 stoves have been used by the members of the women' associations for testing in their households. The other 7,285 stoves produced have been distributed to IDP camps. Today, 750 stoves are ready for distribution to women in a displaced camp. Another 1,130 stoves are now being sold to Goma citizens through the women's associations. The project ends in 2011 unless new funds are available.

Distributed for free to IDP camps, the improved woodstoves have just started being sold to Goma citizens for US$5. WWF subsidizes the amount needed to buy barrels for the production of stoves and containers for the stocking of stoves. At this point, it is not obvious whether the Goma citizens are using the stoves properly, but WWF promotes demonstrations on the use and maintenance of the stoves to ensure their proper and effective use. Still, it is hard to provide a product of good quality on such a large project scale.


Mountain gorilla © WWF-PEVi / Th. Bodson

The production and distribution of woodstoves and the plantation program are running well. It is too early, however, to measure the full success of this initiative in terms of reduced deforestation in the Virunga Park.

For the future, new energy sources need to be developed in Goma because of the enormous population growth in the area. In addition to electricity, other potential sources of energy must be studied. One such obvious alternative source for energy is Lake Kivu, which produces methane gas. This source raises considerable technical and political challenges, but its immense energy potential makes it an intriguing and interesting choice. Sustaining the promotion of fuel briquettes is another way in which WWF could continue supporting renewable energy in Goma and the DRC as well.

Contacts

Thierry Bodson
thierrybodson.wwf.pevi@googlemail.com

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B. Ngarambe Village, Tanzania – Biodiesel and Pure Plant Oil Production

In 2004, WWF and ABB, a global leader in power and automation technologies, began a progressive access-to-electricity program in southern Tanzania to bring sustainable economic, social, and environmental development to the rural village of Ngarambe. The project specifically focused on providing electricity to the village for better health care, increased educational opportunities, and better opportunities for small businesses. To further the environmental aspect of the program in 2006, Ecofys, an environmental consulting company, was contracted to determine the feasibility of using locally produced biofuels to power the Ngarambe village's 60 KvA[39] fossil fuel generator, erected in 2004. Ecofys provided technical, economic, agricultural, and organizational feasibility data to determine the best and most efficient production methods, seeds for oil extraction, and generator modifications for the project. Ecofys recommended *Jatropha* seeds for pure plant oil (PPO) production and outlined modifications to the generator and filtration practices that villagers, WWF, and ABB should follow. Coupling the counsel of Ecofys with the previous experience of local village residents, WWF and ABB began implementing the biofuel program in Ngarambe.


Mechanical sayari press © Ecofys

Location: Village of Ngarambe in Southern Tanzania.
Goals: Improving livelihoods for local communities living close to WWF conservation activities while testing innovative rural electrification systems. WWF has collaborated with the Ngarambe village on conservation and development projects in the Selous Game Reserve and found it would be a good village for a first project within this access-to-electricity initiative.
Technology: The 60 KvA generator is currently employed. In order for the generator to run on biofuels, the engine must be equipped with a two-tank system. A Bielenberg Ram manual press was recommended for the pressing of seeds. After pressing, oil filtration at the 5 μm[40] level is being used to remove impurities and residues.
Partners: WWF, ABB, Ecofys, local villagers, and local government.
Time Frame: The access-to-electricity program has been operational in the Ngarambe village since mid-2004. The recommendations by Ecofys for biofuels production were completed in November 2006. The first significant harvest of *Jatropha* seeds should be in two to three years, allowing a good oil yield. Funding from ABB will most probably end in 2011.
Carbon Market: none.
Potential for Replication: Other projects using fossil fuel generators for electricity in rural villages.
Project Funding: ABB funds the project through WWF International.
Cost of the project: 30 000 CHF a year from 2009 to 2011.

[39] Kilo Volt Ampère
[40] micro-meter

1. Context

Location

The project is located in the rural village of Ngarambe in southern Tanzania. Situated adjacent to the Selous Game Reserve, the oldest and largest reserve in Africa, Ngarambe is home to 1,800 residents.

Significant Landscapes, Habitat, and Species

The rural Ngarambe village is located on the eastern side of the Selous Game Reserve. Having a dry and scorched landscape, Ngarambe is very different from Dar es Salaam, the capital of Tanzania, which has a varied geography and is situated on a unique harbor point on the eastern coast of Tanzania. Ngarambe's average tropical temperatures and short rains from November to February lend the area to species such as the rhinoceros, the desperate shrew, and the Pemba flying fox.

Human Presence

Ngarambe's population totals just over 1,800, a very small number compared to Tanzania's total population of more than 39.3 million residents. Due to the dry climate, most residents of Tanzania live around watered ports, cities, and industrial areas. In cities, population densities can rise to 51 persons per square kilometer while in rural areas the density is a mere one person per square kilometer. The population in Ngarambe continues to grow with a predominately Bantu ethnicity. Nearly 80 percent of Tanzania's population is considered rural.

Economic Status

Although the government of Tanzania has helped decrease the country's overall internal and external debt the last several years, the people of Tanzania still suffer economic hardships. Poor infrastructure, poor governance, a weak exchange rate, and severe droughts have kept foreign investors away. This lack of capital directs the overwhelming percentage of residents to agriculture (80 percent) with agricultural products totaling more than 42 percent of Tanzania's national GDP. Farming in such a dry and arid climate yields small incomes for the average Tanzanian resident. The average per capita income in Tanzania is between $300 and $400 a year.

The industrial and services sectors of Tanzania are centered in the port city Dar es Salaam. Inadequate government policies in the early 1990s led to an increase in small enterprises dominating the market, producing dairy, fruit, and meat products as well as plastics. The mishandling of state-run electrical companies and the lack of government planning in the electrical and power service sectors have hampered the growth of the utilities sector as well. As more emphasis is placed on utility services in the coming years, Tanzania can hope to see electricity reach outlying rural areas and villages.

2. Problem

The problem plaguing the residents of Ngarambe village, as well as almost 90 percent of Tanzanians located throughout the country, is the lack of access to electrical energy. The severe lack of infrastructure throughout the country hampers Tanzania's ability to provide electricity to remote and outlying areas either with government-run power companies or private electricity providers. The lack of electricity hinders Ngarambe residents' ability to work, study, or sell goods and services during evening hours, lowering daily income and educational opportunities. Because education is the best way for Tanzanians to increase their standard of living, the inability to study during evening hours is an increasingly big hurdle to overcome.

Health care and governmental services are also negatively affected. Without electricity, medical supplies cannot be kept in refrigerators. In some instances, residents of Ngarambe have to travel more than 70 kilometers to the nearest hospital to receive medical treatment.

Even after implementation of electrical power, a generator that runs on fossil fuels like the one in Ngarambe has several harmful disadvantages. The fossil fuel used to power the generator is expensive and has to be imported from long distances, further increasing the price for villagers. With very little daily income, fluctuations in fossil fuel prices can be detrimental to Ngarambe residents. A fossil fuel-run generator also emits harmful greenhouses gases that contribute to global warming, although this is a very small contribution on a global scale.

3. Solution

WWF's main goal is to improve communities' livelihoods by providing a sustainable supply of electricity to the Ngarambe village using biofuels to power the electrical source.

Introduction of the Access-to-Electricity Program

In early 2004, WWF and ABB began the access-to-electricity program designed to bring electricity to the rural village of Ngarambe. With the donation of a 60 KvA fossil fuel-powered generator from ABB, the project's leaders were able to help the village power local schools, government offices, churches, hospitals, and houses along the town's main road. ABB financed the installation of the mini-electricity grid while villagers constructed housing for the generator as well as provided trenches for the underground wires. The electricity has raised the standard of living for Ngarambe residents tremendously, as the generator runs for four hours past dusk. Workers are able to spend more time in factories while students can study and complete homework assignments into the night. After installing the underground cables and the low-voltage equipment for the generator, ABB trained Ngarambe residents on the use, maintenance, and running of the power supply.

Conversion to Biofuel

In 2006, WWF and ABB furthered the access-to-electricity project by introducing sustainable energy to Ngarambe using biofuels to power the village's generator instead of using fossil fuels. Ecofys performed research to determine the economic, social, and technical valuation of using biodiesel or PPO for electrical power. With help from local villagers, Ecofys concluded that the plant *Jatropha* was the most efficient and most oil-yielding plant to be used in the project. *Jatropha* is drought-resistant, does well in poorly cultivated soils, and is non-edible. It yields around 660 kg of oil per hectare per year, meaning that it only needs nine hectares of

Manual Bielenberg ram press © Ecofys

agricultural land (or 0.3 percent of current land used for settlement and cultivation) to fulfill the town's need of 6,000 kg of oil per year. Ecofys determined the current fossil fuel-powered generator would need to be modified to a two-tank system in order to accommodate the use of PPO while the manual Bielenberg press would suffice in extracting oil from the *Jatropha* seeds. A manual press is efficient when only small quantities of oil are to be extracted, as in the case of the Ngarambe village, and it is a locally owned and manufactured press, making repairs and replacements easier.

To help finance the conversion to PPO and to offset press and generator repair costs, a communal ownership group of the press was formed to pay for seeds and to sell the oil to the generator operator. This group is responsible for repairs and replacements of the Bielenberg manual press. To ensure fair and equitable electricity prices, the Ngarambe villagers, along with local authorities, have decided how much they should pay for power. Devices that limit current flow ensure that villagers do not use more electrical power than they can afford. The access to electricity in the village has created local economic activity and provided income to local residents. Residents must plant the seeds, harvest them, and extract oil from the seeds—all economic activities that stem from using biofuel instead of fossil fuel.

4. Outcomes and Hurdles

Since the inception of the access-to-electricity program in 2004, educational classes at the local Ngarambe school have formed at night, and there has been a large increase in the number of students attending classes. In 2004 250 students attended classes; now 350 villagers attend classes and study during evening hours. Due to the new power source, the local dispensary has installed a new refrigerator so that medicines for patients can be stored locally. A water pump and a sawmill have been installed in the middle of the community to reduce the amount of travel required by women to gather water and fuelwood. Local businesses are able to sell their products during evening hours, increasing their income and providing services to the community. Eighty-five private homes have been connected and wired to the main grid.

Ngarambe villager © Ecofys

The conversion of the generator to biofuels has not currently taken place, but measures to support this process are under way. Oil pressing and filtering machines have been procured and installed in Ngarambe village. The machines are meant to process seeds for community use, and some will be used by the generator. The edible oil pressing and filtering machines have been tested and are functioning well. An electric utility group was formed in the village to ensure the collection of tariffs, running of the generator, purchasing of oil seeds, pressing of oil seeds, and the sale of excess seeds. The group comprises 12 members from the community. Twelve farmers and three district officials of the Ngarambe village have received training on the theory and practical propagation of *Jatropha* seeds. Furthermore, woodworking facilities have been installed in a warehouse finished by villagers to sell finished wood products in outside market places. The income generated from selling wood products will help people pay their electricity bills, thus ensuring sustainability of the generator.

Forty-two members of the carpentry group, electricity utility group, and local shop owners have also been trained on bookkeeping, accounting, and entrepreneurial measures to help maintain accurate and open bookkeeping services.

In the future, there is also a need to determine the current load capacity after connecting oil pressing and refinery machines, wood factory machineries, and water pump to the main electricity supply. More residential houses may need to be connected to the generator to increase the load and to increase electricity tariffs from more household users.

Competition with food production in terms of land and labor forces should be avoided in the future. Although *Jatropha* is not edible, is does not mean that it would not compete for land or for labor forces. Caution, in this regard, is required.

It is also important to associate the local community as much as possible in the decision-making process, otherwise money and equipment for the project may not be used for its initial agreed-upon purpose. It is clear for the future that there might be competition between sesame seeds and *Jatropha* seeds in relation to the use of the press, as sesame oil is a quite valuable product. The time lag between the moment *Jatropha* seeds are planted and the moment enough are harvested to be pressed usually takes two to three years, and there is a risk that many farmers may stop taking care of the crop during this period of time.

Unfortunately, it is too early to draw conclusions from the biofuel conversion project. The conversion has not currently taken place, mainly because an oil pressing machine has not been installed in the village, but measures to support this process are under way. Officials in charge of the project have been unable to estimate how much oil will be produced per kilogram of seeds due to temporary stoppage of the generator for major service, further halting the conversion of the generator to run on pure plant oil.

Contacts

Gaël Léopold
gleopold@wwfint.org
Tel: +41 22 3649284

Cyprian Malima
cmalima@wwftz.org
Tel. +255-222775346

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C. Toliara, Madagascar – Wood Energy in Southwest Madagascar

Because of the lack of access to electrical power for most residents in the Atsimo Andrefana region of southwest Madagascar, wood represents the most readily available and most easily accessible source of energy for local villages and communities. Used for almost every household cooking need, wood in the Spiny Forest is being harvested at an unsustainable rate. To combat this problem, WWF- Switzerland and various partners funded the project, Energy Environment Synergy in Southwest Madagascar, on February 1, 2008, to help restore forests in the Atsimo Andrefana region through a sustainable wood energy production chain in the town of Toliara. The plan includes planting energy-useful tree species on designated acres with help from villagers, communes, and private operators; introducing better carbonization techniques to charcoal producers; and building the capacities of administrative services and agents who control the fuelwood value chain. A forest energy commission has been established to coordinate the players in the wood energy production chain successfully and efficiently, as well as finding a way to control and enforce sustainable practices throughout the ecoregion. The Forest Energy Commission hopes to track the project with technical reports and local meetings to help foster cooperation and participation by local communes and villages.


Spiny Forest © WWF

Location: Toliara in the “Atsimo Andrefana” region of southwest Madagascar.
Goals: Sustainable wood management to protect the Spiny Forest ecoregion from harmful deforestation for fuelwood.
Technology: Sustainable wood energy. Planting energy-useful tree species for charcoal production. Supporting the sustainable management of forest areas for fuelwood purposes, including the training of coal men with efficient carbonization production methods.
Biomass Source: Energy-useful tree species, particularly local *Eucalyptus camaldulensis, Eucalyptus citriodora, Acacia auriculiformis, Acacia leptocarpa, Acacia mangium,* and *Neem.*
Partners: Project Steering Committee: the European Union, The National Centre for Industrial and Technological Research (CNRIT), WWF-Madagascar and Western Indian Ocean Programme, the Forestry Department (DGF), the Regional Forestry and Tourism Department (DRFT), the Department of Energy, the Inter-regional Department of Energy and Mines, the Atsimo Andrefana Region. Local charcoal producers, charcoal haulers and traders, communes, local governments, private operators, the local community, and the army.
Time Frame: The initial phase of the project began on February 1, 2008. The project is scheduled to take more than 36 months to fully complete.
Carbon Market: No.
Potential for Replication: Wherever it is possible and sustainable to plant fuelwood as a substitute for forest cutting.
Project Funding: European Union, WWF-Switzerland, and the Fund of the Environmental Programme of the Environment Institution (a World Bank fund).
Cost of the project: 970,000 euros, including the development of a sustainable energy strategy for the region, which is not described in this case study.

1. Context

Location

The project's central location is the Atsimo Andrefana region of southwest Madagascar, with a concentration around the town of Toliara and precisely around the road that supplies coal to the town of Toliara. The Toliara province encompasses parts of the Spiny forest, an ecoregion of deciduous thickets located throughout southern and southwest Madagascar. Toliara itself is located on the southwest coast of Madagascar.

Significant Landscapes, Habitats, and Species

The Spiny forest of Madagascar is an ecologically unique region. Many plants in this ecoregion are endemic. The most notable plant species growing in the forest along the low-lying western side of the region is the spiny thicket or spiny brush. Typically three to six meters in height with long root stems, the spiny brush grows well in the dry, arid climate of the Toliara Province. Other plants found in the ecoregion are deciduous woody plants, evergreen succulents, and low-lying grasslands. Due to rapid deforestation and conversion to agricultural purposes, parts of the Spiny Forest are becoming bare limestone protrusions with little vegetation on top. The white-footed sportive lemur, mongoose, hedgehog, many reptiles, and eight bird species are native to this region.

Human Presence

Toliara city has a population of over 200,000. The native ethnic group of fisherman called the Vezo dominates the southern part of the city, while migrants of the area dominate the northern sector. Inhabitants of the region are Malagasy, a mixture of people from many different origins that settled in Madagascar more than 2000 years ago. While Malagasy is the most widely spoken official language, French is also considered an official language. Cities such as Toliara are becoming larger and more densely populated as the industrial sector of the country continues to grow. Nearly a third of people of Madagascar live in cities, while two-thirds populate rural areas.

Economic Status

Located on the southwest coast of Madagascar, Toliara serves as a key port for the country and particularly the Atsimo Andrefana region. Focusing on products such as rice, corn, and cotton, the industrial and trade sector of the local economy remains somewhat stable, although declines in recent years may suggest a downward trend to come. Only around 7 percent of the workforce is positioned in the industrial sector, while agriculture consumes nearly 80 percent of the country's total workforce.

The tourism industry in Toliara continues to grow. As one of the main cities to visit in southern Madagascar, Toliara has calm waters, a warm climate, and a unique landscape appealing to travelers. This industry also benefits from salt marshes and precious stone minerals from the surrounding region.

Historically, the oscillating economy of Madagascar has caused unrest and turmoil to the overall stability of the country's industrial and private sectors. Perceived notions of corruption and ongoing political clashes have hampered the nation's ability to fight stagnation and poverty, particularly in rural areas.

2. Problem

In the Atsimo Andrefana region, where large tracts of the Spiny Forest occur, nearly all residents use wood-burned charcoal as their main source for household energy and cooking needs. The city alone needs 288.782 tons of wood annually. The rapid deforestation of the region to supply these energy needs, as well as for conversion to agricultural purposes, is putting severe pressure on the Spiny Forest ecoregion. Charcoal producers and hauliers in the area also produce wood charcoal using an inefficient method, compared to improved carbonization techniques. As the population in the area continues to grow, further pressure will be placed on the Spiny Forest region. The rapid deforestation now occurring will leave many people in the area without the necessary fuel for household energy requirements, as well as spur the loss of other forest benefits such as building materials, medicinal plants, wild foods in times of drought, and water supplies for local people. It will also cause the decline in endemic mammals, reptiles, and birds due to the loss of the natural habitat of these species.

Charcoal in Atsimo Andrefana region © WWF

3. Solution

WWF's main goals are to coordinate sustainable management of the wood energy production chain in the ecoregion, to introduce energy-useful species to the area, and to teach better carbonization and charcoal techniques to town residents.

Coordinating and Mobilizing Authorities for Action

With help from the European Union, The Department of Energy, the National Centre for Industrial and Technological Research, WWF, and others, a strategy for a sustainable wood energy supply chain has been developed to help in the wood energy management of the region. The main goals are these: helping local authorities and administrators organize a sustainable wood energy production chain; planting energy-useful tree species on designated acres with villagers and private industries; and aiding local communities in forested areas with more efficient and better charcoal production methods. The Forest Energy Commission (CEFR) is now operational in the region and is in charge of coordinating activities between state departments and local communities. Reports of the CEFR will be reviewed regularly at local meetings. Technical reports on the project, investigations, and findings are also being established to review the progress and timeline for meeting specific project objectives. The numbers of nurseries established, nurserymen trained, villages adhering to restoration practices, and trees planted are all indicators tracked by local officials and the CEFR. These indicators will determine the success of the project and help outline areas with the most reforested hectares to date.

Planting Energy-Useful Tree Species

The sustainable wood production chain was proposed to protect the natural endemic species of the Spiny Forest ecoregion as well as protecting those who rely on wood as their main source for energy needs. Energy-useful tree species were chosen to maximize the potential amount of energy produced per acre. *Eucalyptus camaldulensis, Eucalyptus citriodora, Acacia auriculiformis, Acacia leptocarpa, Acacia mangium* and *Neem* have been planted on 12 different nursery sites distributed among four communes. Reforestation energy based on the 2008-2009 campaign conducted in partnership with the decentralized local communities, grass-roots communities, individuals, schools, and the military of the RM 5 zone in the towns of Andranohinaly, Andranovory, Ankilimalinika, Tsianisiha, Analamisampy, obtained the following results: 135,000 plants have been produced, 37 plots have been planted on 135 hectares of surface area with a 30 percent success rate upon implementation of the safeguards against cattle incursions and wild fires that began in April 2009.

Energy-useful plants © WWF

Community-Based Integrated Population

Local authorities are in the process of selecting consultants to assist several charcoal producers around the Toliara area in carbonization techniques. Almost all rural residents around Toliara use charcoal for their household energy cooking needs. The hope is that with better methods, charcoal production techniques will improve in the region, with the result that less wood is used and more forest areas are left intact. The livelihood of charcoal producers, hauliers, and traders will continue. Funded with help from the Program Environment III, the CEFR will track the number of charcoal producers trained in improved techniques.

Preventing Further Habitat Destruction

Planting trees on degraded lands with energy-useful plant species will help quell the further loss of habitat for endemic reptiles, other animals, and plants. The new energy-useful tree species will lessen the destruction of non-nursery forested areas in the ecoregion.

4. Outcomes and Hurdles

Since the project's inception in 2008, over 135 hectares of forest have been replanted with several different plant species, including *Eucalyptus camaldulensis, Eucalyptus citriodora, Acacia auriculiformis*, *Acacia leptocarpa*, *Acacia mangium* and *Neem*. During the 2008-2009 campaign year, 28 villages and 212 reforesting individuals, as well as the RM5 military company, took part in planting with community management plans.

For the 2009-2010 campaign, 700 hectares of additional land have been delimited with a goal to plant more than 1 million tree seedlings. Eighteen sites for nurseries have been identified as well as new areas of reforestation. More than 600 individuals are planning to help plant trees. The objective for the entire duration of the project is to plant trees on 2,000 hectares of surface available at the intervention site.

Eight hundred and thirty-one charcoal makers have been identified and registered in delimited charcoal production areas to control the flow of charcoal (traceability of wood energy products). Thirteen points of sales have been implemented in consultation with the sellers and producers of charcoal, while committees have been established for the management, protection, and conservation of local forests. Also, three charcoal associations have been structured to monitor the sale of charcoal. With help from local partners, the Forest Service in Madagascar has endorsed four new forest community management plans.

A system for monitoring reforestation activities has been put in place, and it enables project partners to draw an inventory of the experiences and lessons to prepare the next campaign. Indicators, such as the amount of households earning a living based on the sustainable wood business, the offer (in tons) of charcoal from the plantations, and especially the reduction of deforestation in some targeted forests, will help in measuring the project's final success. For reforestation in the context of the campaign year 2008-2009, the results are mixed for various reasons, such as not enough controlled techniques, information, or insufficient awareness, and in particular because of very unfavorable climate conditions. Rainfall during this year was not sufficient.

For final results, the project plans to train 25 nurserymen, have 25 nursery sites set up for production of plants, deposit more than 1 million tree seedlings, have more than 1,000 planters working in conjunction on the project, have 25 planter groups, enable two new energy-based management contracts, establish over 10,000 hectares of forest area managed by local communities with a wood energy production, and train 550 charcoal producers in improved coal production techniques.

To ensure sustainability, the project depends highly on volunteers from poverty- stricken local communities. External help is needed, but the residents of Madagascar have to be willing to plant trees and sustain the life of those trees after the project has concluded. Local charcoal producers and traders must be willing to engage in better production techniques, even if it requires longer burning methods or increased inputs. Coordination techniques between the parties involved in the project could present a hurdle, but the idea to set up the CEFR should streamline all processes and help develop quick and precise energy-management contracts.

Contacts

Voahirana Randriambola
vrandriambola@wwf.mg
Rina Andrianarivony
randrianarivony@wwf.mg

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D. Hungary, Tisza Floodplains – Planting Energy for Wetland Conservation

WWF "One Europe, More Nature (OEMN)" has initiated an innovative pilot project in Tiszatarján village, next to the Tisza River in northeastern Hungary. the project's goal is to restore and diversify the area's natural floodplains and produce local renewable energy while increasing and diversifying local income streams. A new company, set up within the framework of the project by the Tiszatarján municipality and a local farmer, paid local people to cut wild bushes of the highly invasive Amorpha species, which was shipped to, and burnt, at a large nearby energy plant to produce "green" electricity. Large areas of land formerly covered by the Amorpha, together with less productive arable lands, are now being given back to nature to restore the floodplain's former glory. Some of the area is being replanted with willow trees, which will serve as a long-term, sustainable supply of "biomass" for the power plant. Participating farmers are obliged to set some lands aside for wetland and grassland conservation, the management of which will be paid for by revenues from biomass sales. Additional project mechanisms include the introduction of grazing animals, such as Hungarian grey cattle and water buffalo, to prevent the return of invasive species and to assist with grassland management. Finally, these changes provide an attractive landscape for ecotourism, which will bring in additional revenues to economically diversify and better sustain this Hungarian rural community.

Tiszatarján floodplains © WWF / JP Denruyter

Location: 30 kilometer-long floodplain of the Tisza River between Tiszatarján village and Tisza Lake, Hungary.
Goals: Linking floodplain restoration to local renewable energy production.
Technology: In a first phase, biomass (*Amorpha fruticosa*) cofiring in a 50 megawatt coal power plant using the fluid bed technique. The long-term target is to diversify biomass sources and to move toward decentralized small capacity heat districts owned and managed by local communities along the river Tisza.
Biomass sources: Amorpha and later native willow (*Salix alba*) plantations.
Partners: Private AES-owned power plant, local landowners, local governments, water management authority.
Time frame: First negotiations with local communities started in December 2006. The supplier contract between the municipality-owned company and AES was signed in December 2007. Biomass cutting and transfer began at the end of 2007. WWF involvement in this first phase ended in September 2009.
Carbon market: Yes through a joint implementation project deal between AES and the Dutch government.
Potential for replication: Other projects using invasive species for biomass.
Project funding: WWF-Netherlands and AES Hungary power company.
Cost of the project: 75,000 euros between 2006 and 2009

1. Context

Location

The project's main location is the active floodplain of the Tisza River between Tiszatarján village and the Tisza Lake. The area is "between the river dykes" covering some 3,500 hectares of a 30 km-long river section, from 0.5 to 4 kilometers wide. Some 10 kilometers away from Tiszaújváros (a large industrial center next to the Tisza River where the power station AES Hungary has its headquarters), Tiszatarján is part of the Mezocsát subregion in Borsod-Abaúj-Zemplén County, North Hungary.

Significant Landscapes, Habitats and Species

One hundred fifty years ago, the area was a beautiful mosaic of sparsely forested floodplain grasslands (similar to savannah or steppe), wetlands (e.g. oxbows, old riverbeds, clay pits), and floodplain softwood forests (mainly willow and poplar). Many landscapes and species remain, but they number far less than before. In 1989, a large part of the area was protected as a national park and internationally protected as a Ramsar wetland site. The area is home to globally significant species such as the black stork, white-tailed eagle and countless water birds that migrate to the area in the spring, including herons and geese. The area is especially noted for its "Tisza Flowering, " the mating dances of a mayfly (*Palingenia longicauda*) species, which create a breathtaking immense cloud of swarming winged insects for only three to four days each May or June.

Human Presence

Tiszatarján's population is 1,465. The population of the sub-region is 15,000, is decreasing, and includes a fairly visible gypsy (Roma) minority.

Economic Status

The subregion is currently economically depressed. Average incomes are low (less than 1,000 euros per year per capita); the level of unemployment is higher than the national average; and the majority of the population is inactive earners[41]. Education and training are below the national average.

Employed people represent 22.6 percent of the population with 14.8 percent in agriculture, 35.2 percent in industry, and 50 percent in the service sector mainly outside the subregion (e.g. local small shops and tourism facilities). Many inhabitants commute outside of the microregion to working places and large factories such as AES Hungary, a chemical company (Tisza Chemical Company), and the Borsodi brewery. The proportion of agricultural businesses in the depressed areas is significantly larger than the regional average.

Historically, the area's habitats and landscapes were maintained and enhanced through traditional practices such as extensive grazing (of local breeds of Hungarian Grey cattle and Mangalica pigs), hay harvesting, sustainable forest management, floodplain orchards (cherry, pear, apple, and plum production), reed harvesting, sustainable fishing, and handicraft production (e.g. willow branch baskets).

[41] pensioners, disabled persons obtaining a pension, pensioners of cooperatives, persons on child care allowance…

2. Problem

In the 19th century, the Hungarian aristocracy introduced massive changes in the region to increase cropland areas for arable production and to seemingly improve flood protection. The result was the engineered regulation of the Tisza River within large earthen dykes, wetland drainage, the straightening of river bends and reductions in river length. Later, construction of new regulated canals and a hydropower plant led to the creation of the artificial Tisza Lake. In wetland areas within the dykes, some traditional practices were maintained, and this is where the main ecological corridor remains. Outside the dykes, new fields, settlements and roads developed. In total, the river has lost 98 percent of its floodplains.

After the Second World War, Hungarian agriculture was characterized by drastic increases in energy-intensive inputs (e.g. artificial fertilizers). Yields doubled over 25 years, while the diversity of yields decreased. As a result, traditional land-use practices declined even more.

With the end of communism in 1989, farmers were hard hit as many state-run agricultural cooperatives closed. Land parcels distributed to private owners were often too small to be financially viable, and there were difficulties in finding markets for local products such as meat and milk. Grazing almost completely stopped within the dykes as many former farmers gave up farming and many lands were left unmanaged and abandoned.

The net result of these changes was that environmental degradation proceeded, especially in former wetlands and floodplain areas. Most wetlands disappeared, both inside and outside the dykes. Many of the natural watercourses flowing to the area dried up, including streams from the nearby (Bükk) Mountains that were blocked and regulated. Groundwater levels dropped, and saline soil replaced many former floodplain grasslands, making the area dehydrated and reducing meadow fertility. The risk of floods increased (five floods in the last 10 years), because the riverbed deepened, and the floodwater retention capacity of the floodplains decreased.

Amorpha fructicosa © WWF / JP Denruyter

A major problem resulting from the decreased grazing and scything was widespread colonization by invasive species such as wild *Amorpha fructicosa* ("running acacia") in the floodplain grasslands and wetlands. Natural forest areas also disappeared, replaced mainly by hybrid poplar forests planted after World War II and with the start of intensive agriculture in the 1970s. This move toward monoculture continues today.

3. Solution

WWF's main goal is to restore the area's natural floodplains and produce local renewable energy while increasing and diversifying local income streams.

New Green Energy Production

A limited company, Tiszatarján Kft, was established by the Tiszatarján municipality, and a local farmer was appointed to manage the project area (initially 53 hectares) during and after WWF's involvement. WWF then mediated an agreement between the company and the energy provider, AES Hungary, whereby the company would provide AES with biomass to produce "green" energy (which is a positive contribution in mitigating climate change). Initially, the biomass is cofired in a local 50 megawatt coal power station. The contract was based on a number of nature conservation criteria written by WWF, such as the requirement for biomass to be certified by WWF. In 2008, the municipality company contracted with local unemployed workers to cut and remove invasive *Amorpha fructicosa* from the floodplains. The resulting 400 tonnes of bundled biomass was sold to AES Hungary, generating 32,000 euros of new income and employing two people full time and more than 30 people seasonally (including many unemployed gypsies). The company prevents the return of *Amorpha fructicosa* and replaces the plant in some less ecologically valuable, former cropland areas with energy-useful willow, a local species that will continually be cut to produce a regular supply of biomass for AES and therefore jobs and income for the community. In 2008, the first willow seedlings were planted in areas formerly covered by *Amorpha* and in former arable lands. The project will later be expanded to nearby areas where invasive species will be similarly cut and replaced with natural areas and with willows for increased green energy production. A long-term goal is for the local communities to become energy self-sufficient.

Support from the Carbon Market

Hungary was taking measures to increase the share of renewable electricity in the country from 0.1 percent up to 3.6 percent, especially through solid-biomass combustion in old coal-fired power stations. Selling the subsequent carbon emission savings would help make those projects financially interesting. AES was the first power company involved in the joint implementation or JI[42] process and signed an agreement with the Netherlands, before the common project with WWF. This was the **first ever JI project in Hungary,** and each step that was taken meant breaking new ground, particularly in negotiation with the Ministry of Environment, which had never issued approvals for Kyoto Protocol transactions before. Ultimately, AES sold the emission reductions (ERUs) to the Dutch government **raising more than 3 million** euros of funding or some **25 percent of the project cost**, substantially cutting the need for equity in the project.

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[42] Joint implementation (JI) is one of three flexibility mechanisms set forth in the Kyoto Protocol to help countries with binding greenhouse gas emissions targets (so-called Annex I countries) meet their obligations. JI is set forth in Article 6 of the Kyoto Protocol. Under Article 6, any Annex I country can invest in emission reduction projects (referred to as "Joint Implementation Projects") in any other Annex I country as an alternative to reducing emissions domestically. In this way countries can lower the costs of complying with their Kyoto targets by investing in greenhouse gas reductions in an Annex I country where reductions are cheaper, and then applying the credit for those reductions towards their commitment goal.

Subsidized Floodplain Maintenance and Restoration

The floodplain restoration plan © WWF / JP Denruyter

The contract between AES and the municipality company obliges landowners to set aside a certain amount of degraded floodplain areas and former arable land for restoration of floodplain habitats, especially wetlands and grasslands. Income earned from the selling of biomass is used by the farmer to cover the costs of maintaining the habitat. This enhances biodiversity and boosts provision of ecological services such as floodwater retention. Examples of wetland work include restoring arable lands that experience regular excess water pouring into wetlands or reed beds, prohibiting water drainage and irrigation from valuable wetlands or the use of pesticides and artificial manure, and stopping the advancement of aggressive weeds and invasive species (e.g. *Amorpha*, hybrid poplar, *Fraxinus Americana*, *Acer negundo*). Examples of grasslands work includ prohibitions on new conversions to arable land or hybrid poplar plantations, the use of pesticides, artificial manure and irrigation, and the introduction of alien species while introducing wise-scything practices for grasses.

Extensive Grazing

The company, with the help of WWF-Hungary, has reintroduced water buffalo in wetland areas and Hungarian long-horned Grey Cattle in woody grassland areas to prevent invasive species from recolonizing and to help restore the grasslands to their former species-rich glory. Another expectation is the future sale of organic beef to supplement local incomes. Semi-managed grazing also attracts new biodiversity, especially water birds around wetlands. Beavers have been reintroduced in the floodplains' project area as the former native ecological engineers are supposed to diversify the wetland's landscape and restructure floodplain habitats.

Ecotourism Expansion

The resultant improvements to the landscapes and biodiversity make the area more attractive to tourists and encourage the development of local tourism facilities. Recently, a bike trail along the top of the dykes was developed. A new ecological corridor to connect protected areas in the Mezocsát microregion with Tisza Lake is also envisioned. In July 2008 and 2009 Tiszatarján hosted the Tisza Big Jump, part of a Europe-wide public event where people jumped into their nearby rivers and lakes at exactly the same time to signify their concern for water and river ecology.

4. Outcomes and Hurdles

Since the program's inception in 2006, AES has bought more than 400 tonnes of invasive species as biomass, clearing more than 15 hectares of floodplain. After removing invasive shrubs, former floodplain habitats have been maintained by semi-natural grazing. On the pilot site, 20 hectares (owned by Tiszatarjan municipality) of wet grasslands and wetlands have been restored by water buffaloes and beavers since the summer of 2008, and 30 hectares (owned by the local farmer) of woody grassland are also being restored by (20) Hungarian grey cattle.

On the former arable land areas of the cleared floodplain, energy-useful willow plantations were established on 20 hectares in 2008. In 2009 another 10 hectares of energy plantations are to be established on former arable lands. The first harvesting activities are scheduled for next winter. This means that willows will replace *Amorpha* as a biomass source after two to three years and will subsidize nature restoration and maintenance of the floodplain habitats.

At present, the project area covers 80 hectares of floodplain areas, and WWF is planning to extend the project to neighboring villages. WWF-Hungary has started to negotiate biomass production and floodplain restoration with three more villages next to Tiszatarjan. Most of the floodplain areas are state-owned but managed by the water management authority. WWF-Hungary has turned to the water management authority with a restoration plan on cutting *Amorpha* on 600 hectares of floodplain and reintroducing new land-use practices that can be seen on the Tiszatarjan pilot site.

At the same time WWF-Hungary, AES, and the local company are negotiating a new supplier contract. AES declared that the biomass provided was satisfactory, and the power plant is ready to buy more or the same amount next year as well.

WWF-Hungary and four local municipalities are also working on a new project proposal for planning and building local heating plants in the villages in order to use local biomass for local communities. Only surplus biomass from this project would be transported to AES.

In Hungary at present, renewable electricity is mostly generated from forest biomass. WWF-Hungary aims to replace this with biomass from sustainable energy plantations and link bioenergy production directly to nature restoration. WWF-Hungaryalso wants to enhance the importance of local biomass as a source of heat for local communities. In Hungary, only renewable electricity is supported (through a feed-in tariff). For renewable energy projects based on biomass, it would also be useful to obtain subsidies for green heat.

Hurdles

The economic crisis can be felt in Hungary and its energy sector. This affects the green electricity market, but at the moment, AES is able to sell green electricity at a higher price than traditional electricity. Also, many competing entrepreneurs are trying to work their way into the project and use invasive species as biomass without floodplain restoration.

Contacts
Csaba Vaszkó (Project Leader)
Álmos vezér útja 69/A, 1141 Budapest, Hungary
csaba.vaszko@wwf.hu
Tel.: +36 1 214 55 54
Mobile: +36 30 586 66 88

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E. Tanzania, Miguruwe Secondary School – Solar PV System for Lighting

WWF through its Coastal East African initiative has come to the help of a Miguruwe government secondary school's need for light to enable students to study in the evening and to provide better security for the teachers and students at the Miguruwe Secondary School. Miguruwe is located next to the Selous Game Reserve, and the community often suffers from crop damage caused by wildlife.

Although able to study during the day, students lack the ability to read, study, or complete homework assignments during the dark evening hours. As education is the key ingredient for young men and women to find employment in the future and potentially raise their standard of living, electricity during late hours is necessary. To alleviate this situation, a local Tanzanian solar company installed a solar PV lighting system for the school's use during WWF's March 2009 Earth Hour celebrations. Solar PV was chosen as the renewable energy resource due to the large amount of sunlight Tanzania receives on a yearly basis and the remoteness of the village relative to the country's existing electricity grid. To ensure that the solar PV system would remain functional, the recipients were trained on the proper maintenance of the system. The project has now been handed over to the recipients.

Miguruwe Secondary School © WWF

Location: Miguruwe Secondary School located in the Kilwa District (101 kilometers from Kilwa Masoko, 315 kilometers south of Dar es Salaam) of Tanzania.
Goals: Providing electricity to remote local school in rural Tanzania via solar energy installation while promoting sustainable energy resources.
Technology: Solar Photovoltaic.
Partners: WWF Tanzania, Miguruwe Secondary School, Kilwa District Council, local Tanzania residents.
Time Frame: PV system completed in March 2009.
Carbon Market: No carbon credits were involved.
Potential for Replication: Any place where decentralized electricity is needed.
Project Funding: WWF-Switzerland.
Cost of Project: US$12,000.

1. Context

Location

The solar energy project is located at the secondary school in the village of Miguruwe in Tanzania. The school is situated next to the 50,000 square-kilometer Selous Game Reserve. The largest and oldest game reserve in Africa, it is home to elephants, rhinos, and African hunting dogs. The remote village of Miguruwe is extremely poor. The local population subsists on the surrounding woodlands and cultivates poor local coastal soils. The community often suffers from crop damage caused by wildlife in the adjacent game reserve, which causes significant hardship for households.

Significant Landscapes, Habitats, and Species

The rural Migurewe village is located 315 kilometers south of Dar es Salaam, the capital of Tanzania, near the Selous Game Reserve. The Selous Game Reserve is full of grassy plains and woodlands as well as rocky outcrops. The major river running through the reserve is the Rufiji river. Its tributaries form numerous lakes and channels that provide habitat for the many species that roam the park.

Human Presence

In 2002, the Miguruwe ward had a population of a little more than 2,500 residents, while the country of Tanzania has a total population of over 39.3 million. In cities, population densities can rise to 51 persons per square kilometer while in rural areas the density is a mere one person per square kilometer. Nearly 80 percent of the population is considered to live in rural areas.

Economic Status

Although the government of Tanzania has helped to decrease the country’s overall internal and external national debt the last several years, the people of Tanzania still suffer economic hardships. Poor infrastructure, a weak exchange rate, and severe droughts have kept foreign investors away. This lack of capital leads the overwhelming percentage of residents to agriculture (80 percent) with agricultural products totaling more than 42 percent of Tanzania’s GDP. The per capita annual income in Tanzania is between $300 and $400 a year.

Inadequate government policies in the early 1990s led to an increase in small enterprises dominating the market, producing dairy, fruit, and meat products as well as plastics. The mishandling of state-run electrical companies and the lack of government planning for electrical and power services has hampered the growth of the industrial sector in Tanzania. As more emphasis is placed on utility services in the coming years, Tanzania can hope to see electricity reach outlying rural areas.

2. Problem

The main problem troubling almost all of Tanzania (almost 90 percent of citizens) and epitomized in the rural secondary school in Miguruwe is the lack of access to electricity for residents. The severe lack of infrastructure throughout the country hampers Tanzania’s ability to provide power to remote and outlying areas either with government-run power companies or private electricity providers. Most Tanzanians are left to use biomass or kerosene for heating and lighting needs.

Although the secondary school in Miguruwe is a great resource for many young children in the Miguruwe village, the lack of electricity and power outages that often occur in Tanzania make education difficult. Without light, completing homework and reading during the evening hours is almost impossible. The lack of proper education and significant training hampers these children's ability to find employment in the future. In August 2009, 12 girls unfortunately died at a secondary school in Tanzania when an unattended candle set fire to the dormitory, providing yet another compelling reason to install and use solar for lighting purposes.

3. Solution

WWF's main goals are to provide light and electricity to the secondary school for educational training, to promote solar renewable energy and access to energy during Earth Hour, and to help a village that deals with human-wildlife conflicts due to its proximity to nature conservation projects.

Providing Power to the Secondary School, Promoting Earth Hour and Conservation

WWF-Switzerland funded the installation of solar PV panels on the roof of the secondary school. The project ensures access to electricity for lighting during the evening hours so that children can continue to study, read, and complete homework assignments. The system, which consists of five solar panels charging six batteries in a 450-watt system, will provide enough electricity to light three classrooms, one teacher's block, and one personal computer. Solar PV was chosen as the renewable source for power at the school due to the typical average sunshine in Tanzania, its convenience, environmental benefits, and relatively low cost. Rex Investments Limited installed the solar panels. This company was preferred as it is a local player and it had already worked with WWF before.

Solar PV system on secondary school © WWF

WWF undertook the solar project in the Miguruwe village because WWF wanted to do something symbolic for Earth Hour. The particular village was chosen because several conservation projects were and still are happening in its surroundings, and the village has faced some human-wildlife conflicts in the past. Thus, WWF wanted to show that conservation also has a helpful and beneficial side. Positively, the project leaders are actively thinking of scaling up the project for 20 schools in a first step. For this, they are working with colleagues from the WWF-China for a Shift Network Initiative.

Helping Communities Develop in Sustainable Ways

The installation of solar PV will help not only the 68 young men and women at the Miguruwe Secondary School directly by providing better assistance in their education, but it will also help the community indirectly by providing residents with the knowledge of solar panel maintenance. The fundamental transfer of knowledge about a solar renewable energy resource will help the

Installation of solar panels at secondary school © WWF - Cyprien community in the future if it wishes to install more solar panels and move toward sustainable renewable energy in the community.

4. Outcomes and Hurdles

The solar PV system installation was completed in March 2009. On March 28, 2009, the school celebrated Earth Day by switching on its solar energy-powered lights for the first time. Since then, the Miguruwe Secondary School has been using the system for power during the evening hours to power classrooms, teacher's blocks, and a personal computer.

In order to minimize hurdles in the future, the residents of Miguruwe were trained in the maintenance of the solar panels. This gives the village the full capability to solve small PV problems as they arise. Responsibility for the project has also been handed over to the recipients of Miguruwe village. Villagers are happy, and the project may have improved the locals' perception of conservation projects.

WWF is currently looking into funding to extend this exciting initiative to 100 remote rural secondary schools around Tanzania's precious protected areas. This will cost around US$1 million.

Contacts

David Hoyle (Co-leader, WWF Coastal East Africa Initiative)
dhoyle@wwf.org.uk
UK Mobile +44 7919 838 486 (BB)
Tanzania Mobile + 255 763151746

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CIA Fact Sheet
2002 Tanzania Population and Housing Census

F. Kiunga Marine National Reserve, Kenya – Wind–Solar Systems

In June 2007, the WWF Eastern Africa Regional Program Office (EARPO) and WWF-US initiated a project to bring renewable power to WWF offices and health centers located within the Kiunga Marine National Reserve (KMNR) in Kenya. As part of the comanagement agreement to protect the natural resources of the park, the project's main goal was to outfit five sites within the KMNR with combined wind-solar renewable power supply sources. For more than three years, local health offices in the region have been lacking power, while WWF offices in Kiunga and the nearby Mkokoni village have experienced intermittent electricity since early March 2007. WWF-US was responsible for the shipping and purchase of the equipment, with voluntary assistance from Southwest Windpower (SWWP). The WWF Kiunga team, David Calley of SWWP, and U.S. volunteers installed four of the systems in February 2009. The WWF Kiunga team later installed the Kiunga Health Center solar panels provided by AEE Solar. The WWF KMNR team is now in charge of maintenance, implementation, and regulation of the combined wind-solar energy supply systems. The joint wind-solar energy sources now provide electricity for two WWF offices, the Mongo Sharif turtle outpost, the Mkokoni Clinic, and the Kiunga Health Center. Refrigerators and freezers were also placed in the local health centers to store vaccines vital to local residents' health and in the WWF office to help reduce fish losses for local fishermen. The KMNR staff and local villagers were trained in maintenance, repairs, and operations of the new energy systems.

Location: Five sites in the Kiunga Marine National Reserve in Kenya: the WWF Kenya Wildlife Service (KWS) office in Mkokoni, the WWF Beach Management Unit (BMU) office in Kiunga Village, the turtle outpost of Mongo Sharif on Rubu Island, the Mkokoni village dispensary, and the health center in Kiunga village.

Goals: Provide renewable power to WWF offices and health centers **Technology:** Wind-solar power supply sources. Wind electric systems include the Skystream 3.7 (2.4 kilowatt) and the Air Breeze (200 watts). Solar panels include the EX-80 supported with aluminum racks. Batteries used are Trojan T-105s. And Xantrex and Outback inverters and Phocos regulators.

Partners: WWF-KMNR team, WWF-US, WWF-Eastern Africa Regional Program Office, David Calley of Southwest Windpower, Jens Calley, Rob Fingerson, local communities and health centers.

Time Frame: The project conception and discussions between WWF-US, the KMNR team, and David Calley began in 2007. Due to various delays and logistical challenges, it took another year to create the system design, acquire the necessary equipment in the United States, and ship it to Kenya. All five installations were completed by June 2009.

Carbon Market: None.

Potential for Replication: Regions where there is a lack of electrical power supplies.

Project Funding: WWF-US and a private donor, David Calley of SouthWest Windpower, who donated his time, products, and expertise. Because of his contacts in the industry, Calley also got equipment donated to the project (some of the Trojan batteries, regulators and inverters.) **Cost of the project:** US$70,000.

1. Context

Location
The project is located at five sites within the KMNR. The KMNR is situated on the northeastern coast of Kenya near the Somalia border. The WWF-KWS office near Mkokoni village, the WWF-BMU office in Kiunga Village, the turtle outpost of Mongo Sharif on Rubu Island, the Mkokoni village dispensary, and the health center in Kiunga village have all been outfitted with renewable energy supply sources.

Significant Landscapes, Habitats, and Species
The KMNR is home to a very diverse and precious ecosystem. Endangered Eastern African mangroves growing along the eastern coast of Kenya provide nutrients and shelter for fish nurseries, sea turtles, and migratory birds, as well as many other animals. The semi-arid climatic conditions in the KMNR, coupled with southeast and northeast monsoons during the year, provide submarine groundwater discharges. These discharges make ideal conditions for mangroves and supply freshwater to plants. Coral reefs and sea grass beds are located just off the coast of Kenya and provide wave relief to the mangroves and the coast. Wildlife in the KMNR include the dugong, five species of marine turtle, roseate terns, and the curlew sandpiper.

Human Presence
Kiunga Village is home to more than 300 families and 3,500 people, while the Mkokoni village is smaller and home to around 1,500 villagers. Located away from major cities, the villages of Kiunga and Mkokoni are principally dependent on fishing for their livelihood, as well as subsistence agriculture. Residents in the villages are of Bajuni and Boni ethnicity.

Economic Status
After experiencing rapid economic growth during the 1960s and 70s, Kenya saw a decline in GDP and economic expansion during the next two decades. Government interference, poor land policies, and faulty trade programs led to a decrease in overall wealth, foreign and domestic investments, and national GDP. In 2002, economic opportunities increased and growth in the country returned until political fighting and violence erupted in 2008 around the national election, halting the agricultural, industrial, and tourism sectors for a while. Today, almost 75 percent of the Kenyan workforce is involved in agriculture, with most based on subsistence. Many Kenyans still remain in poverty, earning on average $680 a year.

The tourism industry in the KMNR has some potential, though this is decreasing due to the proximity to Somalia and the recent political instability following the last elections. Throughout Kenya, tourism accounts for almost $1 billion in yearly GDP. The KMNR offers spectacular views, beaches, wildlife, and unique channels with eight species of mangroves present. Two lodges are currently functioning within the reserve: Kiwayu Safari Village and Mike’s Camp.

2. Problem

The major problem affecting the Kiunga and the Mkokoni areas within the Kiunga Marine National Reserve was the lack of reliable electrical power for offices and health care centers located in the region. WWF offices in both villages as well as local dispensaries, a health center, and a local turtle outpost were without power or on intermittent power for more than two years. The lack of electricity hinders the staff’s ability to complete necessary work assignments and to help serve the local community and population. Without power, the Kiunga health center and dispensary relied on gas-powered refrigerators to store vaccines; there was no power and lighting for emergency operations, medical equipment, offices, or staff rooms.

With no public infrastructure for electricity supply in the area, the KMNR project has had to rely on expensive diesel-generated power. The generator could only run for four hours every day to keep costs down. Diesel fuel consumption at the WWF-KWS Camp alone was 20 liters per day, or 7,200 liters per year. This translated to 72 tonnes of CO_2 emission and a US$12,000 annual fuel and maintenance bill. The cost nearly doubles when other costs are considered (personnel, damaged office equipment due to fluctuation of generator power, data loss, and recovery costs during an abrupt power outages).

The price of diesel fuel is ever increasing, and on average, the cost of fuel is 50 percent higher in the Kiunga area compared to the national average. The high cost of fuel coupled with the logistical challenges of transport and the low income of residents in the area, increases the hardships of obtaining fuel, repairing diesel generators, and maintaining the system against breaks.

Power has been a major challenge to WWF's population-health-environment project in KMNR. This project, in partnership with the Ministry of Health and health NGOs, has been bringing maternal and child health care and other basic health services to the people of the reserve since 2003. The project, along with other community work such as support for secondary school education and a women's handicraft project, has greatly changed community attitudes to the reserve. Whereas 10 years ago the community was hostile to the reserve, now people are collaborating by reporting turtle nests, exchanging harmful fishing gear for more sustainable nets, and setting aside no-take zones to conserve the fisheries. The addition of renewable energy for the health facilities has strengthened the health services that the Ministry of Health can provide, and this will continue to contribute to strengthening relationships between the reserve and the local community.

3. Solution

Provide reliable sources of electrical power to five sites within the Kiunga Marine National Reserve

Providing Combined Wind-Solar Systems

In February 2009, WWF US teamed up with WWF EARPO, the WWF staff in KMNR, and David Calley of Southwest Windpower to deliver, install, and implement combined wind-solar supply systems to the Kiunga region. The wind-solar systems provide a total of 19.5 kilowatts of electricity generation capacity for WWF offices and local health care centers in the area. The project initially began by choosing which sites within the KMNR to outfit with a reliable electricity source. The five sites chosen were the WWF-KWS office in Mkokoni, the WWF-BMU office in Kiunga Village, the

Green power in Kiunga, Kenya © Sam WERU / WWF-EARPO turtle outpost of Mongo Sharif on Rubu Island, the Mkokoni village dispensary, and the health center in Kiunga village. The Kiunga Base and the WWF-KWS office at Mkokoni were outfitted with the Skystream 3.7 wind turbine and solar panels. The other sites were equipped with a smaller wind turbine known as the Airbreeze and solar panels.

The WWF-KWS Camp has an 8 kilowatt capacity. In Kiunga Village, the fisheries, Beach Management Unit and a WWF outpost now have 7 kilowatts of power, while the Mongo Sharif Turtle Monitoring Camp on Rubu Island has 1.5 kilowatts. With 1 kilowatt of green power, the Kiunga Health Center can now afford to provide better health care to the local residents as it can now store vaccines. The same can be said of Mkokoni Dispensary, which boasts a 2 kilowatt capacity.

WWF-US coordinated the purchase and delivery of the Skystream 3.7 and Airbreeze wind turbines, the EX-80 solar panels, and the various inverters and regulators for the wind-solar systems. The WWF KMNR staff installed the solar panels, batteries, wind turbines, and regulators with assistance and guidance from David Calley, a founder of Southwest Windpower, his brother Jens Calley, and their colleague, Rob Fingerson, a geotechnical engineer. During and after installation of the systems, David Calley trained, advised, and assisted the KMNR staff on maintenance, repairs, and operations of the combined wind-solar systems.

Refrigerators and Freezers Installed

The project provided new refrigerators and freezers: The Kiunga health center added two new refrigeration units to cool and store vaccines for the local community. The Mkokoni dispensary has a new refrigerator, and the WWF-KWS office has one freezer and two refrigerators. The addition of refrigerators to the health clinics prompted the Ministry of Health in Mkokoni to install an 80 watt freezer. These units halt the need for local villagers to travel to surrounding health care centers for vital vaccines. The WWF-BMU office in Kiunga also installed a large chest freezer to prevent fish losses from spoilage for local fishermen. The chest can hold large quantities of fish for several days while fishermen sell or prepare to transport their daily catch. Providing power to fishing communities to reduce post-harvest loss directly means more income for the fishermen and goes hand in hand with WWF's work with them, empowering them and promoting their livelihoods.


Skystream and the installation team in WWF-KWS Camp © Caroline Simmonds/WWF US

4. Outcomes and Hurdles

Since the projects inception, the five proposed sites have been outfitted with wind-solar energy supply systems, although the Kiunga health center had only solar installed in June of this year, as the challenges to wind installation include high surrounding trees. The energy capacity of the systems combined is over 19.5 kilowatts. This is more than enough to meet all the power needs of the five sites estimated during the initial assessment of the project. For all power supply systems, connections, and wiring have to be inspected every month. All systems upgrades are assessed to have a lifespan of 5 to 10 years.

“By greening Kiunga, WWF will showcase sound and practical environmental management as well as affording the community an opportunity to experience modern life. WWF is about humans living in harmony with nature, and cares about the direct welfare of the people,” says Sam Weru, WWF's national marine coordinator (Kenya).

After installation, the head KMNR electrician visits all five sites regularly and reports to WWF-US on a quarterly basis about the status of the systems. Maintenance is minimal, but the systems require personnel to follow up every month. The biggest challenge to date has been corrosion on Rubu Island. Inverters are being replaced with marine inverters.

The biggest hurdles and difficulties encountered during the project included the timing. It took much longer than expected from project inception to project installation. Securing the numerous and various pieces of equipment in the United States, then coordinating the shipment to Kenya, then from Mombasa to Mkokoni, was very challenging and time-consuming for WWF-US, ttaking nearly a year. (All equipment was imported because it was decided that the best equipment was not available locally.) In addition, installation took longer than expected, and the costs were higher than expected. When winds are low, WWF and the KWS staff are learning how to be more energy-efficient. Now everyone is learning how to turn off lights, and attitudes are changing toward saving electricity.

This project was only possible with the voluntary support and work of David Calley, Jens Calley, and Rob Fingerson. In the future, project leaders have decided they would use a contractor to install the systems, as the KMNR team was not able to do any other work during the three weeks of installation. The project would also take into account the availability to source materials, expertise, and equipment as locally as possible to avoid the coordination challenges faced during the venture.

Contacts

Caroline Simmonds (Project Leader)
Caroline.simmonds@wwfus.org

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G. Vientiane, Laos – Building a Solar PV System on a WWF Office

WWF-Laos, in conjunction with WWF-Austria, has teamed up with the company Fronius, an expert in producing and installing photovoltaic systems worldwide, to build a grid-connected photovoltaic system on top of the WWF office in Vientiane, Laos. With a staff of around 50, the WWF office has many IT and computer electrical power needs that can be addressed by the addition of the solar power system. As part of the agreement between related parties, the electricity generated by the solar PV system must be used directly in the workplace for related office needs. The system, which is a high-performance thin-layer system rated at 7.3 kilowatts peak (kWp), is being placed on the south, east, and west roofs of the building. Any surplus electricity generated will feed into Laos's main public electricity supply, marking the first time in the country's history that solar energy will be used to help supply the main electricity grid.

Solar panels on WWF Office in Vientiane, Laos © Fronius

Location: WWF office in Vientiane, Laos.
Goals: Equipping the WWF office in Vientiane with a photovoltaic system to provide for the office's electrical needs and to supply electricity to the grid.
Technology: The photovoltaic system to be installed is a grid-connected installation, specifically rated at 7.3 kWp with 90 amorphous thin-layer modules. Each module's output equals 81 watts of energy. A power inverter per part system will supply the WWF center with electricity generated from modules placed on the south, east, and west roofs of the building.
Partners: Fronius International GmbH, WWF Laos.
Time Frame: Since 2005, Fronius has provided services and expertise to many WWF-International projects. Early in 2008, negotiations between WWF-Laos, WWF-Austria, and Fronius commenced on bringing solar power to the WWF office in Laos. On October 10, 2008, a formal agreement was reached whereby electrical power was to be provided by a high-performance thin-layer photovoltaic system designed by Fronius. Building has started on the office.
Carbon Market: No.
Potential for Replication: Other WWF operations that require electricity, especially those in equatorial regions with hotter climates.
Project Funding: Fronius International within the WWF CLIMATE GROUP partnership (climate-friendly company platform in partnership with WWF-Austria).
Cost of Project: No complete cost sheet is available at this time.

1. Context

Location

The solar energy project is located at the WWF office in Vientiane, Laos. Vientiane, the capital of Laos, is situated on the Mekong River along the western border of the country. The WWF building houses around 50 employees.

Significant Landscapes, Habitats, and Species

The most significant feature running throughout Laos is the Mekong River. This long, winding tributary runs from north to the south along the country's western border through the capital city. Rugged and steep mountains are found in the northern region, while alluvial plains can be located in almost all areas of the country. The low-lying southern region, in conjunction with monsoon-type weather patterns, is suitable for rice paddy farming, although only 4 percent of land is arable. Natural resources in the country include timber, rattan, tin, and gold. The landscape is home to the majestic Asian elephant, the tapir, the elongated tortoise, and the black crested gibbon, all of which have seen natural ecosystem decline from deforestation.

Human Presence

The Vientiane prefecture, which includes the city, urban outskirts, and surrounding areas, has a population of 711,919. Most inhabitants of this prefecture are ethnic Lao, descendents of the Tai people from China. The average population density of Laos in 2006 was 27 persons per square kilometer. Although the country includes more than 6.8 million people, most inhabitants are situated along the valleys of the Mekong and its tributaries, causing the population to be very unevenly spread out across the countryside.

Economic Status

Laos has been hampered in recent years by the inefficiency of its agricultural sector, which constitutes approximately 39.2 percent of its annual GDP and employs almost 80 percent of the population. Due to this inefficiency, the annual per capita income for a citizen in Laos is $765. Most Laos' residents are unskilled laborers participating in subsistence farming. Glutinous rice, coffee, corn, and sugarcane are the main crops grown in Laos and exported, with rice amounting to a very large percentage of total crops harvested.

Industry and services make up 34.3 percent and 26.6 percent of the national GDP respectively. These sectors have continued to produce lower GDP numbers than agriculture due to the restrictions imposed on private-sector businesses during the early 1970s by the Laos government. The nature of these government policies stunted private industry growth. In fact, in 2008, 84 percent of the government's budget was produced from donor-funded receipts and projects. Even after development of the "new economic mechanism" by the LRPR in 1986, the private sector has never fully recovered.

2. Problem

Although there was no significant problem plaguing the WWF office in Vientiane, WWF-Laos and WWF-Austria undertook this project to actively support the Greater Mekong Project. The venture was a great opportunity to transfer beneficial field expertise and knowledge of renewable energy technologies where such technology is not very common. The electricity would also be used for the office's computer, IT, and other electrical services currently running off electricity generated from the country's main energy grid.

3. Solution

WWF's main goal is to set up a solar renewable energy source to contribute electricity and power to the WWF office in Vientiane, Laos.

Solar Energy Production

Fronius, a privately owned company with headquarters in Sattledt, Austria, is working to build a grid-connected photovoltaic solar power system on the roof of the WWF programoffice in Vientiane, Laos. Fronius and WWF-Austria, partners within the WWF Climate Group, decided to engage in Laos because WWF-Austria has a strong connection to the Greater Mekong Program and because there was and still is a great need for electricity support within this region. WWF-Austria, Fronius, and WWF-Laos have been working together since 2007 to obtain permits to install this high performance thin-layer system, and building has initially begun. The PV system will be rated at 7.3 kWp and generate 81 watts of energy per thin-layer module. More than 90 modules are to be installed on the east, west, and south roofs of the WWF office. The project's partners chose to pursue solar power for the building because this is the cleanest and most ecologically friendly energy source they can use. According to the agreement between related parties, nearly all the energy produced from the solar power system will be used in the workplace. This power system will produce a reliable and efficient source of energy for the WWF office while any electricity surplus generated will feed into the country's main electricity grid, marking the first time in the history of the country that solar power has been fed into the mains supply.

Solar modules on roof © Fronius

Showcase for Solar Renewable Energy

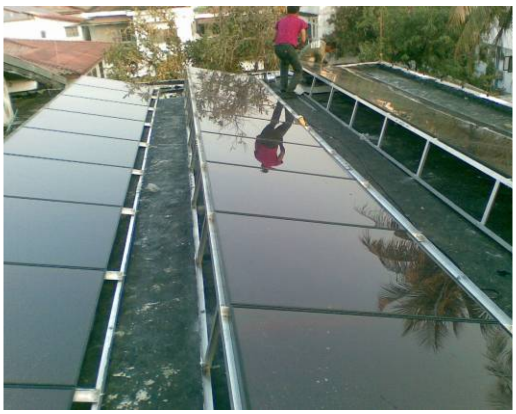
Solar systems, such as the one being completed on the WWF Program office in Vientiane, can also help increase electricity supply to those not connected to the country's main electricity grid. In Laos, hydroelectric power provides a substantial percentage of the country's electricity. Other renewable energy sources, such as geothermal, wind, and solar, provide little to no energy. The introduction of the solar photovoltaic system at the WWF office will provide a much-needed showcase to illustrate the benefits of decentralized solar energy systems for businesses and communities in rural areas. It is also intended to demonstrate to the decision makers in Laos just what can be achieved with solar power.

Knowledge Transfer

With the support of Roland Eve, a local partner, and Thai-German Solar, Fronius' service partner who oversaw the planning on the ground, WWF Laos and Fronius hope to transfer the knowledge, use, and maintenance of solar photovoltaic systems to the residents of Laos. Fronius' project leader has the expertise in the area of battery charging systems, welding technology, and solar electronics that makes the transfer of this knowledge easy and efficient. Upon successful completion of the system, a blueprint for other solar projects will be handed directly to local businesses, the government, and the citizens of Laos. If similar projects are to be undertaken in the future, residents will already be familiar with the implementation and installation of a photovoltaic solar system, thus increasing the efficiency and effectiveness of future projects. This venture is a great example of knowledge and renewable energy expertise transfer and cooperation on an international level.

4. Outcomes and Hurdles

During the project implementation, challenges began to arise. Laotian law did not allow solar power to be fed into the public electricity grid. For the PV system, Fronius received a special permit for getting a connection to the public electricity grid in order to feed in solar power when producing a solar electricity surplus. Fronius also had to convince the electricity stakeholders of the safety of such a PV system. The key for every network-linked PV station is, of course, unlimited access to the electricity net. In this case, a lot of negotiations are needed with every network operator. This problem is not unique to Laos.



Solar panels installed © Fronius

Contacts
Kathrin Hebel
Kathrin.hebel@wwf.at
Tel: +43 1 48817 256

Sources
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Press Release: WWF and Fronius in Laos
Kathrin Hebel Email

H. Terai Arc Landscape, Nepal – Biogas Technology

In 2003, WWF-Nepal and the Khata Community Forestry Coordination Committee, an entity comprising 32 forest user groups in the Khata area, began incorporating health services into conservation work in the southern region of the Terai Arc Landscape (TAL), Nepal. The Khata corridor is a critical area connecting Bardia National Park in Nepal and Katarniaghat Wildlife Sanctuary across the border in India, and a suite of activities was planned to restore degraded forest land in the corridor by relieving the main threats to the forest and promoting community forest management. Subsequently, WWF-Nepal expanded this program and began introducing the use of biogas technology more widely in the region to produce an efficient, environmentally friendly, locally constructible, and healthy energy source for local communities. Biogas would be used to combat biodiversity loss in the landscape due to increased agricultural grazing and deforestation for firewood. WWF-Nepal signed an agreement with the Alternative Energy Promotion Centre and Biogas Sector Partnership–Nepal to develop its own WWF-Nepal Gold Standard Biogas VER project in Nepal in 2006. Initially starting in January 2007, the program's goal was to build 7,500 biogas plants in buffer zones throughout the TAL. With preliminary funding from WWF-Germany, WWF-US, WWF-Finland, Johnson & Johnson, and the USAID Nepal Mission, and seeking matching funds from carbon financing, WWF-Nepal introduced micro-financing loans so that villagers could afford to install biogas plants.

Biogas cooking stoves © WWF/Ugan Manandhar

Location: Terai Arc Landscape, Nepal.
Goals: Reduce deforestation in buffer zones and corridors of the Terai Arc region from fuelwood use and cattle grazing by introducing biogas technology to rural communities. Address health and sanitation issues.
Technology: Biogas technology. The biogas plant consists of an airtight underground pit known as the digester that is normally around six cubic meters. Water is mixed with cattle dung and human excreta to produce methane. A small pipe leads methane from the pit to a gas stove in the kitchen.
Partners: Alternative Energy Promotion Centre, Biogas Sector Partnership–Nepal, Community Forest User Groups, Community Forest Coordination Committee, National Government, local governments, local communities.
Time Frame: WWF-Nepal signed a pact with the Alternative Energy Promotion Centre and Biogas Sector Partnership–Nepal in 2006. The project began in January 2007 and is scheduled to be completed by December 2010.
Carbon Market: The project has been validated by TUV Nord and is under verification by the same designated operational entity.
Potential for Replication: Elsewhere in Nepal and in other regions where biogas can be produced easily (presence of livestock, climatic conditions).
Project Funding: WWF-Germany, WWF-US, WWF-Finland, Johnson & Johnson, USAID
Cost of the project: US$3,226,190.

1. Context

Location

The project is located in buffer zones and corridors in the Terai landscape of Nepal. The Nepal Terai is a 26 to 32 kilometer-wide belt of land that runs along the southern part of Nepal between the Yamuna River and the Brahmaputra River.

Significant Landscapes, Habitats, and Species

In terms of biodiversity, the Terai in Nepal is the most richly diverse region of the country. It encompasses grassland, marshes, and fertile river plains with tropical climates permeating in the southern lowland jungles. Although it constitutes only 0.1 percent of the world's landmass, Nepal is home to 4 percent of the world's mammal species, 8 percent of the birds, and 2 percent of the world's flower species. The fertile river plain of Terai shelters the Bengal tiger, the Asian elephant, the one-horned rhinoceros, and many other wild mammals. Seventy-five percent of the remaining lowland forests of Nepal occur in the Terai. Due to its ecological importance, the Terai has several national parks and wildlife reserves, including Suklaphant National Park, Bardia National Park, the Parsa Wildlife Reserve, and Chitwan National Park, the first and oldest national park in Nepal.

Human Presence

Over the last century, Nepal has experienced a five-fold increase in national population with more than 29 million currently residing in the country. This increase has not been proportionately spread throughout the region, though, as 48 percent of Nepalese reside in 17 percent of the country's landmass known as the fertile Terai. Many of them moved there after the 1940s following the eradication of malaria. Nepali is the country's official language, but there are 30 other major dialects spoken throughout the region.

Economic Status

Since beginning its transformation into a modern state in the early 1950s, Nepal has achieved considerable economic expansion with the building of schools, electric services, and telecommunications. Agriculture dominates the economic landscape in Nepal, particularly the harvesting of rice, wheat, and corn. The agricultural sector employs nearly 71 percent of Nepalese and provides almost 32 percent of the nation's GDP. Considered one of the poorest countries in the world, the per capita income for a Nepal resident for the fiscal years 2007-2008 years was less than $500 annually—considerably below the established poverty line. The microregion of Terai contains double the amount of people living in poverty, compared to those residing in Nepal's the urban areas.

Industries on the rise in the country are tourism and hydroelectric power. Lagging far behind agricultural activity, the tourism industry in Nepal has grown considerably in the last several years due to the fact that Nepal contains eight of the world's ten tallest mountains peaks. In 2007, tourism jumped by 32.1 percent from the previous year following the end of the Maoist insurgency. The hydroelectric industry in Nepal has considerably high promise and upside due to the swift rivers running through the northern region. To date, only 1 percent of the hydroelectric potential in Nepal is being used.

2. Problem

Unsustainable fuelwood extraction from the TAL for household cooking and other energy needs threatens the region's fragile ecosystem and biodiversity. Nearly 61 percent of the residents in the Terai region consume fuelwood for cooking needs, using inefficient and outdated woodstoves. The wood burned is primarily cut from government- and community-managed forests. Home to the Bengal tiger, the Asian elephant, and numerous other endangered species, this landscape contains animals that cannot live without large blocks of forest cover. The degraded forest cover from fuelwood removal and overgrazing leads to increased human-animal contact with serious injuries and deaths occurring from such incidents. In the 15-year period from 1990 to 2005, nearly 1.2 million hectares of Nepalese forests were cut.

The use of wood-burning stoves also causes serious health problems for many Nepalese women and young children. Most old woodstoves emit large amounts of pollutants into the air when wood and charcoal are burned. Because most rural village homes to do not have proper ventilation, such as a chimney, those in the kitchen are subject to these harmful pollutants. Acute respiratory infections are common for women and young children, and women also bear the burden of collecting heavy loads of firewood from the forest.

3. Solution

WWF's main goals are to decrease deforestation of the TAL due to fuelwood extraction by introducing biogas plants to rural villages in buffer zones while simultaneously addressing health and sanitation issues.

Introduction of Biogas Plants to Reduce Deforestation

In order to implement a substantial number of biogas plants in rural communities across the Terai, WWF-Nepal began an ambitious microfinancing program in 2007 to increase the affordability of biogas plants to those most in need. The program uses community forest user groups (CFUGs) to recommend credit and assess the feasibility of biogas and repayment credit plans.

Biogas digester © WWF-Nepal

According to this plan, WWF releases a subsidy amount to its partner, the Alternative Energy Promotion Center (government of Nepal), which is then given to the CFUGs. The TAL program provides another subsidy amount for the toilet that is attached to the biogas plant. The CFUGs subsequently works with the microfinance institutions to release loans to the beneficiaries, while the beneficiary provides services such as digging, hauling rocks, and providing natural materials. For many villagers living below the poverty line, these loans are the only means of affording a biogas plant. A typical biogas plant is built underground, is nearly six cubic meters, and is sealed airtight to allow methane to produce from dung and excreta in anaerobic conditions. The methane produced is fed via a pipe directly to a cooking stove. The methane provides a clean method of cooking from renewable energy without the need for firewood. After installation, WWF instructs the residents on the use of the biogas plant so that maintenance can be handed over to the recipients.

Addressing Health, Sanitation Issues, and Gender Equity

Biogas plants also cut down on other problems, such as acute respiratory infections, extended cooking time, and collection of firewood or charcoal. Bathrooms are installed alongside the biogas plant so that human excreta can be used to produce methane for household cooking. This sanitary device helps decrease instances of harmful infections and diseases. The methane produced from the biogas plants is odorless and contains no harmful emissions.

Decreasing Greenhouse Gas Emissions

A single biogas plant can reduce carbon dioxide emissions by up to 4.02 tons per year and save more than 4.5 metric tons of fuelwood, as indicated by WWF in the carbon project development plan. 7,500 biogas plants would save a significant amount of greenhouse gas emissions. In order to ease the project's financing, WWF is planning to measure emission reductions and obtain financial resources through the carbon market. It is estimated that 148,000 tons of carbon dioxide could be saved over the project's lifetime. The project will be Gold Standard[43] certified.

Decreasing Overgrazing of Livestock

Deforestation in the Terai has not only been caused from overpopulation and firewood extraction, but also from overgrazing by cattle. Until recently there were an estimated 9.3 million head of cattle in the Terai. Biogas plants require cattle dung, which means that cattle have to be kept at the homestead rather than running loose in the forest. This has provided a strong incentive for households to keep their cattle out of the forest and keep a smaller number of improved breed animals near the homestead, where they are stall-fed. The stall-fed cows also produce milk, providing nutrition for households as well as being an extra source of income for villagers through the sale of excess milk.

Increasing Ecotourism

As deforestation in the Terai begins to decrease and forest cover regenerates, the ecotourism industry represents an alternative source of income for people living in the region. The time saved from not having to scrub soot from dishware, collect firewood, or burn charcoal allows local people to sell field products, guard wildlife, or lead tourists into the surrounding forests. This additional income from an environmental source raises the standard of living for residents while decreasing deforestation in the Terai.

Biogas chamber © Ugan Manandhar / WWF

4. Outcomes and Hurdles

From January 2007 to August 2009, more than 3,628 biogas plants were constructed and are operational in buffer zones and corridors across the Terai. To finance the installations, microfinancing institutions now work in 13 different sites across the TAL. The village of Badreni in Chitwan has earned the title of

First Biogas Village in the TAL, as 80 of the 82 houses in the village now have biogas plants.

Due to the nature of the project, hundreds of jobs for local Nepalese residents have been created for planning, construction, and maintenance of the biogas plants. The hope is for the project to eliminate as much as 148,000 tons of carbon dioxide being emitted into the atmosphere.

Contacts

Ugan Manandhar (Project Leader)
Ugan.manandhar@wwfnepal.org
Tel: +977 1 443 4820

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I. Chaurikharka, Nepal – The 70 Kilowatt Ghatte Micro-hydro Project

In 1996, the Department of National Parks and Wildlife Conservation (DNPWC) of Nepal and WWF-Nepal conducted hydroelectrification surveys along the buffer zones of Sagarmatha National Park as part of the Sagarmatha Community Agro-Forestry Project (SCAFP) in northern Nepal. The region was and still is experiencing the loss of greenery, natural resources, and forests due to fuelwood consumption for energy and from increasing amounts of waste due to the high tourism volume in the area. WWF-Nepal and the DNPWC chose to start with the 70 kilowatt Ghatte Micro-hydro Project in March 2006 as an energy substitute to fuelwood. The hydropower project hoped to ease pressure on Sagarmatha National Park as well as other forests located in buffer zones around the region. The project uses water diverted from the nearby Ghatte stream. The diverted water runs into a turbine coupled with a generator to produce electricity, whereupon it then flows back into the stream leaving minimal environmental impact.

Internet café in village © WWF-Nepal / Ugan Manandhar

Location: Chaurikharka Village Development Committee-5, located along the southern border of Sagarmatha National Park in northern Nepal.
Goals: Reduce pressure on forests and natural resources and improve the livelihood options for people living in one of the buffer zones of Sagarmatha National Park by introducing micro-hydropower.
Technology: A micro-hydropower system along streams with good water discharge and heads. Water is diverted from the river to power a turbine coupled with a generator in a powerhouse to produce electricity.
Partners: Kadoorie Agricultural Aid Association (KAAA–BGN), WWF-Nepal, WWF-UK, WWF-US, and Sagarmatha National Park and Buffer Zone Management Committee –BGN.
Time Frame: The Micro-hydro project was first implemented in March 2006 and was completed in June 2007.
Carbon Market: No carbon credits involved.
Potential for Replication: Other projects in regions where there are pressures on forests from fuelwood consumption and available streams with good water discharge and heads.
Project Funding: Kadoorie Agricultural Aid Association (KAAA-BGN), WWF-US, WWF-UK
Cost of the project: US$190,000.

1. Context

Location

The project is located along the Ghatte River in the Chaurikharka Village Development Committee (VDC) – 5. Chaurikharka is situated in northern Nepal along the southern border of Sagarmatha National Park. Villages included in the Chaurikharka VDC – 5 affected by the project are Tok-Tok, Nemboteng, Jhamphutte, Rangding, Sano Gumila, and Phakding.

Significant Landscapes, Habitats, and Species

The Chaurikharka VDC has long been a buffer zone for animals moving across northern Nepal into the wet southern region of the country. The area has many mountains, deep valleys formed by years of water erosion, and glaciers along significant fault lines. Located adjacent to Sagarmatha National Park, Chaurikharka has a climatic zone similar to Sagarmatha’s lower forested climatic zone. Birch, juniper, bamboo, and firs grow in this region. Sagarmatha National Park is part of the Himalayan mountain range as well as part of Mount Everest. The snow leopard, the lesser panda, and the wild yak are only a few of the numerous rare species found in this VDC.

Human Presence

The Chaurikharka area is home to more than 3,500 Nepalese. Part of the Solukhumba District, Chaurikharka is located at 10,000 feet above sea level. Due to its location, Chaurikharka is home for many native Sherpas and other indigenous ethnic groups living in the area. Predominately Buddhist, the village has a mix of Tibetan and Chinese culture.

Economic Status

Since beginning its transformation into a modern state in the early 1950s, Nepal has achieved considerable economic expansion with the building of schools, electric services, and telecommunications. Agriculture dominates the economic landscape in Nepal, particularly the harvesting of rice, wheat, and corn. The agricultural sector employs nearly 71 percent of Nepalese and provides almost 32 percent of the nation’s GDP. Considered one of the poorest countries in the world, the per capita income for a Nepal resident for the fiscal years 2007-2008 years was less than $500 annually— considerably below the established poverty line.

In the Chaurikharka village, most residents rely on tourism as their main source of income. The close proximity of the village to Sagarmatha National Park and the Himalayan mountain range provides opportunities for residents to benefit from a recent increase in the tourism sector. Tourism throughout all of Nepal for the year 2007 jumped by 32.1 percent from the previous year, following the end of the Maoist insurgency.

2. Problem

Due to its geographic location next to Sagarmatha National Park and the Himalayan Mountain Range, the Chaurikharka VDC received an influx of high-value tourism activities during the early 1980s. With an increasing need to satisfy tourists and benefit from the influx of foreign dollars, many Nepalese residents began setting up businesses and other commercial services such as restaurants and lodges. As there was a lack of electrical service in the region, most residents used fuelwood and natural resources to provide energy for their businesses and eateries. Nearly 465 households in the Chaurikharka area were consuming 6,437 tons of fuelwood per year, along with many more tons of kerosene, to supplement their energy needs. The lack of natural resources regulation in the area prevented any relief from deforestation, resulting in the loss of habitat for wildlife, erosion, more rapid runoff, and the loss of natural resources for local people.

The use of fuelwood and kerosene not only caused the thinning of greenery in the area, but it emitted harmful pollutants inside the houses. Because most rural village homes and businesses do not have proper ventilation, such as a chimney, those in the kitchen—particularly women and children—were subject to harmful fumes and particulates. This came on top of the burden of collecting heavy loads of firewood from the forest.

3. Solution

WWF's main goal was to provide hydropower-based electrification in the Chaurikharka VDC of the Sagarmatha region to curb deforestation and prevent the further loss of natural resources.

Ghatte Micro-hydro Project

To combat deforestation occurring in the Chaurikharka area, WWF-Nepal and the DNPWC of Nepal started the SCAFP in 1996. The goal of the project was to find alternative means for fuelwood energy in the region to help minimize the loss of natural resources in the buffer zone while strengthening the communities in the region to achieve sustainable natural resource management. Most restaurants can switch from wood cookers to electricity-based hot plates, microwaves, or rice cookers to fulfill their cooking and heating needs. The two organizations soon began micro-hydroelectrification surveys throughout the region. Hydroelectric power was chosen due to the cold climatic conditions of the area. In such a cold region, other alternative energy sources, such as biomass, biogas, or solar were not feasible or economical. Although many sites were surveyed, the 70 kilowatt Ghatte Micro-hydro Project was chosen as the first hydro project in the area and implemented in March 2006.

Micro-hydrohydro project © Ugan Manandhar/WWF

The Ghatte Micro-hydro Project diverts water from the Ghatte stream into a turbine attached to a generator in a powerhouse. The Ghatte stream can produce enough electricity for residents as it has a good water discharge and a powerful head. From the generator, the water flows back into the Ghatte stream. In order to assess and monitor energy use and consumption, a Ghatte micro-hydro management committee has been locally formed to manage the handover of the project to villages in the Chaurikharka area. This micro-hydro management committee collects fees from the beneficiaries of the hydroelectric program to ensure sustainability and further success of the project. Four operators have been trained on operations and management of the generator so that the recipients can be responsible for the project in the future.

Health Issues and Emissions Addressed
As more households in the village have switched to hydroelectric power, harmful emissions from the burning of fuelwood and kerosene have decreased significantly. Most restaurants can switch from wood cookers to hot plates, microwaves, or rice cookers to fulfill their cooking and heating needs. The burden on residents to collect firewood has also decreased, enabling them to spend more of their time on income-producing activities.

Ecotourism Benefits
As tourism provides a substantial percentage of the Chaurikharka residents' local income, the regrowth of greenery and natural resources in the area is critical. Also, the time saved from not having to scrub soot from dishware, collect firewood, or burn charcoal allows those in the kitchen more time to sell field products or lead tourists into the surrounding forests. Finally, the cleaning up of waste produced by tourist activities in the early 1980s has helped increase the tourism industry throughout the region once again.


Villager in home © WWF-Nepal / Ugan Manandhar

4. Outcome and Hurdles

Since the inception of the program in March 2006 until its completion in June 2007, more than 108 households in Tok-Tok, Nemboteng, Jhamphutte, Rangding, Sano Gumila, and Phakding have benefited from using hydropower for electrical needs. Fuelwood consumption in the area has decreased significantly, as well as the amount of residents' incomes spent on energy needs. Greenery and natural resources in the area have started to regrow, increasing the chances of survival for many endemic animals in the region.

Local communities have also taken responsibility for the project. Under the management of the Ghatte Khola Micro-hydro Management Committee, beneficiaries of the project pay for their electrical bills to ensure sustainability of the project. Local operators have been trained on the use and maintenance of the system.

Due to the success of the Ghatte project, several other micro hydro sites have been surveyed, commissioned, and are functional. These are the 35 kilowatt Ghuna micro-hydro project in Ghunsa, Kanchenjunga, the 35 kilowatt Chaalgadh micro-hydro project in Tripurakot, Dolpa, the 50 kilowatt Mahadev Line Extension project in Mahavev, Dolpa, and (VDC) of the Sagarmatha region. All have contributed to the reduced forest pressure for fuelwood in their respective areas. More than 480 households in these communities now use hydropower for their energy needs.

Contact
Ugan Manandhar
ugan.manandhar@wwfnepal.org
Tel: +977 1 443 4820

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J. Terai Arc Landscape, Nepal – Solar Cookers

Solar cooker in Nepal © WWF / Ugan Manandhar

In January 2008, WWF-Nepal began a solar cooking pilot project with the residents of the TAL, the Kanchenjunga Conservation Area, and the Langtang National Park in southern and northern Nepal. More than 60 percent of residents in these areas use fuelwood for household energy needs. The rapid deforestation for fuelwood and increased livestock grazing represent a large loss in ecosystem biodiversity for the region.

The aim of the project was to reduce fuelwood consumption from surrounding forests. With funding from the Alcoa Foundation, more than 40 households in the Terai and 500 households in the Kanchenjunga Conservation Area and the Langtang National Park have received solar cookers known as "hotpots." The project took little under a year and concluded in December 2008. The recipients of the solar cookers have been trained on the use, maintenance, and repair of the solar cookers.

Location: Terai Arc Landscape in southern Nepal, the Kanchenjunga Conservation Area, and the Langtang National Park in northern Nepal.
Goals: Reduce deforestation from fuelwood by introducing solar cooking technology to rural communities.
Technology: Solar cookers. The hotpots consist of a reflector panel, a large black steel enameled pot, a Pyrex glass bowl, and a glass lid.
Partners: WWF-Nepal, local governments, and local communities.
Time Frame: The project was implemented in January 2008 and ran until December 2008.
Carbon Market: No carbon credits involved.
Potential for Replication: In other regions where solar cookers can be easily introduced as an alternative to fuelwood and kerosene.
Funding: Alcoa Foundation.
Cost of the project: US$150,000.

1. Context

Location

The project is located in the TAL in southern Nepal, the Kanchenjunga Conservation Area (KCA) in northeast Nepal, and the Langtang National Park in northern Nepal. The Kanchenjunga encompasses more than 2,000 square kilometers, while the Langtang National Park covers more than 1,700 square kilometers along the Nepal-China border.

Significant Landscapes, Habitats, and Species

Designated as the first Himalayan National Park in 1970, Langtang National Park has a wide array of climatic and topographic conditions. Forest cover accounts for more than 25 percent of the park's land area and provides protection for the red panda, the musk deer, and the rhesus monkey. Although encompassing many of the same plant and animal species as Langtang, the Kanchenjunga Conservation Area in northeast Nepal consists of rocky outcrops, subtropical forests, and steep mountain ranges. Named after the Kanchenjunga Mountain, the park experiences a temperate climate during the spring when many of Nepal's endemic plants flower. The TAL in southern Nepal is a very diverse region encompassing grasslands, marshes, and fertile river plains with tropical climates permeating in the southern lowland jungles. The fertile river plains of the Terai shelter the Bengal tiger, the Asian elephant, the rhinoceros, and many other wild mammals. Although it makes up only 0.1 percent of the world's landmass, Nepal is home to 4 percent of the world's mammal species, 8 percent of the birds, and 2 percent of the world's flower species.

Human Presence

Langtang National Park is home to more than 45 villages and 3,000 households. The primary ethnic group is the Tamang, an ancient race that practices Tibetan Buddhism and Bon. The Kanchenjunga Conservation Area is more culturally diverse, as the larger land area allows for the Limbu, the Lama, and the Sherpa people to reside in the region. Overall, 48 percent of the Nepalese people reside in the TAL. Nepali is the country's official language, but there are 30 other major dialects spoken throughout the region.

Economic Status

Since beginning its transformation into a modern state in the early 1950s, Nepal has achieved considerable economic expansion with the building of schools, electric services, and telecommunications. Agriculture dominates the economic landscape in Nepal, particularly the harvesting of rice, wheat, and corn. The agricultural sector employs nearly 71 percent of Nepalese and provides almost 32 percent of the nation's GDP. Considered one of the poorest countries in the world, the per capita income for a Nepal resident for the fiscal years 2007-2008 was less than $500 annually—considerably below the established poverty line. The microregion of Terai contains double the amount of residents living in poverty, compared to those residing in the urban areas of Nepal.

Industries on the rise in the country are tourism and hydroelectric power. Lagging far behind agricultural activity, the tourism industry in Nepal has grown considerably in the last several years due to the fact that Nepal contains eight of the world's ten tallest mountains peaks. In 2007, tourism jumped by 32.1 percent from the previous year, following the end of the Maoist insurgency. The hydroelectric industry in Nepal has considerably high promise and upside due to the swift rivers running through the northern region. To date, only 1 percent of the hydroelectric potential in Nepal is being used.

2. Problem

In recent years, household fuelwood use in the project areas has increased. Today, more than 61 percent of the residents in the TAL use fuelwood for energy needs while more than 3,000 households in Langtang National Park use the surrounding forests for wood resources. The Terai, as well as the conservation area and national park, are home to many endemic plant and animal species. These species cannot live without sustained forest cover. The degraded woodland leads to increased human-animal contact, with serious injuries and deaths occurring from such incidents. In the 15-year period from 1990 to 2005, nearly 1.2 million hectares were cut from Nepalese forests.

3. Solution

WWF's main goal was to introduce and pilot solar cookers to villages in southern and northern Nepal to curb deforestation from fuelwood.

Introduction of Solar Cookers

WWF-Nepal, with funding from the Alcoa Foundation, began a pilot project in early January 2008 to introduce solar cookers to villages in the TAL, the Kanchenjunga Conservation Area, and Langtang National Park to combat deforestation. As part of the project, residents were given solar cookers known as hotpots to replace charcoal and wood-burning woodstoves. The hotpot solar cookers consisted of a pot placed in the center of a reflector panel. The pot was essentially a glass Pyrex bowl with a glass lid encompassed by a larger black steel enameled pot. The black pot attracted the sunlight concentrated by the reflector panel, while the glass bowl trapped the heat in a small greenhouse effect and cooked the food. Upon implementation of the project, residents, along with field mobilizers, were trained on the use and maintenance of the hotpots.

Solar cooker hotpot © Ugan Manandhar / WWF

Allowance for Other Daily Activities

Although food usually takes twice as long to cook in a hotpot as with a woodstove, the food does not burn. Due to this fact, residents in these areas can leave cooking food unattended while they complete other household or daily activities. This allows for extra time during the day and reduces household expenditures for firewood.

Ecotourism Increases

As deforestation in the Terai begins to decrease and forest cover regenerates, the ecotourism industry represents an alternative source of income for people living in the region. The time saved from not having to collect firewood, burn charcoal, or watch over cooking food allows those in the kitchen to sell field products or lead tourists into the surrounding forests. This additional income from an environmental source raises the standard of living for residents while decreasing deforestation stress on the Terai, Kanchenjunga Conservation Area, and Langtang National Park.

4. Outcomes and Hurdles

Solar cooker in use © Ugan Manandhar / WWF

Since the program's inception in January 2008, more than 540 households have been given solar cookers. The recipients of the solar cookers have been trained in the use, maintenance, and repair of the solar cookers.

During the project, there were different perceptions on solar cooking. Some villagers expected the hotpot to cook at night from energy stored during the day, which was a wrong perception. Project leaders had to explain how the product worked, using energy instantly from the sun.

Some beneficiaries also expressed the opinion that solar cooking was very slow and that the cookers did not match their lifestyle. Due to this discrepancy, some villagers were reluctant to accept and use the product. Those interested were immediately selected by community-based management committees. Some villagers even suggested product modifications, i.e. making it bifunctional both electrically (solar battery backup) and with solar energy.

Finally, in these areas hotpots can only be used efficiently in the summer. Wood is still needed during the winter months.

Contacts

Ugan Manandhar
ugan.manandhar@wwfnepal.org
Tel: +977 1 443 4820

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