

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION



GLOBAL ENVIRONMENT FACILITY INVESTING IN OUR PLANET

THE ROLE OF BIOENERGY IN THE CLEAN ENERGY TRANSITION AND SUSTAINABLE DEVELOPMENT

LESSONS FROM DEVELOPING COUNTRIES



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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INCLUSIVE AND SUSTAINABLE INDUSTRIAL DEVELOPMENT

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ACRONYMS AND ABBREVIATIONS

ACSD	Albanian Center for Sustainable Development	HHEA	Household Energy Economic Analysis	PDD	Program Design Document
ASEAN	Association of Southeast Asian Nations	ніс	High Impact Countries	РоА	Program of Activities
BEIA	Biomass Energy Initiative for Africa	ISBWG	International Sustainable Bioeconomy Working Group	РРА	Power Purchase Agreement
BRL	Brazilian Real	кмитт	King Mongkut's University of Technology Thonburi	ProAlcool	National Alcohol Program
CCL	Consumer's Choice Limited	KSD	Khongsedone Ltd	PSGF	Private Sector Guarantee Fund
CC-SF	Clean Cooking Social Facility	kW _{et}	Kilowatt electrical	R&D	Research and Development
СНР	Combined Heat and Power	kW _{th}	Kilowatt thermal	RE	Renewable Energy
CO ₂	Carbon dioxide	kWh	Kilowatt-hour	RFS	Renewable Fuel Standard
СОР	Conference of Parties	kWh _{et}	Kilowatt-hour electrical	ROI	Return on Investment
CSTR	Continuous Stirring Tank Reactor	kWh _{th}	Kilowatt-hour thermal	SCIP	Strategic Climate Institutions Program
DC	Developing Country	Lao PDR	Lao People's Democratic Republic	SDG	Sustainable Development Goal
DFID	Department for International Development	LDC	Least Developed Country	SEI	Stockholm Environment Institute
EGM	Expert Group Meeting	LDO	Liquor Distillery Organization Excise Department	SME	Small and Medium Enterprise
EMD	Ethanol Micro Distillery	LHV	Lower Heating Value	SSA	Sub-Saharan Africa
EPA	Environmental Protection Authority	lpd	Liters per Day	SS-TT	South-South Technology Transfer
EUR	Euro	m³	Cubic meter	TBS	Tanzanian Bureau of Standards
FAO	Food and Agriculture Organization of the United Nations	M&E	Monitoring and Evaluation	ТІВ	Tanzania Investment Bank
FIRI	Food Industries Research Institute	MEF	Market Enabling Framework	TPSF	Tanzanian Private Sector Foundation
FIT	Feed-in Tariff	MEL	Monitoring, Evaluation and Learning	US	United States
FWFCA	Former Women Fuelwood Carriers' Association	MW	Megawatt	USD	US dollar
GBE	Green Bio Energy	MWel	Megawatt electrical	VAT	Value Added Tax
GDP	Gross Domestic Product	NDF	Nordic Development Fund	VHG-SSF	Very High Gravity Simultaneous Saccharification and Fermentation
GEF	Global Environmental Facility	NSTDA	National Science and Technology Development Agency	VP	Vegpro
GHG	Greenhouse Gas	Nm³	Normal cubic meter	WB	World Bank
GL	Gigaliter	0&M	Operation and Maintenance	WHO	World Health Organization

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FOREWORD

Reaching the targets set by the Paris Agreement, the 2030 Agenda for Sustainable Development and the related Sustainable Development Goals (SDGs) was always going to be challenging. The emergence and rapid global spread of COVID-19, however, has compounded the situation. While we are still in the midst of the global pandemic, with the true impacts still to be measured in the years to come, it is important to note that despite seemingly insurmountable challenges, we have witnessed unprecedented rapid, collective, transboundary and cross-sector action in the development and rollout of a vaccine; we have witnessed hope - a hope that the deadly virus could be eliminated, but perhaps so too that the world could unite to actively and decisively respond to recovery and fast track the way to SDGs with the same urgency.

It is, therefore, in this light that our efforts to work collectively to promote, advance and mobilize climate technologies must continue with zest. It is clear that knowledge sharing – through channels such as this report – will provide the leverage needed for others to learn, plan and implement their own bioenergy projects, ultimately contributing to our collective efforts in reaching selfreliance in energy and achieving the SDGs.

What follows in this report is an overview of bioenergy projects from around the world, mostly implemented by UNIDO, with funding from GEF. While the scope, technologies, applications, descriptions and results vary, they are united by the goal to achieve reliable, safe and affordable clean energy for people in low income countries, bringing clean energy to some of the world's most vulnerable and under-served people, at the same time, helping to reduce dependency on fossil fuels and the associated greenhouse gas (GHG) emissions. We are pleased to share with you a look into the relatively small, but hugely promising bioenergy sector.

From project planning, development and rollout, to key lessons learned, and a brief analysis of the sector at large, readers will gain helpful insights into what it takes to provide locally available bioenergy solutions at household, community and industrial levels.

While it is true that some of the lessons learned from the featured projects are context-specific – matters relating to political, financial or geographical locations, for example, have resulted in unique approaches – it is also true that we are not only limited to the act of replication for the project to be useful to others. The act of harvesting (taking what is useful) or leveraging knowledge (building on what is there) holds similar value in the face of increasing urgency.

The SDGs will not be reached in isolation and one way to work jointly for meaningful progress is to invest time in knowledge sharing and harvesting. By leveraging the knowledge of a wide range of successful and not so successful bioenergy projects, it may be possible to avoid certain challenges, be more resilient to challenges, save time and money, and ultimately accelerate climate action on the ground.

EXECUTIVE SUMMARY

Over the past decades and in multiple countries, bioenergy has supported the development of local economies, while helping to reduce the dependency on imported fossil fuels. If bioenergy resources are produced sustainably, their energy use can contribute to the reduction of GHG emissions.

Placed within the overall context of bioeconomy, bioenergy represents a major sector, spread across the globe, as bio-residues generated by other bioeconomy sectors are often used as raw material in bioenergy conversion processes. These bio-residues can be either bio-effluents, or solid residues from forestry, farming or wood and agro-industries.

Solid biomass is one of the most used forms of bioenergy. It has been and is still traditionally used for cooking or heating in many countries, especially in developing countries (DCs) and in least developed countries (LDCs). Gaseous or liquid forms of biofuels, such as biogas and bioethanol, are increasingly available and used, as biogas/biofuel projects are being implemented all around the world, using increasing amounts of performant conversion technologies.

Several bioenergy case studies presented in this document provide good examples of successful biomass, biogas, and bioethanol projects. Their key features are presented, together with their success factors and the lessons that can be learned from their implementation. Moreover, their sustainability is the development of the local economy by creating new jobs, using locally available biomass that would often be left to rot, and (b) to the reduction of deforestation and mitigation of GHG emissions. It is key to use simple, if possible, locally made and fully proven equipment, and make sure that there is enough raw material and sufficient funding to sustain the projects.

In the chapter on biogas, different applications, based on various types of waste, are presented:

- cogeneration from the use of biogas produced from avocado waste in Kenya;
- cogeneration from biogas produced from swine and food waste in Brazil; and
- diesel substitution by biogas for power generation in Kenya.

All these biogas projects use proven technologies and well-trained personnel. They are commercial projects in which local investors expect to fully cover their own energy requirements. They have the confidence of financial institutions (banks and international donors), as their financial proposals were strong, and as the quality and quantity of the feedstock supply as well as the off-take of the produced energy (heat and/or power) had already been secured. They offer a great replication potential.

In the chapter devoted to liquid biofuels, all the projects are bioethanol projects:

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