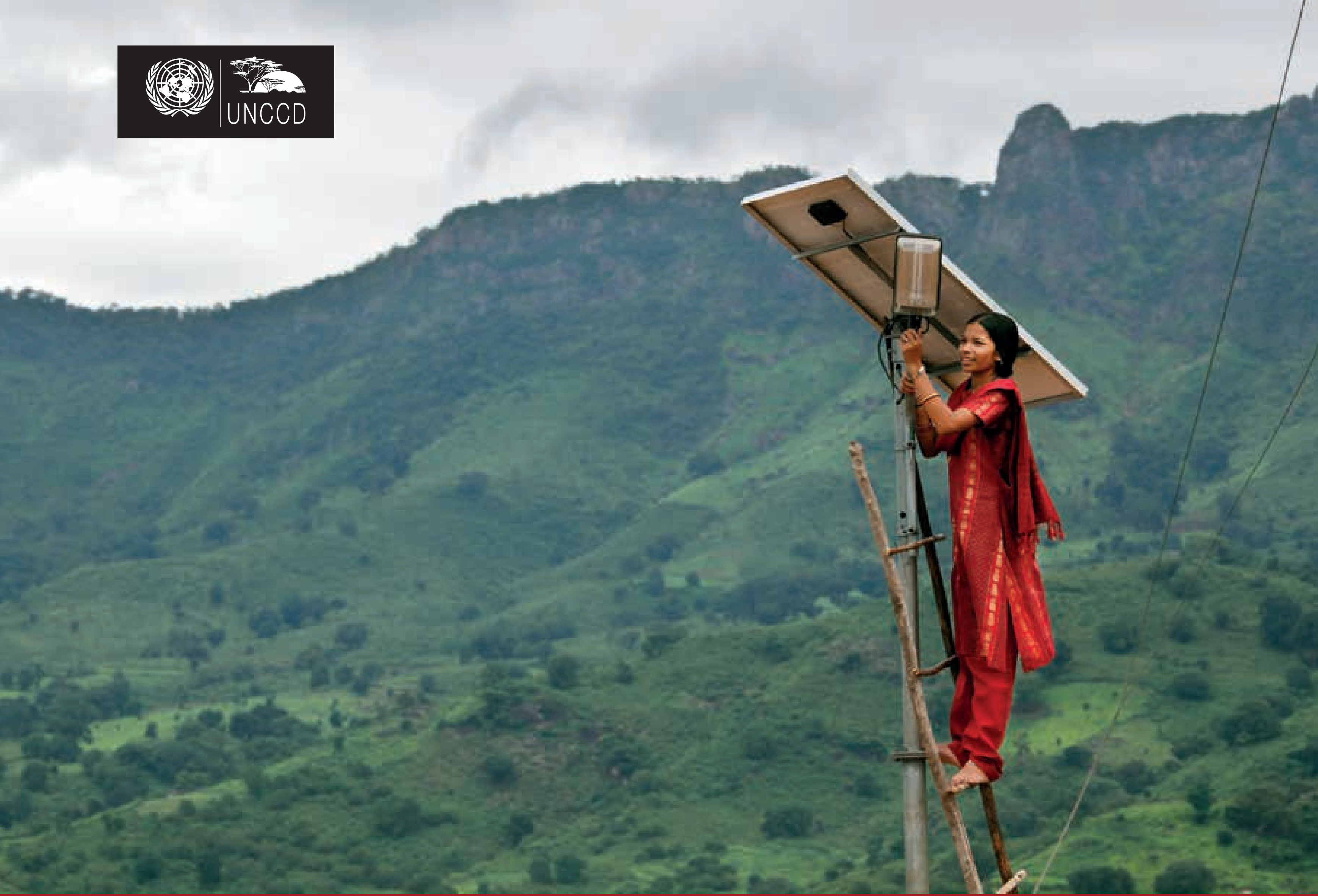

# FUEL FOR LIFE

## SECURING THE LAND–ENERGY NEXUS

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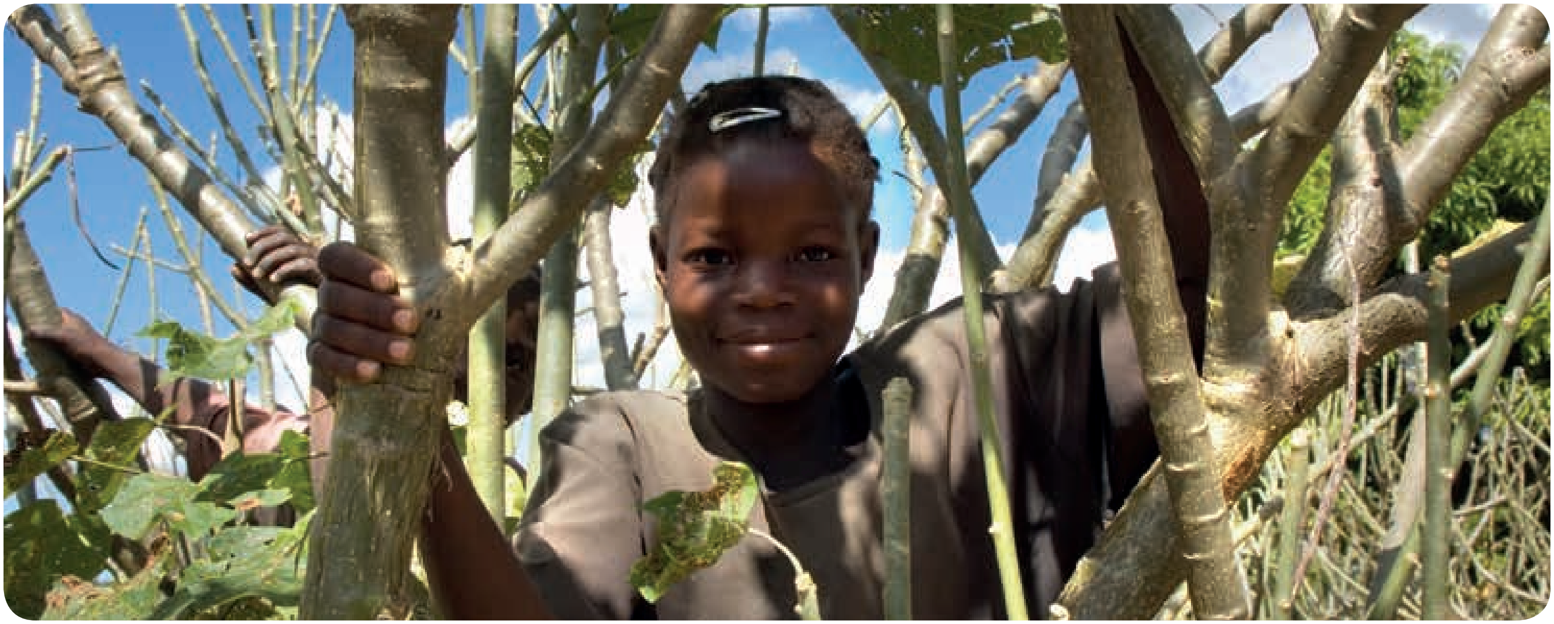


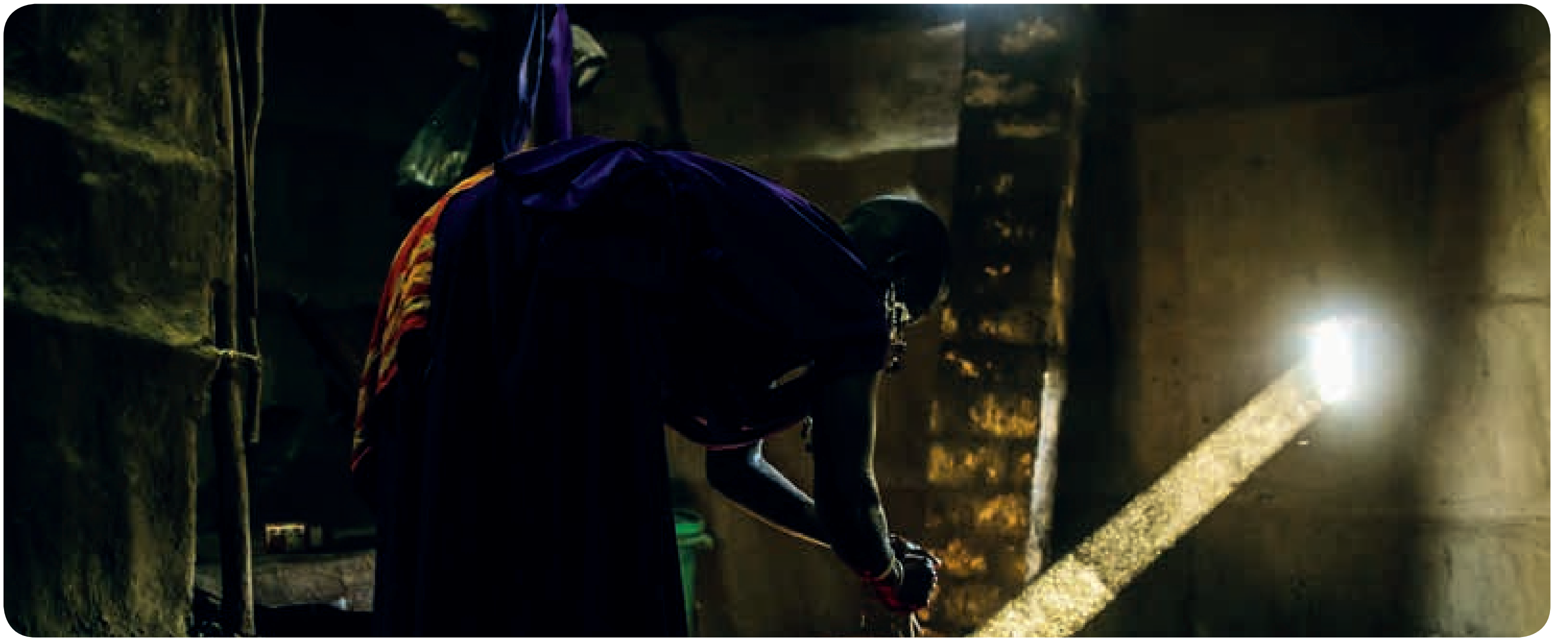
# RISING TO THE ENERGY-FOR-ALL CHALLENGE

Energy is central to nearly every major challenge and opportunity the world faces today. Be it for jobs, security, climate change, food production or increasing incomes, access to energy for all is essential. Sustainable energy is an opportunity too as it fuels lives, economies and the planet. Getting sustainable energy to all who want it represents one of the biggest development challenges of the 21st century.

Research suggests that 1.4 billion people — over 20% of the global population — lack access to electricity, and that at least 2.7 billion people — some 40% of the global population — rely on the traditional use of biomass for cooking. According to International Energy Agency, 1.2 billion people will still lack access to electricity in 2030, 87% of them living in rural areas. The number of people relying on the traditional use of biomass for cooking is anticipated to rise to 2.8 billion in 2030, 82 % of them in rural areas.[1]

Meeting worldwide growing energy demand is becoming more difficult. With a population set to reach 9.7 billion by 2050, demand for energy, water and food is mounting across the board. Traditionally, growth in demand has been met predominantly by tapping further into fossil fuel, freshwater and land resources. Taken together however, these resources are limited in nature and their extraction and use often has significant social and environmental impacts, from resource-driven conflict to climate change.

Business as usual — for energy the extraction of non-renewable fossil fuels like coal and oil — is not an answer. Energy is the dominant contributor to climate change, accounting for around 60 per cent of total global greenhouse gas emissions. Reducing the carbon intensity of energy is a key objective in long-term climate goals. In a time of climate change, economic growth and social wellbeing will depend heavily on the rapid scaling up of low-carbon, clean energy sources and their effective and efficient distribution.



## Managing trade-offs

Renewable energy sources may be the only smart choice for scaling up energy provision and meeting demand, particularly in poor rural communities, in a time of climate change. A key question is whether we can afford to use available productive land for agriculture or water for human use to provide renewable energy and power.

The adequate supply of productive land is, at least, as important as the reliable supply of energy; and the fact is that the exploitation of renewables can have unintended consequences. Energy production and delivery require lots of water and land; water supply and irrigation requires energy and land; and land-based activities such as agriculture and forestry depend upon the availability of energy and water. Energy security, for example, is threatened by the lack of available water resources for thermoelectric power and hydropower plants. Energy production intensifies the competition between different uses of land (e.g. food vs. biofuels) and can jeopardize the quality of the land for future use.[2]

| Energy sources and their impacts[3] | |
|---|---|
| Solar: | Solar cells assembly waste,<br>end of cycle waste,<br>land-use footprint |
| Wind: | Landscape,<br>land-use footprint |
| Geothermal: | Sulphur dioxide and carbon dioxide emissions,<br>land subsidence,<br>'micro-earthquakes',<br>noise |
| Hydropower: | Water consumption,<br>emissions from deforestation,<br>ecosystems |
| Biofuels: | Land-use change including use of fertile agricultural land,<br>greenhouse gas emissions from downstream processing,<br>soil degradation,<br>water use and water contamination |
| Wood fuel/charcoal: | Deforestation,<br>greenhouse gas emissions,<br>soil erosion,<br>land degradation |

Smart decisions on how energy is generated and supplied will be needed. Securing a reliable supply of renewable energy for all will rely to a great extent on healthy and functioning ecosystems. Understanding these interactions and getting the choices about energy right — where land, water and energy collide — will be vital. Each choice we make is a trade-off. In some cases, such trade-offs directly lead to increasing rates of land degradation.

Land, water and energy as resources are all pillars of our survival and of sustainable development. They stand or fall together. To be sustainable and in particular to reach poor rural populations, we need to enhance supply, access and security across all three pillars, at the same time, while supporting global climate ambitions. If done right, renewable energy technologies can contribute to meeting the sustainable development challenge for food and water security. Renewable energy production can be planned to reduce negative environmental impact and enhance energy security by decreasing dependence on fuel imports. Water and food security can also be improved if suitable renewable energy technologies are deployed to expand access to modern energy or agriculture services.[7]

A closer look at the most prominent renewable energy sources, such as biofuels, wood-fuel and charcoal as well as hydropower and geothermal, shows us how it is possible to manage trade-offs. Our aim should be a win-win situation where we have energy security and at the same time provide sufficient healthy and productive land to provide for everyone's pressing needs for food and water. Getting the mix right and minimizing the negative impacts of trade-offs will be important for our future survival.

**The situation in Africa**

In Africa in particular, access to energy is a pre-requisite of economic and social development. By 2050, the continent will be home to at least 2 billion people — twice as many as today — with 40% living in rural areas. Large parts of rural Africa face specific sustainable development and energy challenges, including lack of access to electricity and clean cooking facilities as well as low population densities and the distance to national grids.[4] In 2010, about 590 million African people (57% of the population) had no access to electricity, and 700 million (68% of the population) were living without clean cooking facilities. If current energy access trends continue, in 2030 there will still be 655 million people in Africa (42% of the population) without access to power, and 866 million (56% of the population) without clean cooking facilities.[5] The lack of reliable clean energy is depriving the majority of the population of the opportunity to pursue a healthy and productive life.

At the same time, Africa's economies are growing currently at an average rate of 4% per year. Sustaining such growth and leveraging Africa's considerable human capital and natural assets for the benefit of the population will only be possible if fuelled by a much larger and better performing energy sector. Africans currently consume only one quarter of the global average energy per capita, using a mix of hydropower, fossil fuels and biomass — mostly in traditional uses. Providing full electricity access to all Africans would require only an additional 900 terawatt hour (TWh) over 20 years, an amount that corresponds to one year of current additional global power consumption.[6]

# LAND AND BIOFUELS

## Part of the solution or part of the problem?

Biofuels, while less emission intensive and arguably more sustainable than other extracted fuels, could lead to increases in global food prices and land degradation. Should land be increasingly used for biofuels while pressures such as land degradation and climate change limit society's ability to feed a growing population expected to reach 9.7 billion people by 2050?

Concerns about high energy prices and carbon emissions have led to increasing calls for biofuel production and use. Currently, biofuel feed-stocks occupy 2-3% of arable land worldwide. Even a goal for biofuels to meet 20% of the world's total energy demand by 2050 — would require us to at least double the world's annual harvest of plant material.[8] Projections of future biofuel and food production needs indicate the potential for growing competition for land. This will be a particular concern if all biofuel policies are implemented or when biofuels become more economically viable. It has been suggested that biofuels could be responsible for 27% of global energy consumption for transportation by 2050. At this point biofuels would be using 6% of the world's arable land.[9]

Global biofuel production, in particular, changes land-use. In many cases, the most profitable way to produce biofuel feedstock is to clear the land of its native ecosystem, be it rainforest, savanna, or grassland. The resulting release of carbon dioxide from burning or decomposing biomass and oxidizing humus can negate any possible greenhouse gas benefits of biofuels.

Biofuel production also affects food prices. The impact of biofuels on food production depends on context-specific factors such as the land, technology and farming model used and whether there is a spillover to other crop production. Some biofuels are also very water-intensive. The average water footprint of biofuels is 70 times bigger than that of oil.[10] However, the water footprint of biofuels also varies widely across countries and contexts. This underlines the need to monitor the effects of biofuel production on both water and land use.

**Case study Mali[19]: Jatropha electrification**

The Garalo Project in the Garalo commune, Mali, was established to provide the local community with access to electricity produced from jatropha oil. Small-scale farmers are at the heart of the business model supplying jatropha oil to a hybrid power plant. Electricity is then sold by the private power company ACCESS to residential and business consumers. Out of a forecast of 10,000 ha of jatropha, 600 ha, involving 326 rural families are already under cultivation on land previously allocated to cotton — a product which has significantly dropped in market value over recent years. The project provides a stable income to farmers, as well as access to modern energy services for the community, both stimulating the local economy. Furthermore, producer and consumer rights have been promoted through the establishment of co-operatives and associations.

## Can we rehabilitate degraded land with biofuel crops?

To avoid trade-offs between expanding biofuel cultivation, conservation of biodiversity and food security, three types of land have been suggested for potential agriculture expansion: "marginal" land, degraded land and abandoned land. "Marginal" land comprises all non-cultivated area where actual primary production is too low to allow competitive agriculture. Degraded land has been cultivated before and became marginal due to soil degradation or other impacts resulting from inappropriate management or external factors. Abandoned land comprises degraded land with low productivity as well as land with high productivity.

Some biofuel crops can grow on degraded land and help restore its soil quality and productivity and may be taken into consideration in moves to achieve Land Degradation Neutrality (Global Goal for Sustainable Development 15.3).

One example is switchgrass. The use of leguminous nitrogen-fixing plants is also an option to improve soil fertility as they maintain ground cover, control weeds and increase soil phosphorus availability. This type of crop could be easily used between cropping cycles, providing land restoration alternatives to farmers. A further option is deriving biofuel from low-input high-diversity (LIHD) mixtures of native grassland perennials that can be produced on agriculturally degraded lands.

**Land availability for biofuel production**[15]

The amount of marginal agricultural land has been estimated for biofuel production in Africa, China, Europe, India, South America and the continental United States. In total, these countries/regions can have 320-702 million hectares of land available, only counting abandoned and degraded cropland, mixed crop and vegetation land. If grassland, savanna, and shrubland with marginal productivity are considered, as well, the total land availability increases to between 1107 and 1411 million hectares.

Inclusive consultations with communities should take place before marginal land is converted into biofuel feedstock in order to avoid unwanted social and ecological impacts. As some degraded and marginal lands are used by poorer households for biomass, building materials, fruit and nut gathering and in some cases for subsistence crops. Competition for land resources between biofuel producers and poorer stakeholders may result in loss of access to the land on which poorer minorities depend. In this context, large-scale biofuel plantations, especially if they are based on extensive land acquisitions, are usually problematic.

Biofuel production should be developed from an ethical, environmental and economic stand point.[18] Biofuels can be part of the energy mix but for sustainable production if producers adopt a range of practices that minimize adverse effects on ecosystems, reduce water and fertilizer use. Such practices are essential to ensuring viability of future biofuel production. Production needs to be carried out at appropriate scales that maintain ecosystem function and biodiversity across landscapes. Small is sustainable. Small-scale biofuel projects in particular can bring important benefits not only in terms of energy security but also through the creation of new livelihood opportunities. Throughout the developing world, examples of small-scale initiatives can be observed, working to provide improved energy access through the development and transformation of various bioenergy resources into cleaner and more convenient forms of energy at local level. Biofuel projects can contribute significantly to local and household energy security in remote areas.

# LAND, WOOD AND CHARCOAL

## Tradition meets modernity

Wood has been used as fuel for millennia, meeting humanity's basic needs for cooking, boiling water, lighting and heating. Today, wood used as fuel (wood-fuels — i.e. firewood and charcoal) still accounts for around 10% of the global energy supply. It dominates energy provision in many parts of the developing world, particularly remote communities. Over 90% of the population in sub Saharan Africa relies on wood-fuels.

Firewood serves mostly rural populations' fuel needs. In combination with deforestation from charcoal fuel-stock sourcing, rural populations are forced to drive and feel the brunt of land degradation resulting from forest over-exploitation. Charcoal demands on the other hand are closely associated with urbanization and supply is primarily met from unsustainable dryland sources. Charcoal is preferred in urban areas due to its higher energy density, lower transport costs and relatively low emissions. In East Africa, 70–85% of urban households rely on charcoal.

With continual urbanization, the demand for charcoal in recent years has increased. This has been observed in sub-Saharan Africa in particular where average annual consumption of charcoal grew by 3% from 2000 to 2010. Firewood consumption grew by 1% a year over the same period. Unsustainable charcoal production in rural areas is one of the major causes of forest degradation in these areas, leading to biodiversity loss and ultimately economic derailing. The negative impacts of charcoal production on dryland forest and woodlands are likely to increase with urbanization and population growth. The expected increase in charcoal demand could have significantly negative impacts on tree cover in dry forests, with all the associated degradation and climate change impacts. It is thus imperative that other more sustainable fuel sources are found along with moves to support sustainable charcoal production for developing countries and their rural communities.

**Case study Rwanda[22]: Private woodlots making more out of wood-fuel**

Rwanda is one of the few African countries with increasing forest cover, growing by 7 percent from 2000 to 2005 due to the expansion of forest plantations. This apparent success follows the earlier loss of two-thirds of the country's natural forest cover, along with much of its biodiversity. Practically all wood-fuel in Rwanda is now derived from planted trees, and harvesting from natural forests is almost non-existent. Plantations larger than 0.5 hectare cover about 241,000 hectares of land, of which 65% is owned by the central or regional government, 25% by farmers and other private landowners, and 9% by institutions. With secure land tenure and rising wood-fuel prices, it has become profitable for private individuals to invest in tree planting to produce building poles, timber, firewood, and wood for charcoal making. Due to rising income, the social standing of farmers has improved and they are able to engage traders — who formerly held most of the power in the wood-fuel value chain — on a more balanced footing when negotiating prices.

**Case study: Reducing fuelwood demand in Cambodia[21] with efficient stoves**

In countries such as Cambodia, unsustainable demand for fuelwood and charcoal represent a significant degradation driver, which can be addressed in part by improved efficiency in the creation of energy from this fuel source. A project has created 265 additional jobs and stove users have saved a total of US$2.5 million on charcoal purchases between 2003 and 2006 (GERES, 2007). Emission reductions between 2003 and 2007 totalled 179,518 $tCO_2e$ and have been verified by a third party to the Voluntary Carbon Standard, demonstrating that emissions reductions from fuelwood projects can be real, measurable and verifiable.

## Are there sustainable charcoal options?

Options to improve sustainability include promoting the efficiency of charcoal production and consumption within a better framework of enabling policies. More efficient production will reduce the amount of wood required per unit of charcoal produced, particularly if modern techniques are implemented. Improved cooking stoves will reduce charcoal consumption and also cut local air pollution and emissions. Changes in land management are also required to create sustainable charcoal supply systems rather than 'one-off' harvesting of wood. With improved management, biomass carbon stocks in forests may recover and be maintained along with charcoal production.

Agroforestry plays an important role in making charcoal supply more sustainable by reducing harvesting pressure on natural sources, making the whole process more sustainable. Another technique widely used to reduce waste and increase productivity from charcoal, forestry and agriculture is briquetting or compressing material into usable bricks of fuel. This process further increases the sustainability of charcoal production.

In 2007, the charcoal industry in sub-Saharan Africa was estimated to be worth over US$ 8 billion, employing more than 7 million people (close to 1% of the region's population) in production and marketing, up from US$ 6 billion in 1995. There is significant potential for further economic development by means of charcoal value chains when dryland residents,

**Case study Guatemala[20]: Safeguarding fuelwood supply through agroforestry**

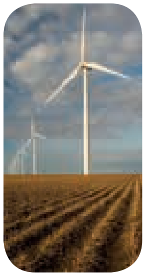
In Guatemala, the conversion of degraded land to woodlots and permanent agriculture through agroforestry systems increased fuelwood supply and met most of the local fuelwood needs (Bryant et al., 1997). In this case, a CARE project established tree nurseries run by local farmers which later became self-sufficient. It also increased fuelwood and agricultural productivity by providing trees. The agroforestry systems have persisted during years of political strife and uncertainty primarily because they involve local people as the primary stakeholders. The local farmers then adopted the project's techniques in areas beyond its boundaries by setting up their own tree nurseries, potentially increasing the amount of carbon sequestered (positive leakage) and providing a steady and sustainable supply of fuelwood. In this case, the methods of increasing fuelwood availability and agricultural productivity were widely replicated.

and especially women, become charcoal suppliers under enabling and environmentally friendly policies. By 2030, the market is predicted to exceed US$ 12 billion, employing 12 million people.

## OTHER OPTIONS FOR RENEWABLE ENERGY PROVISION

Growing global demand for clean, reliable, and affordable energy will also lead to an expansion of the role of hydropower, geothermal, solar and wind energy generation infrastructure. In turn, it offers important opportunities for poverty alleviation and sustainable development.

Beyond their traditional role in providing critical electricity access, renewables may have a powerful contribution to make to regional cooperation and development. Renewables as of May 2015 account for approximately 24% of the world's electricity[23] and play a unique dual role in climate change: as an adaptation strategy for growing weather variability and as a renewable resource to move economies to a low carbon future.[24]



Hydropower has shaped and promoted economic growth in developed countries as Canada, Norway and the United States. It can do so in other parts of the world. It is an interesting fact that the amount of untapped hydropower in the developing world is tremendous — nearly four times the capacity currently installed in Europe and North America. As a matter of scale, if Africa were to develop the same share of hydropower potential as Canada, it would realize an eight-fold increase in electricity supply and, with complementary investments in transmission and distribution, bring electricity to the entire continent with multiple additional benefits for water management and regional integration.[26]

On the downside, hydropower can be complex and can bring a range of economic, social and environmental risks if not done properly. Hydropower can be run on a small or even micro level with subsequently less environmental impact. Micro hydropower development is a proven, attractive and economically promising resource especially in remote parts of the world lacking huge investment capacities. It works best if the land is healthy.

**On a regional basis, unexploited potential — in percent of total potential — amounts to:**

- 93% in Africa
- 82% in East Asia and the Pacific
- 79% in the Middle East and North Africa
- 78% in Europe and Central Asia
- 75% in South Asia
- 62% in Latin America and the Caribbean

**Case Study Kenya[27]: Out of poverty through micro hydropower**

The Tungu-Kabiri community micro hydropower project, funded by the United Nations Development Programme and developed by Practical Action East Africa and Kenya's Ministry of Energy, brought 200 households together to own and operate their own power station, supplying electricity to local businesses and households.

Once river flow records, going back 40 years, had been assessed and the river Tubgu, near Mbuiru, had been passed as suitable, work began on building the hydropower station.

To construct the scheme, villagers gave up their Thursdays every week for several months, digging, shifting stones, laying concrete, building the intake weir and canal and penstock. The project took two years but now provides real benefit to all 200 households. Electricity from the plant gives the community access to power to charge car batteries, to light their homes, and to charge mobile phones.

Hydropower is highly sensitive to droughts and land degradation, as both can affect water level and water flow, even up to a complete dry-up, and thus affect electricity plant productivity. California hydropower production for instance declined significantly during the recent drought, as water flows dropped, with both economic and environmental costs. Much of this lost hydropower was made up by purchasing and combusting natural gas, costing California ratepayers an additional $1.7 billion and producing an additional 13 million tons of carbon dioxide. It should be noted that this also led to the release of substantial quantities of other pollutants that are known triggers for asthma and contributors to the formation of smog.[28]

While drought as a natural phenomenon cannot be prevented — though it can be better managed — land degradation can be prevented. If land is healthy, it can store water. A fully functional hectare of soil can hold 3,750 tons of water. Sustainable land management can bring back soil health and offers cost-effective and flexible solutions for hydropower supply by decreasing the sediment yield and hedging against the negative impacts of water shortage or run-off.

**Case study Rwanda: Ecosystem restoration and sustainable hydropower production**

In 2003-04, Rwanda experienced a major electricity crisis. The crisis was triggered by a steep decline in power generation at the Ntaruka hydropower station, attributed to a significant drop in the depth of Lake Bulera, the station's reservoir. The water loss was precipitated by a combination of factors, including: poor management of the upstream Rugezi Wetlands; degradation of the surrounding Rugezi-Bulera-Ruhondo watershed due to human activity; poor maintenance of the station; and reduced rainfall in recent years.

In response to its energy crisis, Rwanda sought to restore the degraded watershed by halting ongoing drainage activities in the Rugezi Wetlands and banning agricultural and pastoral activities within and along its shores, as well as along the shores of nearby Lakes Bulera and Ruhondo. But this left the region's poor rural households unable to access key resources, jeopardizing their livelihoods. The Government responded with additional agricultural and watershed management measures including: building erosion control structures; planting a bamboo and grass belt around the Rugezi Wetlands; planting trees on surrounding hillsides; distributing improved cookstoves; and promoting both environmentally sound farming practices, and introducing additional income-generating activities such as beekeeping.

Today, the Ntaruka hydropower station has returned to full operational capacity while local livelihoods are, in the main, more secure. The story of Rwanda's electricity sector demonstrates the importance of integrated watershed management in pursuing energy security in a changing climate.

# LAND AND GEOTHERMAL ENERGY

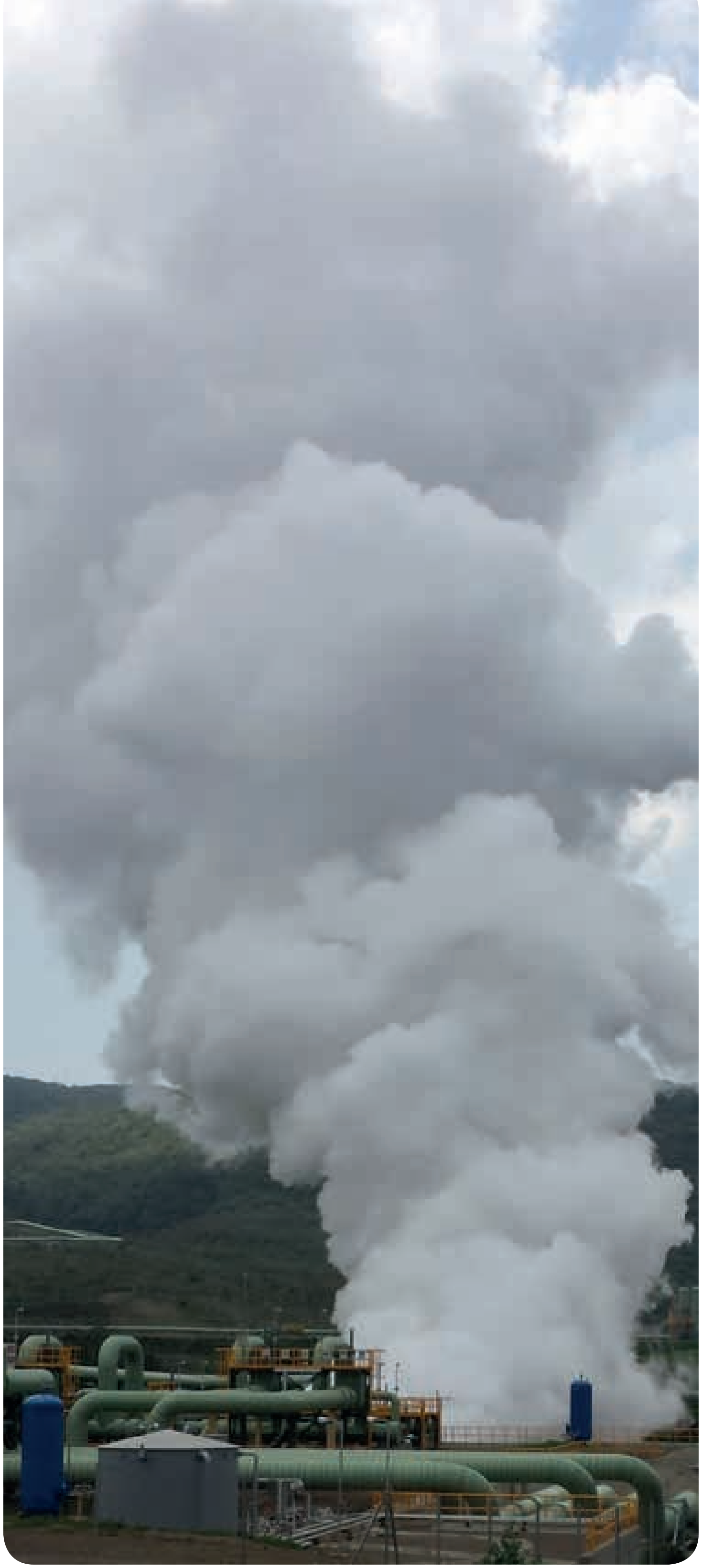
Geothermal energy is another interesting source of renewable energy. In contrast to wind and solar energy, geothermal electricity generation does not depend on the weather and can be applied throughout the year. In geothermal energy generation, the thermal energy stored in the accessible upper layers of earth is converted into electricity or used for heat supply.

Electricity is currently produced by geothermal energy in 24 countries. Five of these countries (Costa Rica, El Salvador, Iceland, Kenya, and the Philippines) obtain 15–22% of their national electricity production from geothermal. It is estimated that future geothermal deployment could meet more than 3% of global electricity demand and about 5% of the global demand for heat by 2050.[32]

Compared to other energy resources, the exploitation of geothermal energy exhibits a relatively low environmental footprint. Potential impacts range from the drilling of boreholes and of exploratory and production wells, to some gaseous pollution releases during drilling and field testing.[33] The installation pipelines may incur similar environmental impacts to those of drilling. The exploitation of geothermal energy does not ultimately create additional $CO_2$ because there is no combustion process. However the rate of natural emissions can be altered by geothermal production depending on the plant configuration.

On a local scale, geothermal development should involve consideration of land and water use impacts. These are common to most energy projects such as noise, vibration, dust, visual impacts, surface and ground water effects, ecosystems, biodiversity as well as specific geothermal impacts. These can be altering outstanding natural features such as springs, geysers and fumaroles.[34] Examples exist of unobtrusive, scenically landscaped developments[35] and integrated tourism/energy developments.[36] However, land use issues still seriously constrain new development options in some countries[37] particularly where new projects are often located within or adjacent to national parks or tourist areas.

Successful geothermal projects need the acceptance of local people. To secure this, there should be no adverse effects on people's health; minimal negative environmental impacts; and the creation of direct and ongoing benefits for the resident communities. Geothermal development can create local job opportunities during the exploration, drilling and construction period, typically around four years. It can also create permanent and full-time jobs when the



**Geothermal energy: challenges and pitfalls**[39]

Ethiopia started a long-term geothermal exploration in 1969. This work peaked during the early to mid-1980s when exploration drilling was carried out in Langano (Lakes District). The 7.2 MW net capacity pilot plant installed at Langano has faced operational difficulties due to the lack of management skills.

In Zambia a mini-geothermal pilot power plant (200 KW) was installed on the basis of limited exploration work, and the plant never became operational.

Countries such as Malawi, Rwanda and Tanzania have to date not gone beyond making an inventory of the resource potential, which is the starting point for geothermal work.

power plant starts to operate since the geothermal field from which the fluids are extracted must be operated locally. This can alleviate rural poverty in developing countries, particularly in Asia, Central and South America, and Africa where geothermal resources are often located in remote mountainous areas.

Multiple land use arrangements that promote employment by integrating subsurface geothermals energy extraction with labour-intensive agricultural activities are useful.

With an estimated potential of 20,000 MW, geothermal energy could provide a good part of the answer to the African continent's energy shortage. However this immense potential remains largely untapped, as the continent faces challenges in terms of skilled human resources and development of technological know-how.[38]

**Case study Kenya[40]:**
**Geothermal energy — a success story**

Kenya's 280 MW Olkaria geothermal power plant, the world's largest, began commercial operation in 2015. The plant provides almost 20% of the nation's total power capacity. Kenya is among the world's most active regions for geothermal development and geothermal power now accounts for 51% of installed power capacity, displacing hydropower as the top energy source.

Even solar and wind power, where the relationship with land is less obvious and not directly extractive, consume and use land. While the direct impact on land productivity of wind turbines can appear to be low; the footprint of the projects can be much larger in terms of emissions caused by production and in terms of land put beyond use. Both energy sources have a measurable land-foot print and that needs to be taken into account when planning land use.

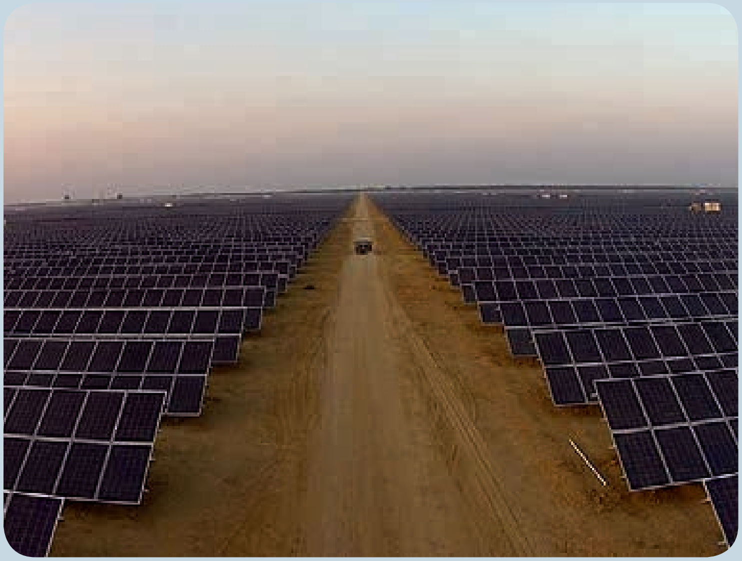
Though the footprint varies by type of technology, data from the United States National Renewable Energy Laboratory (NREL) suggests for example a large fixed-tilt solar photovoltaic plant requires 2.8 acres (1.1 hectares) per GWh/year of generation. Put another way, a photovoltaic plant spanning 32 acres (13 hectares) could power 1,000 households.[41]

**Connectivity in a rural context**[43]

Large-scale power plants appropriate for an urban environment are not necessarily suited to power remote, low density areas. Mini-grid and off-grid solutions can create a favorable environment for rural entrepreneurs to become small power producers, and help meet rural electrification needs. A mini-grid can power household use and local businesses with almost the same quality and services as the national grid. In the case of isolated households with limited electricity demand, the third option is that of individual energy systems (i.e. solar home systems, wind home systems or pico-hydro systems).

**Case Study: One Belt One Road**

China has been leading industrial development of the photovoltaic sector taking up to 70% of the world's photovoltaic market capacity. In Pakistan, some 400,000 solar panels, spread over 200 hectares of flat desert, glare defiantly at the sun at what is known as the Quaid-e-Azam Solar Power Park (QASP) in Punjab, named after Pakistan's founding father. The 100 MW photovoltaic (PV) solar farm was built by Chinese company Xinjiang SunOasis in just three months, at a cost of around US$130 million (833 million yuan), and started selling electricity to the national grid in August 2015. It is the pilot stage of a more ambitious plan to build the world's largest solar farm. Once complete in 2017, the site could have capacity of 5.2 million PV cells producing as much as 1,000 MW of electricity — equivalent to an average sized coal-fired power station — and enough to power about 320,000 households.[42] As China's US$40 billion Silk Road Fund for „One Belt, One Road" Initiative projects picks up steam, the initiative should create favourable conditions for exploitation and development of energy. There is a drive up the share of renewables in the total energy mix.



# CONDITIONS FOR SUCCESS: SECURING THE LAND–ENERGY NEXUS

Affordable, reliable and environmentally sustainable energy sources can increase incomes in rural areas, open new economic opportunities and serve as a basis for broader rural development. Sustainable renewable energy relies to a great extent on healthy and functioning ecosystems. The production of renewable energy requires the use of additional land and water, which can affect the availability of these resources for future generations, especially in combination with the effects of climate change and population growth. Planning sustainable land, water and energy management and supply together can be the only practical solution.

## Some important lessons learned and conditions for success in the implementation of energy projects that reach the poor in developing countries:

**Understand linkages:**

Understand the relationships between land, water and energy supply.
Look at possible unintended consequences of a decision or trade-off.

**Scale matters:**

Most renewable energy sources, especially biofuels [plant or wood], can be part of the solution, but small-scale site-specific solutions are best, as they have fewer negative environmental consequences.

**Plan at the landscape level:**

Consider the size of the land and water footprint of each power generating method.
Get the mix of energy sources and land uses right so that all stakeholder needs can be addressed.

**Promote natural solutions:**

Use green infrastructure where it is cost-effective. E.g it is now clear that forested watersheds regulate, filter and delivery water more cheaply, and are far less energy intensive than grey infrastructure.

**Deliver appropriate levels of connectivity:**

Mini-grids can be a viable and cost-effective route to electrification where the distance from the grid is too large, and population density too low to economically justify a grid connection.

**Engage local people and promote ownership:**

This applies to both land and energy projects.
Rights must be protected.
Consultations must be inclusive.

**Build local capacity:**

Typically, renewable energy projects suffer from limited skill transfer after initial capacity installation, causing increasing maintenance problems later.
Equally there is little knowledge about sustainable land management practices.
Developing capacities within local communities helps ownership, increasing system sustainability and maximising local value creation.

**Support an enabling environment:**

Encourage public sector activities that create and improve the enabling environment for private sector investments in sustainable energy, water and land.
Central is access to affordable capital and credit at different stages of development for long term investment.
This includes legal, regulatory and policy regimes that provide clear and predictable rules for project development, implementation and operation.

## Energy for all and land degradation neutrality: Two sides of the same coin

Securing life on land (goal 15) and the provision of reliable, sustainable energy (goal 7) feature highly in the Global Goals for Sustainable Development. It is clear that done right, these goals are complementary.

Given that energy-related greenhouse gas emissions are rising while the atmosphere's sink capacity is finite, the world certainly needs to move from a high-carbon to a low-carbon lifestyle, while still providing the required energy services for inclusive and sustainable growth. The fact is, land-based renewable energy sources such as biofuels, biomass and hydropower may be deemed more "climate friendly", but this does not, in itself, guarantee environmental sustainability. The production of renewable energy requires the use of additional land and water, which can affect the availability of these resources for current and future generations, especially in combination with the effects of climate change, population growth and food security.

The key to securing the double benefit of climate change mitigation and energy security, particularly in the developing world, is the sustainable and equitable management of land. Increased future demands for food, fibre and fuels from biomass can only be met if the available land and water resources on a global scale are used and managed in the most efficient manner and vice versa.

The Global Goals for Sustainable Development can help promote effective land and water management and deliver energy to all. Through achievement of target 15.3 on land degradation neutrality, we will secure vital ecosystem services, we will support energy security and we will adapt and mitigate climate change without compromising food security. Land degradation neutrality needs to become the new normal. Incentives that promote the rehabilitation of degraded land and the wide-spread adoption of sustainable land and water management practices will all be needed.

Land needs energy. Energy needs land. They must be developed and planned to work in harmony. Together, they are our fuel for life.

### Land degradation neutrality

Land degradation neutrality means that the amount of healthy and productive land remains stable or increases in a given time and space.

This can happen naturally or because of improved land management and ecosystem restoration.

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