Sustainable Bioenergy: A Framework for Decision Makers

UNITED NATIONS

UN-Energy

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Preface

In our first paper, UN-Energy focused on "The Energy Challenge for Achieving the Millennium Development Goals." We pointed out that available energy services fail to meet the needs of the world's poor, with 2.4 billion people relying on traditional biomass for their energy needs and 1.6 billion not having any access to electricity. The basic commitments to poor people cannot be met without a far more focused approach to energy services.

At the same time, awareness has grown across the world of the impact of human energy consumption on our environment, and specifically on our global and regional climate. Whatever the optimal energy mix, it is clear that nations face tough choices in their approach to sources of energy.

It is no surprise, then, that global interest in bioenergy has grown rapidly in recent years. From being merely an interest of marginal innovators, it has become a multi-billion dollar business—transforming economies—thanks to rising attention and support from governments and the public. What could be more appealing than home-grown energy, essentially created by sun-and-water-fuelled photosynthesis, with new jobs and development opportunities to be tapped?

Yet, nothing human or ecological is straightforward. And so it is with biofuels, perhaps particularly liquid biofuels. Will biofuels push out food crops, raise food prices, and exacerbate food security? Will biofuels create unexpected negative rather than positive external environmental effects? Could biofuels even exacerbate the impact on climate when the entire production chain is taken into account? How will increased investment in biofuels affect trade patterns? What would a sustainable approach to bioenergy look like? These questions need to be addressed.

In this latest publication, UN-Energy seeks to structure the approach to the current discussion on bioenergy. "Sustainable Bioenergy: A Framework for Decision-Makers" is the contribution of the UN system to the issues that need further attention, analysis, and valuation, so that appropriate trade-offs can be made and both the energy needs of people met and the local and global environment adequately protected. We hope that development partnerships at the country level as well as the management of global issues will be helped by our articulation of the issues.

UN-Energy is a collaborative framework for all UN bodies that contribute to energy solutions. It was born out of the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa. Based on the Summit's outcomes and action plan, it brings together the top-level energy managers of the UN system in a modest, collective approach to inform analysis, inspire dialogue, and ultimately promote action by governments, energy stakeholders, and multilateral organizations. We do not replace inter-governmental policy dialogue. Nor can we match the resources of the private sector and civil society.

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However, rooted in the multilateral frameworks of the Millennium Summit, Financing for Development, the WSSD, and the World Summit of 2005, we hope to use the collective strength of the UN system to effect change.

This paper was sponsored by the Food and Agriculture Organization (FAO), drawing on important support from the Worldwatch Institute in creating the document. Many members of UN-Energy have contributed actively. We are grateful to all, and in particular to the Vice Chair of UN-Energy, Gustavo Best of FAO. In the spirit of our chosen method of work, this is a joint product. We hope that you will find it inspirational reading.

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Section 1: Purpose of the Paper

This paper on sustainable bioenergy was drafted collectively by UN-Energy members, which include all of the United Nations (UN) agencies, programmes, and organizations working in the area of energy, reflecting their insights and expertise. It is intended to contribute to international discussions on the strategies and policies needed to ensure economic, sustainable, and equitable development of bioenergy in the years ahead.

UN-Energy uses the definition of sustainable development adopted by the UN Commission on Sustainable Development (CSD), i.e., "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

The paper points to key social, economic, and ecological sustainability issues raised by the rapid development of bioenergy in both small- and large-scale applications. It encompasses the entire bioenergy value chain, from production to use, with the goal of providing a framework for decision-makers who are considering adopting new policies or launching new investments in the bioenergy sector. It is not designed to provide prescriptive measures, but rather to identify areas that require priority attention at the national and international levels.

The paper encompasses all bioenergy systems but focuses in particular on modern bioenergy, which includes liquid biofuels, biogas, and solid biomass for heat and power generation. Traditional use of bioenergy, in the form of inefficient direct combustion, is prevalent in many poor rural regions but is not the primary focus of this document. Because of rapidly increasing attention to liquid biofuels, this paper discusses these in more detail than other forms of modern bioenergy.

The issues raised by bioenergy development are complex and highly dependent on local circumstances (climatic, agronomic, economic, and social), such that sweeping generalizations about the efficacy of particular approaches are rarely valid. The paper is intended to raise key questions and explain the principal trade-offs involved in bioenergy development, and to contribute to both the international discourse on these issues and the informed decision-making of policy makers.

Growing commitments to bioenergy in recent years are based on studies showing that the diversification of energy supplies can contribute to both economic and environmental goals, including the UN Millennium Development Goals (MDGs), adopted in 2000.

The paper adopts the following outline. Section 2 describes the role of bioenergy in the global energy context, including the potential benefits and trade-offs. Section 3 provides a framework for decision-makers to consider nine key sustainability issues facing bioenergy development:

1. *The ability of modern bioenergy to provide energy services for the poor;*
2. *Implications for agro-industrial development and job creation;*
3. *Health and gender implications;*
4. *Implications for the structure of agriculture;*
5. *Implications for food security;*
6. *Implications for government budget;*
7. *Implications for trade, foreign exchange balances, and energy security;*
8. *Impacts on biodiversity and natural resource management; and*
9. *Implications for climate change.*

Section 4 concludes that bioenergy should continue to be discussed at the national and international levels and offers a brief framework for action. Section 5 provides a list of sources and suggestions for further reading.

Section 2: Bioenergy in the Global Energy Context

Bioenergy, defined as energy produced from organic matter or biomass, has recently become one of the most dynamic and rapidly changing sectors of the global energy economy. Accelerated growth in the production and use of bioenergy in the past few years is attracting interest from policy makers and investors around the globe.

Modern bioenergy technologies[1] that produce heat, electricity, and transport fuels are advancing rapidly, with much of the recent interest focusing on liquid biofuels, in particular ethanol and biodiesel. The United States and Brazil dominate today's liquid biofuels industry, but many other governments are now actively considering the appropriate role for biofuels in their future energy portfolios.

"The gradual move away from oil has begun. Over the next 15 to 20 years we may see biofuels providing a full 25 percent of the world's energy needs." —Alexander M ller, Assistant Director-General for the Sustainable Development Department, FAO

Global production of biofuels alone has doubled in the last five years and will likely double again in the next four. Among countries that have enacted new, pro-biofuel policies in recent years are Argentina, Australia, Canada, China, Colombia, Ecuador, India, Indonesia, Malawi, Malaysia, Mexico, Mozambique, the Philippines, Senegal, South Africa, Thailand, and Zambia.

"[Bioenergy] is an opportunity to add to the world supply of energy to meet the enormous growing demand and hopefully to mitigate some of the price effects. It's an opportunity to do so in an environmentally friendly way and in a way that is carbon-neutral. It's an opportunity to do so in a way that developing countries like Brazil can provide income and employment for their people." —World Bank President Paul Wolfowitz.

Three times in the past three decades, oil-dependent economies have been affected by dramatic oil price increases—in the mid 1970s, the early 1980s, and the current period (2004–07). Oil imports now consume a large and unsustainable share of the meagre foreign exchange earnings of many poor nations, in some cases offsetting any gains from recent foreign debt elimination agreements. In some countries, the foreign exchange drain from recent higher oil prices was five times the gain from recent debt relief.

Unstable and unpredictable oil prices have complicated economic planning around the world, and market analysts expect this pattern to persist. Oil production has already peaked in a long list of major oil producing nations, including Indonesia, Mexico, Norway, the United Kingdom, and the United States. The International Energy Agency projects that oil prices will remain in the $48–$62 range through 2030.[1] In addition to the price level, the dramatically increased volatility of oil prices that began in 2004 is further damaging poor economies.

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Africa's current oil crisis is "an unfolding catastrophe that could set back efforts to reduce poverty and promote economic development for years." —Abdoulaye Wade, President of Senegal

Recent oil price increases have had devastating effects on many of the world's poor countries, some of which now spend as much as six times as much on fuel as they do on health. Others spend twice the money on fuels as on poverty reduction. At a time when energy analysts predict a period of

[1] Modern bioenergy refers to biomass that may be either burned directly, further processed into densified and dried solid fuels, or converted into liquids or gaseous fuels using so-called first- or second-generation technologies, depending on their level of development.

Section 2: Bioenergy in the Global Energy Context

unpredictable oil markets, with prices dependent on developments in some of the world's least stable regions, fossil fuel dependence has become a major risk for many developing economies. In such national settings, the macroeconomic benefits of channelling fuel revenues into poor, rural economies could be substantial.

With oil production already in decline in many nations, greater biofuel use could help bring the oil market into balance and greatly reduce oil prices. For countries that obtain 50–100 percent of their modern energy from an increasingly unstable world oil market, the arguments for supply diversification are strong. Many of these nations lie in tropical zones where relatively low-cost biofuel crops, such as sugar cane and oil palm, already grow. In this context, 12 African nations joined Senegal in 2006 in forming the Pan-African Non-Petroleum Producers Association, aimed in part at developing a robust biofuels industry in Africa. The idea behind such efforts is to divert a portion of the money now being sent abroad to pay for oil to local agricultural and manufacturing sectors, where it would strengthen economies and generate employment.

Modern bioenergy can also help meet the needs of the 1.6 billion people worldwide who lack access to electricity in their homes, and the 2.4 billion who rely on straw, dung, and other traditional biomass fuels to meet their energy needs. Locally produced bioenergy can provide energy for local agricultural, industrial, and household uses, in some instances at less than the cost of fossil fuels.

The rapid development of modern bioenergy worldwide clearly presents a broad range of opportunities, but it also entails many trade-offs and risks. Experience with the associated economic, environmental, and social impacts is limited, and the types of impacts will depend largely on local conditions and on policy frameworks implemented to support bioenergy development. Agricultural policy, including the availability of rural infrastructure, credit, and land tenure, will determine the scale and distribution of economic benefits. At the international level, efforts to reduce agricultural subsidies in rich countries and to allow free trade in agricultural commodities are inextricably linked to the development of first-generation[2] liquid biofuels which have become the fastest growing segment of the world agriculture market. Trade reform efforts will both have powerful effects on and be subject to sizable impacts from biofuels expansion.

The development of new bioenergy industries could provide clean energy services to millions of people who currently lack them, while generating income and creating jobs in poorer areas of the world. But rapid growth in first-generation liquid biofuels production will raise agricultural commodity prices

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and could have negative economic and social effects, particularly on the poor who spend a large share of their income on food. In many countries, the current structure of agricultural markets means that the bulk of the profits go to a small portion of the population. Unless ownership is shared more equitably, this divide could become as true for energy commodities as it is for food commodities today. For instance, two companies, Cargill and Archer Daniels Midland, control more than half of the world's grain trade.

Thus, the economic, environmental, and social impacts of bioenergy development must be assessed carefully before deciding if and how rapidly to de-

[2] "First-generation" fuels refer to biofuels made from sugar, starch, vegetable oil, or animal fats using conventional technology. "Second-generation" fuels are made from lignocellulosic biomass feedstock using advanced technical processes.

velop the industry and what technologies, policies, and investment strategies to pursue. Rapid growth in liquid biofuel production will make substantial demands on the world's land and water resources at a time when demand for both food and forest products is also rising rapidly. Liquid biofuel growth has already begun to raise the prices of the world's two leading agricultural feedstock—maize and sugar—and soaring palm oil demand may be leading industrialists in Southeast Asia to clear tropical forests for new plantations.

The ability of various bioenergy types to reduce greenhouse gas emissions varies widely, and where forests are cleared to make way for new energy crops, the emissions can be even higher than those from fossil fuels. Unless new policies are enacted to protect threatened lands, secure socially acceptable land use, and steer bioenergy development in a sustainable direction overall, the environmental and social damage could in some cases outweigh the benefits.

The rapid advance of new crops, farming practices, and conversion technologies now under development may mitigate some of the social, environmental, and economic costs associated with large-scale production of liquid biofuels and increase their potential environmental and economic benefits. The bioenergy field is experiencing an unprecedented wave of research and development, flowing from both the public and private sectors. The timing of commercialization is uncertain, but those countries that have begun to develop bioenergy industries may be the most likely to attract investment and benefit from the resulting technology transfer.

Accelerated interest in bioenergy in the coming years will place great demands on decision-makers to evaluate and guide the development of these new industries. They will need to address chronic structural problems in agriculture, forestry, and the economy so that the economic benefits to the poor outweigh the losses. Brazil, the European Union, and the United States have already demonstrated that government regulations and tax incentives are essential to the development of modern bioenergy. The structure of these and other policies will shape the direction of the new industries in a powerful way.

Section 3: Key Sustainability Issues

Bioenergy is being used all over the world. In some instances it is truly sustainable, and in others it is highly destructive. A wide range of bioenergy types currently exists, as well as a variety of production and utilization systems that have very different social, economic, and environmental impacts. The following eight sections discuss the key issues related to the sustainability of bioenergy and raise critical questions for decision-makers to consider as they evaluate various bioenergy options.

Issue 1 — Ability of Modern Bioenergy to Provide Energy Services for the Poor

INTRODUCTION

No country in modern times has substantially reduced poverty in the absence of massive increases in energy use, and countries with higher incomes and higher human development indexes also tend to be those with higher energy consumption. For the world's poorest households, basic energy services for cooking and heating, lighting, communication, water pumping, and food processing are particularly important. Shifting these basic energy uses from traditional bioenergy (when used in unsustainable and health-damaging forms) to modern fuels and electricity is probably one of the most important and long-lasting challenges.

worries, it establishes a context for transitioning to more sustainable and renewable resource bases in the future. Solar systems such as cookers and water heaters have had some success and will probably continue to enter poor rural societies mainly in the form of subsidised programmes. Modern bioenergy as a solution to lack of energy services by the poor fits in a context that includes many more such solutions—LPG and solar systems as well as microhydro and wind energy, to name a few.

The situation with modern bioenergy systems is more complex to assess due to the variety of options as well as trade-offs among various social, environmental, and economic sustainability goals. Some, such as more efficient cook stoves, may contribute to reduced biomass demand in many countries. Work continues to enhance efficiency, reduce costs, and better understand acceptability. Biofermentation (biogas) systems can be a first-rate solution when the necessary feedstock, water inputs, and knowledge converge. Other systems, such as small-scale biomass gasification, torrification, and charring, are still under development and demonstration, with outstanding examples in some countries. Liquid biofuels such as vegetable oils and biodiesel offer opportunities for power production at relatively small scales and, in particular, for small and medium-size electricity grids at village or community levels. The adaptation of the many existing diesel engines to use these biofuels has