IRENA INNOVATION WEEK 2025

Innovative Business Models for Bioenergy in Global South

Organised in partnership with:

WORLD BIOENERGY ASSOCIATION

13 June 2025 | 09:00-10:30

#IIW2025

IRENA INNOVATION WEEK 2025

Opening remarks

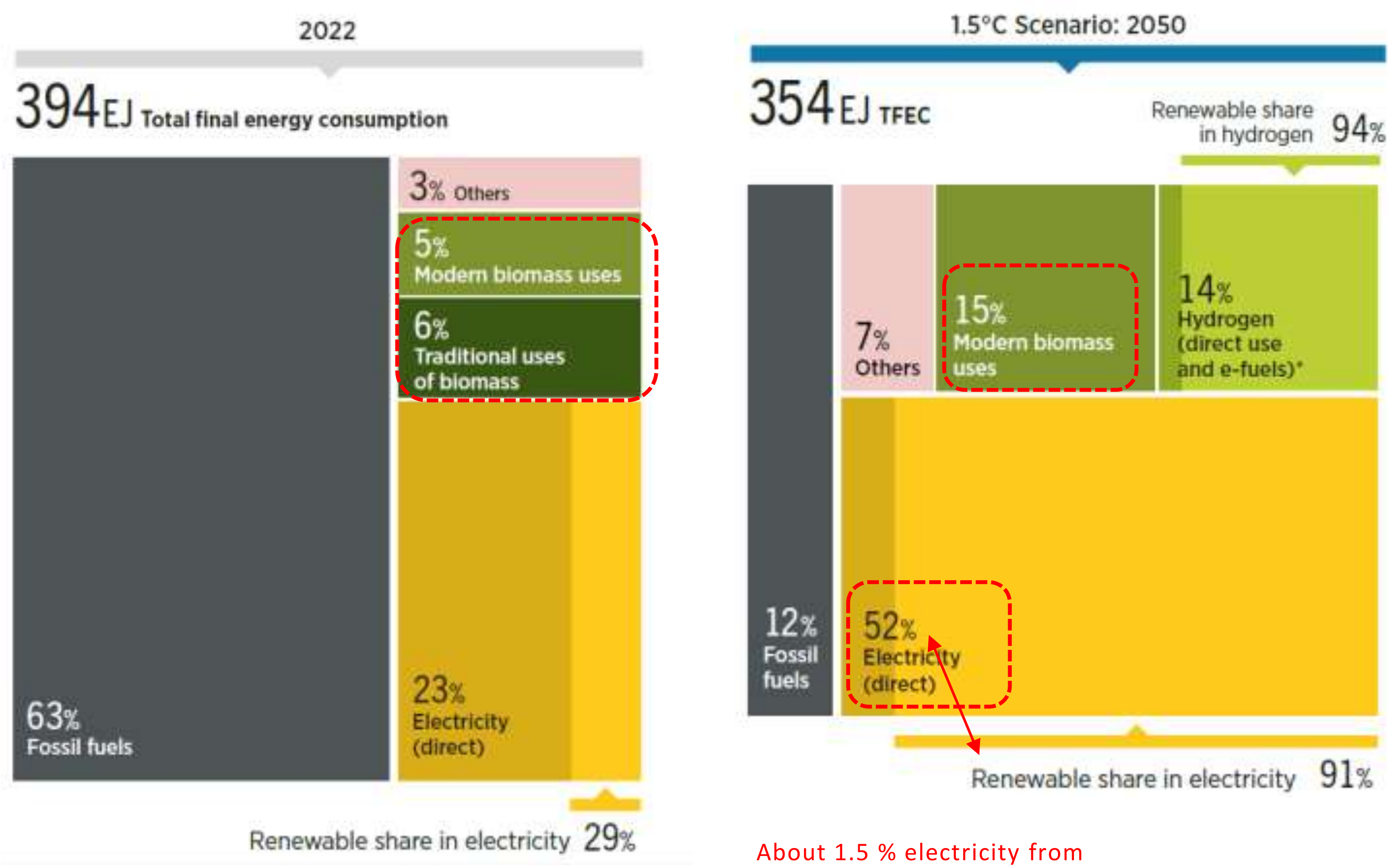
Ricardo Gorini, DSc.

Head REmap & Bioenergy
IRENA

#IIW2025

Role of bioenergy in energy transitions

FIGURE 1.3 Breakdown of total final energy consumption by energy carrier between 2022, 2030 and 2050 under the 1.5°C Scenario

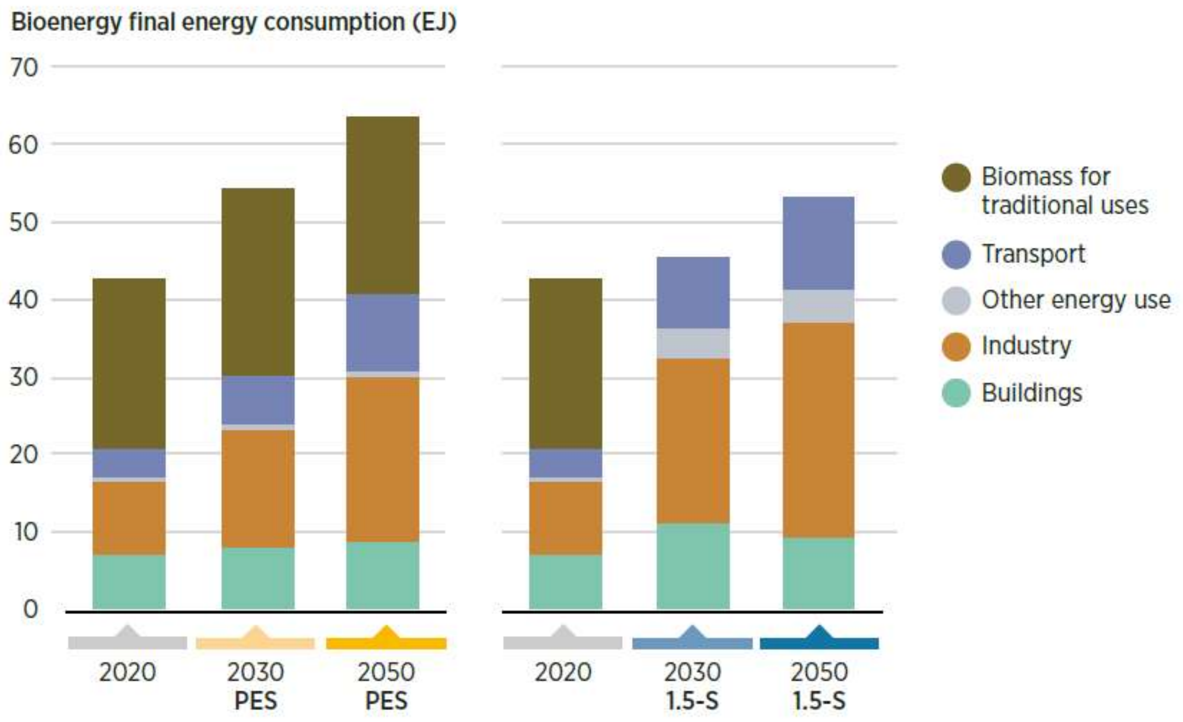


About 1.5 % electricity from bioenergy
(3.1% of total Electricity)

- Traditional biomass would need to be phased out
- Modern bioenergy may reach 15% of the total energy mix by 2050
- Bioenergy may further contribute 1.5% via electricity generation

Sectorial contribution – Overview

FIGURE 2.8 **Bioenergy final energy consumption by sector in 2020, 2030 and 2050 under the Planned Energy Scenario and 1.5°C Scenario**



Notes: 1.5-S = 1.5°C Scenario; EJ = exajoule; PES = Planned Energy Scenario.

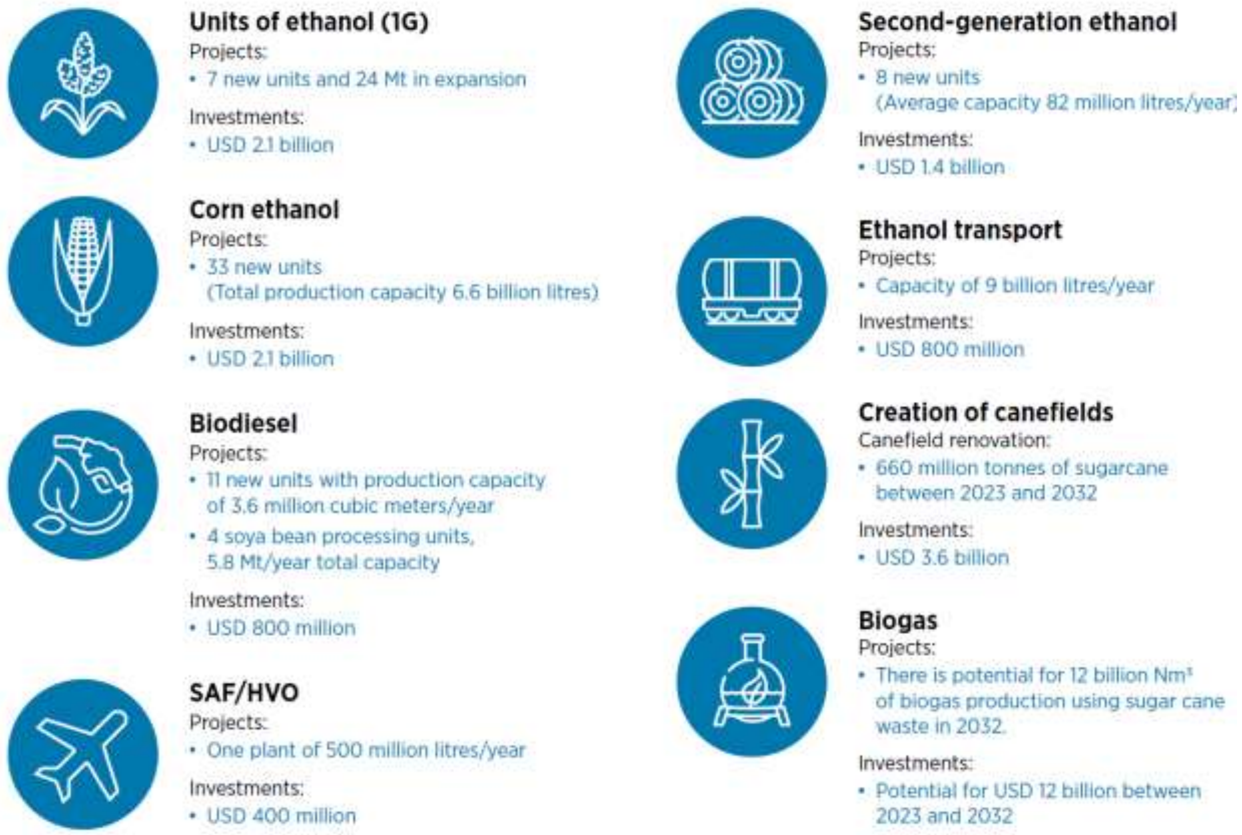
Key changes from 2020-2050 in 1.5-S:

- A complete shift from traditional biomass to modern bioenergy
- A steady growth in transportation biofuels, including sustainable aviation and shipping fuels
- A much larger increase of bioenergy use in Industry compared to PES
- About **USD 204 billion per year** of investment would be needed to achieve the 1.5-S scenario by 2050 [biofuels and biomass-power]

Investment is key- Case of Latin America

- IDB estimated [Latam] that an annualised investment of USD 45 billion is required in biofuels up to 2050.
- Overcoming challenges:
  - Define an appropriate legal framework
  - Implement a bioenergy market
  - Progressively develop and diversify products and markets
  - Innovation – value chain
  - Develop and promote the benefits

Figure 2 Expected investment in biofuel production in Brazil to 2032



Source: "Situation and outlook for bioenergy in Brazil", presented by Solange O. da Costa, EPE, at the workshop.

Notes: Mt = million tonnes; Nm^3 - A standard cubic meter, *i.e.* the amount of a gas contained in a volume of 1 m^3 at 1.01325 bar and 0 °C.

Source: IRENA (2023) Sustainable bioenergy pathways in Latin America: Promoting bioenergy investment and sustainability

IRENA INNOVATION WEEK 2025

Presentation

Bharadwaj Kummamuru

Executive Director
World Bioenergy Association (WBA)

#IIW2025

Innovation to unlock bioenergy potential in India

Bharadwaj Kummamuru

Executive Director, World Bioenergy Association

IRENA Innovation Week 2025

Bonn, Germany (13 June 2025)

Energy situation in India

Challenge

- One of the fastest growing economies with largest population in the world
- Increasing energy demand among all end use sectors
- Significant imports (90% of oil) and over reliance on coal power (70 – 75%)
- Issues with air pollution due to stubble burning

Opportunities

- Approx 700 million tonnes of residues produced annually
- Presence of large agro processing industries (e.g. sugarcane) – more residues available
- Favourable policies and political will for exploring alternative sources of energy: e.g. Net Zero by 2070, RE capacity targets

Bioenergy in India – status

- Important, yet neglected
- Power Sector
  - Total Capacity: 11.6 GW - only 27% of potential utilized
  - Predominantly sugarcane bagasse
- Transport
  - Slow uptake in the past, rapid consumption to E15/E20
  - CBG gaining prominence
- Other sectors
  - Industrial decarbonization – Beverage, Pharma, Cooking

Year	Small Hydro Power	Wind Power	Bio-Power		Solar Power	Total RES Capacity
			BM Power/ Cogeneration	Waste to Energy		
2014-15	4.06	23.44	8.31	0.24	3.99	40.04
2015-16	4.27	26.78	8.67	0.25	7.12	47.09
2016-17	4.38	32.28	8.84	0.28	12.78	58.56
2017-18	4.49	34.15	9.36	0.31	22.35	70.65
2018-19	4.59	35.63	9.78	0.32	29.10	79.41
2019-20	4.68	37.74	9.88	0.35	35.60	88.26
2020-21	4.79	39.25	10.15	0.39	41.24	95.80
2021-22	4.85	40.36	10.21	0.48	54.00	109.89
2022-23	4.94	42.63	10.25	0.55	66.78	125.16
2023-24	5.00	45.89	10.36	0.59	81.81	143.64
Gr (2014-15 to 2023-24)	23.15%	95.78%	24.67%	145.83%	1950.38%	258.74%
CAGR (2014-15 to 2023-24)	2.34%	7.75%	2.48%	10.51%	39.88%	15.25%

Source: MNRE, India

Challenges for scaling up bioenergy

- Supply Side Challenges
  - Feedstock aggregation
  - Cost
  - Quality
  - Seasonality
- Other aspects
  - Safety
  - Technical expertise
  - Affordable finance

Innovations to overcome challenges

- **Co location** of pellet mills at power plants – finance available
- **Mobile pelletizers** for pellet production at farm
- Setting up **agri hubs/aggregators** for easing supply chain issues
- Digital **marketplaces** for trading biomass feedstock
- Tabletop **quality control machines** with blockchain enabled
- **Heat as a service** for industries

Digital marketplace – Biofuel Circle

Tabletop analyser with Blockchain/App

Mobile pelletizers

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IRENA INNOVATION WEEK 2025

Presentation

Michela Morese

Senior Natural Resources Officer & Energy Team Leader
Food and Agriculture Organization of the United Nations (FAO)

#IIW2025

Food and Agriculture Organization of the United Nations

Energy-Smart Agrifood Systems for Development and Climate Actions

Innovative bioenergy solutions in agrifood systems

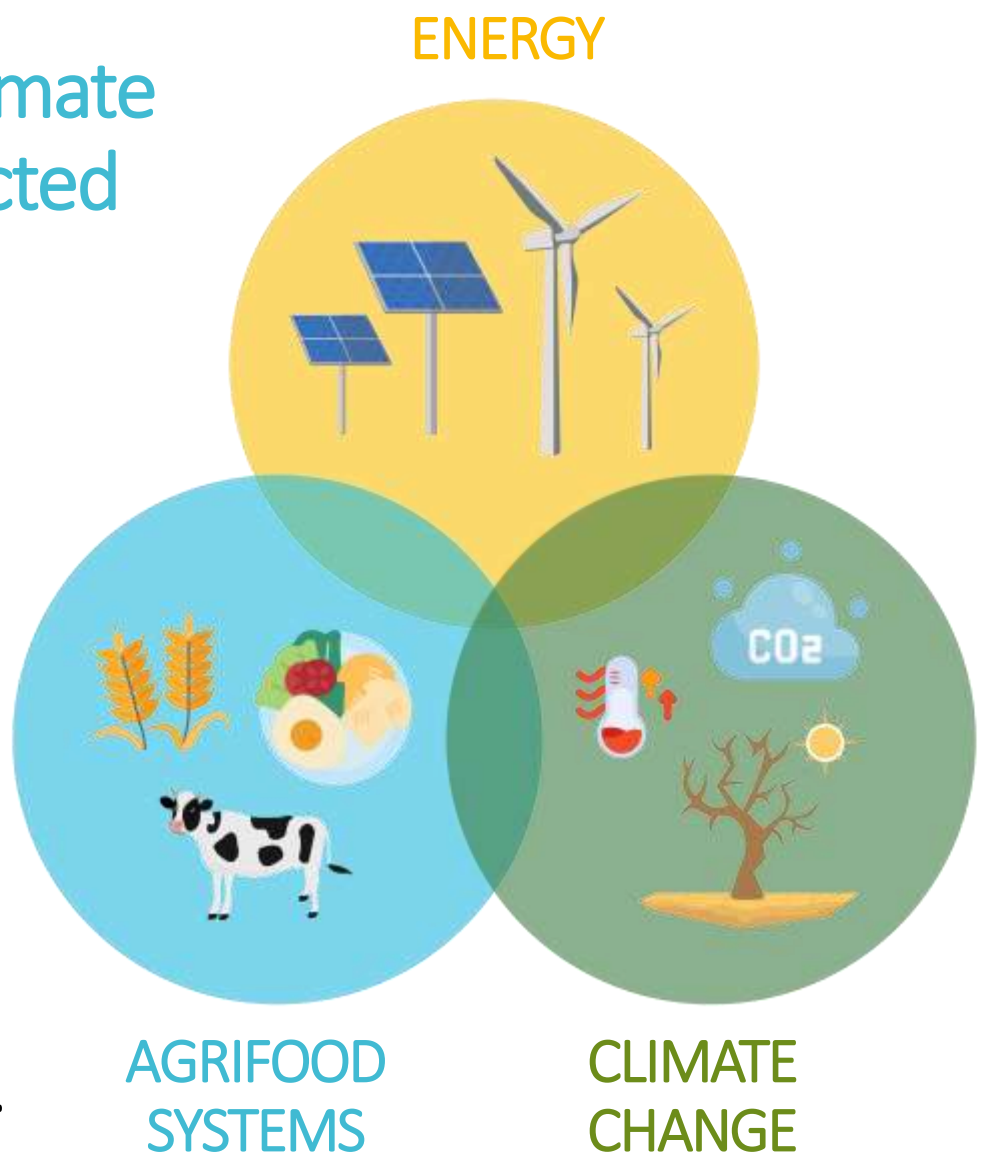
Dr. Maria Michela Morese
Senior Natural Resources Officer
Energy Team Leader

Office of Climate Change, Biodiversity and Environment (OCB)
Food and Agriculture Organization of the United Nations (FAO)

Agriculture, energy security and climate change are intrinsically interconnected

- Agrifood systems need energy at each step of the value chain
- 30% of the world energy is used within agrifood systems
- This energy use produces 31% of total GHG emissions impacting on climate change
- About 1/3 food is lost or wasted after farm gate → 38% of energy equally wasted

Energy-smart agrifood system solutions are key.



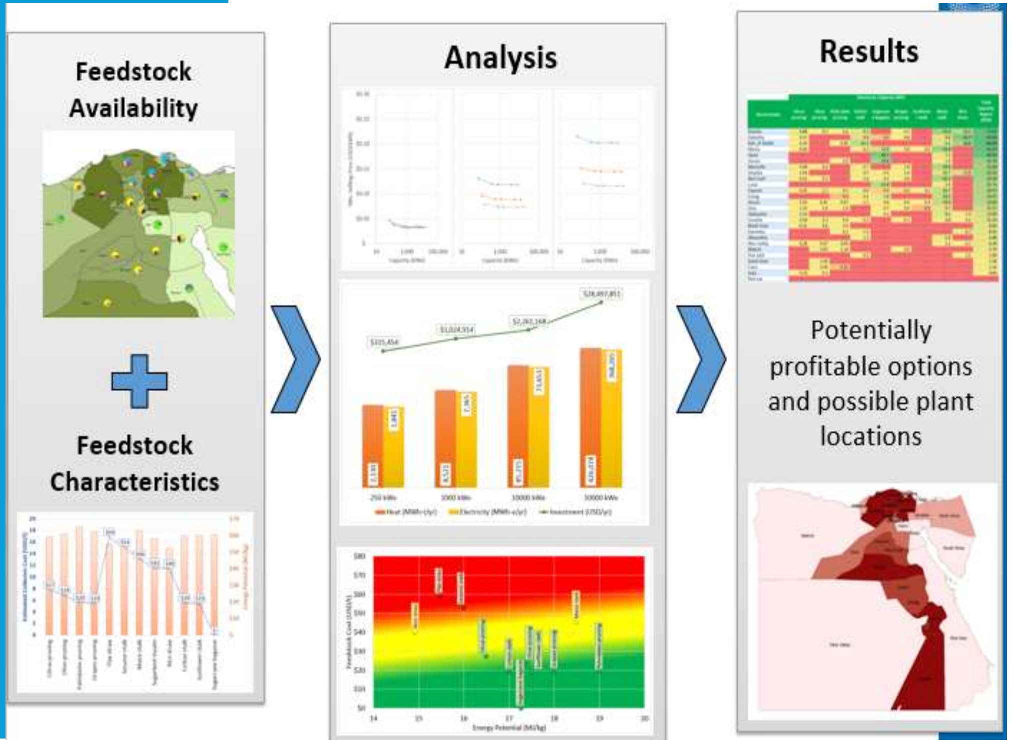
Our role

Provide energy-smart solutions at each step of the value chain to help transform the agrifood systems (very energy intensive and mostly fossil fuel based) to sustainably feed a global population of almost 10 billion by 2050

Agriculture is part of the solution.

FOCUS ON BIOENERGY SUSTAINABILITY

BEFS Assessment Approach - EX-ANTE



GBEP Sustainability indicators - EX-POST

ENVIRONMENTAL

1. Life-cycle GHG emissions
2. Soil quality
3. Harvest levels of wood resources
4. Emissions of non-GHG air pollutants, including air toxics
5. Water use and efficiency
6. Water quality
7. Biological diversity in the landscape
8. Land use and land-use change related to bioenergy feedstock production

SOCIAL

9. Allocation and tenure of land for new bioenergy production
10. Price and supply of a national food basket
11. Change in income
12. Jobs in the bioenergy sector
13. Change in unpaid time spent by women and children collecting biomass
14. Bioenergy used to expand access to modern energy services
15. Change in mortality and burden of disease attributable to indoor smoke
16. Incidence of occupational injury, illness and fatalities

ECONOMIC

17. Productivity
18. Net energy balance
19. Gross value added
20. Change in consumption of fossil fuels and traditional use of biomass
21. Training and re-qualification of the workforce
22. Energy diversity
23. Infrastructure and logistics for distribution of bioenergy
24. Capacity and flexibility of use of bioenergy

FAO's CASE STUDIES

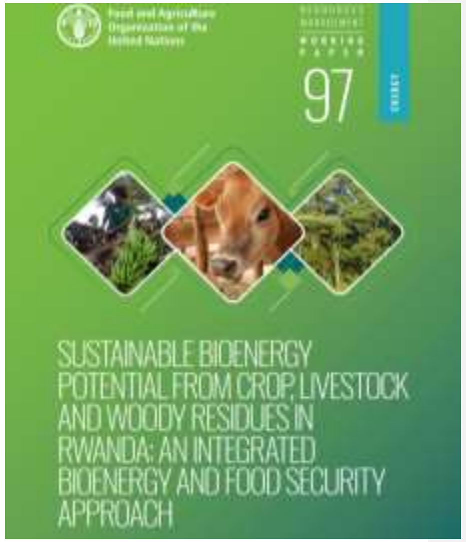
1. **Clean Cooking** in **Rwanda** and **Zambia**
2. **Biogas in the dairy value chains in East Africa: Kenya**, **Rwanda**, **Uganda** and **Tanzania**
3. **Biogas from livestock, cattle, vegetable markets and urban dumpsites** in the **Gambia**
4. **Biogas from pig manure and organic waste in the Solomon Islands**
5. **Biogas from organic waste in Vanuatu**
6. **Rice straw in India**
7. **Bioethanol from sugarcane and corn in Paraguay**

1. Clean cooking in Rwanda and Zambia

Rwanda

- BEFS Assessment of **potential to produce sustainable bioenergy** in Rwanda using crop, livestock and woody residues.
- **Cooking fuels:** total potential energy from **biomass pellets and biogas** could reach ~13K TJ/year and lead to **33 percent increase in access to clean cooking fuels**.

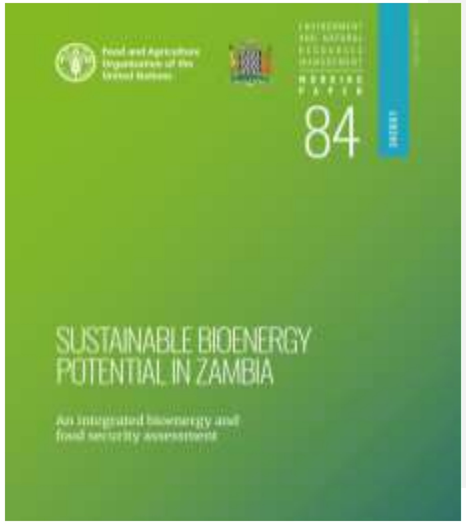
Investment
- 10 USD/tonne/yr for biomass pellets → ~7.5 ml USD
- 0.44 USD/m^3/yr for biogas → ~1 ml USD



Zambia

- BEFS Assessment of **potential to produce sustainable bioenergy** for off-grid electricity, clean cooking and heating, and production of liquid biofuels.
- **Cooking fuels: briquettes and biogas** from agriculture residues could reach ~16K TJ/year and **meet up to 12 percent of the country's clean cooking fuel target**.

Investment
- 19 USD/tonne/yr for biomass briquettes → ~ 6.5 ml USD
- 20 USD/tonne/yr for charcoal briquettes → ~ 8.5 ml USD
- 0.62 USD/m^3/yr for biogas → ~68.5 ml USD



2. Biogas in the dairy value chains in East Africa Kenya, Rwanda, Uganda and Tanzania

- Explore the **potential of biogas production using manure from dairy industries** in **Kenya, Rwanda, Tanzania** and **Uganda** --> readiness for a GCF project just approved!
- Estimate **economic benefits, GHG mitigation and green jobs** creation potential.
- Provide **recommendations to support investments and facilitate** their implementation.

Key Results

- ✓ Promoting biogas systems for dairy farms or industries would require an ***average capital investment ranging from 1.3 – 19 million USD per country*** (depending on adoption rate)
- ✓ The introduction of biogas systems across the dairy value chain could ***generate approximately on average 3 000 – 44 000 green jobs*** across the four countries.
- ✓ When replacing grid electricity, the ***average GHG savings range between 2 000 – 30 000 tonnes CO_2eq/year***, while replacing diesel-powered electricity could achieve ***savings of 4 000 – 60 000 tonnes CO_2eq/year***
- ✓ The ***Levelized Cost of Carbon Abatement (LCCA)*** demonstrates the technology's cost-effectiveness for reducing emissions:

  Tanzania achieving the lowest carbon reduction costs (3 USD/tonne CO_2eq), followed by Uganda (84 USD/tonne CO_2eq), Rwanda (88 USD/tonne CO_2eq), and Kenya (146 USD/tonne CO_2eq).

Source: FAO, 2025 (in publication stage)

3. Biogas from livestock, cattle, vegetable markets and urban dumpsites in the Gambia

CASE STUDIES 15 yrs project lifespan	Feedstock	Biogas potential m3/year	CAPEX (investment) USD	NPV Net Present Value to shareholders 15 years	IRR Internal Rate of Return	Payback period	Mitigation tCO2e 15 yrs	Carbon reduction cost USD/tCO2e 15 yrs
Poultry and dairy farm (small-scale)	Manure	180 000	**210 000**	210 000	**14,2%**	7 yrs	15 800	13
Cattle market and slaughterhouse (medium-scale)	Manure, Wastewater	376 300	**110 000**	92 000	**11,9%**	8 yrs	5 000	22
Fish and vegetable market (medium-scale)	Fish and vegetable waste	291 000	**290 000**	357 000	**17,3%**	6 yrs	25 800	11
Dumpsite (large-scale)	OFMSW	1 315 000	**1 250 000**	610 000	**11,1%**	9 yrs	77 500	16
		2 162 300	**1 860 000**				**124 100**	**~ 15**

Source: FAO-UNDP, 2024

4 CASE STUDIES

Total Investment
1,8 ml USD

Total biogas
m3/15yrs
32,5 ml

GHG savings
124 100
tCO_2eq/15yrs

Average Carbon Reduction Cost
USD 15/tCO_2eq/15yrs

4. Biogas from pig manure and organic waste in the Solomon Islands

CASE STUDIES 25 yrs project lifespan	Feedstock	Biogas potential m3/year	Electricity produced kWh/year	CAPEX (investment) USD	NPV Net Present Value to shareholders 25 years	IRR Internal Rate of Return	Payback period
Outback piggery (small scale)	Manure	14 000	30 000	**24 000**	46 500	**27,9%**	5 yrs
Ranadi Landfill Guadalcanal province (large scale)	Organic waste	1 740 000	3 800 000	**4 100 000**	8 300 000	**31,9%**	4 yrs

Source: FAO-UNDP, 2024

2 CASE STUDIES

Total Investment
4,2 ml USD

Total biogas
m3/25yrs
45 ml

5. Biogas from organic waste in Vanuatu

- Waste management is a major challenge
- **Lack of waste management systems** leads to unregulated dumping, environmental pollution, GHG emissions, and health risks from burning and leaching
- Open burning of waste releases Persistent Organic Pollutants (**POPs**)
- **Organic waste** (40–60% of landfill mass) and **plastic waste** (30%) are major contributors

↓

Waste-to-Energy systems to convert organic waste into **biogas** for electricity

Unsegregated waste burning in informal dumpsite

Waste from tourism sector ~2,600 tonnes/year → Biogas plant capacity potential: ~ 42 kW

→ Emissions reduction:

- CO_2eq: ~500 tonnes/year
- POPs: ~2.5 million µg of TEQ/year

→ Investment needed ~ 450-500K USD

6. Rice straw in India – from waste to value

→ An estimated 500 Mt of crop residues are generated annually across India

→ Even just 30% of rice straw in Punjab can contribute to REACH STATE TARGETS:

Pellets

- NTPC (National Thermal Power Company) is India's largest coal consumer power producer.
- NTPC aims to use pellets made from biomass to co-fire with coal
- National Target – 5 million tonnes of pellets are expected to be used per year

Ethanol

India Ethanol blending program

- Aims to achieve E20 by 2025
- Both 1G and 2G ethanol envisaged
- Multiple feedstock expected to be utilized
- Need to produce around 9 billion litres to reach the E20 target by 2025.

Compressed Biogas

- Sustainable Alternative Towards Affordable Transportation (SATAT) scheme aims to increase production of compressed biogas in the country as transport fuel
- Planned to roll out 5 000 CBG plants by 2024
- The target is set to produce 15 million tonnes of CBG per year

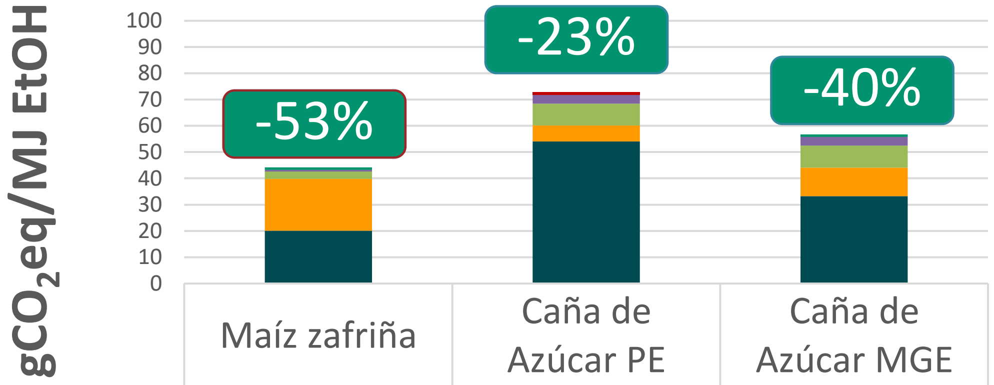
7. Bioethanol from sugarcane and corn in PARAGUAY

- Bioethanol production **278 ml Lts in 2016** (56% from grains – 44% from sugarcane)
- It accounted for around **28% of total gasoline consumption**, reducing country dependence on fossil fuel imports.

Sustainability assessment

- Crop yield:
  - Sugarcane yield is one of the lowest in the region (2016 - PY 56t/ha - PERU 120 t/ha)
  - Maize yield is low (4,7 t/ha) and can be further improved
- Sustainable intensification (production)
- Land Use Change is determining factor in terms of good practices: corn in crop rotation reduces impacts compared with sugarcane (monocrop)

GHG emissions savings Ethanol vs Gasoline



	Maíz zafriña	Caña de Azúcar PE	Caña de Azúcar MGE
Use	0.97	0.97	0.97
Processing	0.64	3.36	3.36
Transport	2.84	8.30	8.31
Cultivation	19.73	6.12	10.86
LUC	20.06	54.07	33.27

FAO, 2018

Highest GHG emission savings for corn-based ethanol

Thank you

Office of Climate Change, Biodiversity and Environment
www.fao.org/climate-change
www.fao.org/biodiversity

FAO

IRENA INNOVATION WEEK 2025

Presentation

Gabriele Giannini

Head of Africa Agri Business
Eni

#IIW2025

Agri-feedstocks for biofules production

Eni distinctive model

June 2025

Agenda

Net Zero By 2050

Eni Pathway Towards Carbon Neutrality

NET ZERO TARGETS

	2030	2035	2050
Net carbon footprint upstream Scope 1+2 equity boundary ($MtCO_2eq.$)	NET ZERO UPS		
Net carbon footprint Eni Scope 1+2 equity boundary ($MtCO_2eq.$)		NET ZERO ENI	
Net GHG lifecycle emissions Scope 1+2+3 equity boundary ($MtCO_2eq.$)			NET ZERO
Net carbon intensity Scope 1+2+3 equity boundary ($gCO_2eq./MJ$)			NET ZERO

Intermediate targets

- ✓ 2024: - 55% vs. 2018 baseline
- 2040: - 80% vs. 2018 baseline
- 2040: - 55% vs. 2018 baseline

DECARBONIZATION LEVERAGES

Upstream

Gas component over 60% by 2030 and >90% by 2050

Methane emissions close to zero by 2030

Downstream

>5 million tonnes of biofuel production capacity by 2030

↑

Agri-feedstock

Renewables

15 GW in 2030 and 60 GW in 2050 of installed capacity

40k electric vehicle charging points by 2030 and ~160k by 2050

Carbon Capture and Storage (CCS)

>15 Mton CO2 Storage Capacity in 2030 to reach ~60 Mton CO2/y by 2050

Carbon Offset

~15 Mton CO2/year from carbon offsets in 2030

Source: Eni for 2024

A distinguishing model

AGRICULTURAL PRODUCTION



SMALL FARMERS
Cultivation of non-food crops on degraded land (according to EU RED)

LARGE FARMERS
Cover and intermediate crops after cereal production

AGRO PROCESSING & AGRO-FORESTRY
Residues and food rejects

AGRICULTURAL SUPPLY CHAIN

Cultivation entrusted to farmers on their own lands

Capacity building targeting the best agricultural practice and **carbon farming**

Access to market & socio-economic development in rural areas

Sustainable agricultural Land Management (**SALM**)

Model Farm promoting the best agricultural practices, pilot fields, training and transfer of knowledge

INDUSTRIAL PLANTS
AGRI HUB (OIL EXTRACTION PLANTS) & THIRD PARTY EXTRACTION SERVICE (TOLLING)

VEGETABLE OIL
Feedstock for bio refineries

BY PRODUCTS
Animal feed and fertilizers

INDUSTRIAL PLANTS

Industrial model **flexibility**

Agri -Hub standardization

Food security with animal feed & fertilizer

Local content and transfer of **industrial know-how**

WASTE & RESIDUES

WASTE & RESIDUES SUPPLY CHAIN

In country **collection of agro-industrial waste and residues**

Vertical integration with bio-refinery system

Agri-Feedstock Projects

Initiatives to develop the biofuel supply chain based on circular economy models

ONGOING INITIATIVE
9 countries (5 in Africa)

IN EVALUATION
2 countries

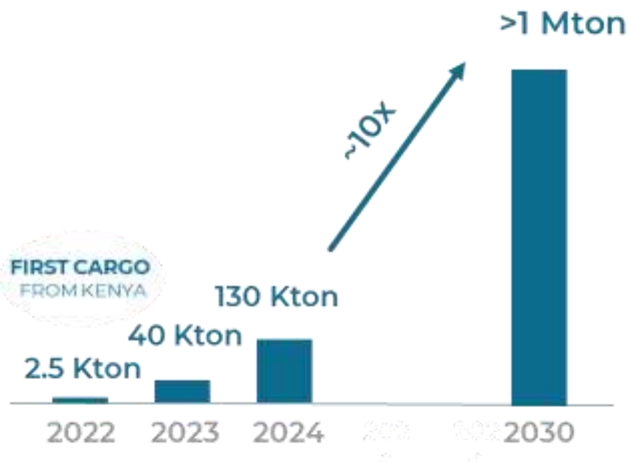
SCOUTING: more than 10 geographies in Far East, East EU, Africa and Americas

Mother Fields

CURRENT BIOREFINERIES ENILIVE

ENI UPSTREAM PRESENCE

PRODUCTION



NUMBER OF FEEDSTOCK

3 → > 10 → > 20

TARGETS BY 2030

CULTIVATED LAND
~1 M hectares regenerated and valorized

FARMERS
~700k involved with opportunity for long term, stable additional revenues

CIRCULAR ECONOMY
>1 Mton animal feed and fertilizers to support food security

THANK YOU

Presentation

Verena Brinkmann

Component Lead Promotion of Climate-Friendly Cooking: Kenya and Senegal
EnDev/GCF

Verena Brinkmann
Lead of Global Component

“Innovative business models to accelerate adoption of modern cooking solutions”

a contribution of
Energising Development (EnDev) & Promotion of Climate-Friendly Cooking: Kenya and Senegal (EnDev/GCF)

Innovative business models for bioenergy in the Global South
IRENA Innovation Week 2025
Bonn 13.06.2025

Content

- Role of biomass in energy access
- Solutions: Strategies for reducing consumption of traditional biomass
    - Alternative fuels
    - Efficient technologies

- Innovative business models to accelerate adoption of modern cooking technologies

endev 20 years

Role of biomass in energy access

- Primary Energy Source for Cooking and Heating
  → traditional biomass provides energy access to ~2.1 bn people
- **Transition to Modern Biomass**
  → cleaner and more efficient technological solutions improve energy access
- Electricity Generation
  → biomass may be used for powering rural mini-grids
- Supporting Livelihoods
  → biomass energy supports productive uses
- Renewable and Locally Available
  → Depending on production and supply features

- Challenges
  - Environmental concerns, like forest and land degradation from unsustainable harvesting.
  - Health risks from smoke if not used cleanly.
  - Need for investment in cleaner biomass technologies and infrastructure.

Solutions: Strategies for reducing consumption of traditional biomass

a) promotion of alternative fuels

b) acceleration of modern biomass technologies

endev 20 years

EnDev‘s contribution to the solution

Scaling markets for cooking energy.

Range of technical solutions:
- From promotion of alternative fuel solutions,
- To acceleration of modern biomass technologies

Transition to clean fuels: EnDev is contributing to a sector-wide transformation to cooking with electricity.

Leave No One Behind (LNOB): Biomass-based cooking solutions remain relevant on the path to the cleanest possible cooking solutions.

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Energising Development (EnDev) at a glance

Since 20 years, the strategic partnership EnDev provides access to climate-friendly energy in 20 countries, contributing directly to SDG 7

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Key achievements

33.9 million

people with access to modern energy

of which

26.1 million

people with access to modern cooking solutions

of which

7.8 million

people with electricity

113,480

micro, small and medium-sized enterprises with access to modern energy for productive uses

35,480

social institutions with access to modern energy

3.02 million

tons of CO_{2e} mitigated in 2024

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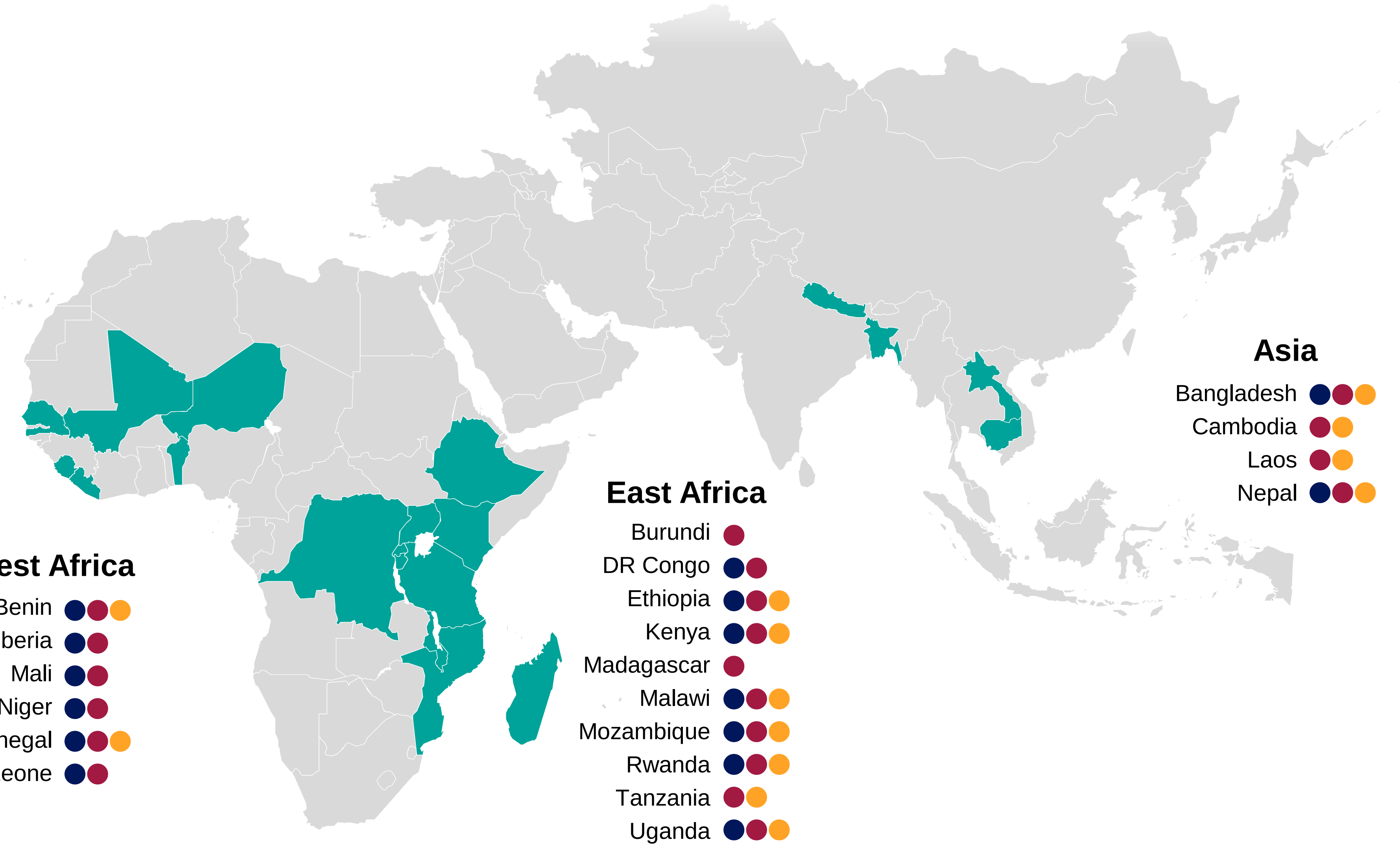
As of 12/2024

Country portfolio in 2025



West Africa

Country	Electrification	Cooking	eCooking
Benin	●	●	●
Liberia	●	●	
Mali	●	●	
Niger	●	●	
Senegal	●	●	●
Sierra Leone	●	●	

East Africa

Country	Electrification	Cooking	eCooking
Burundi		●	
DR Congo	●	●	
Ethiopia	●	●	●
Kenya	●	●	●
Madagascar		●	
Malawi	●	●	●
Mozambique	●	●	●
Rwanda	●	●	●
Tanzania		●	●
Uganda	●	●	●

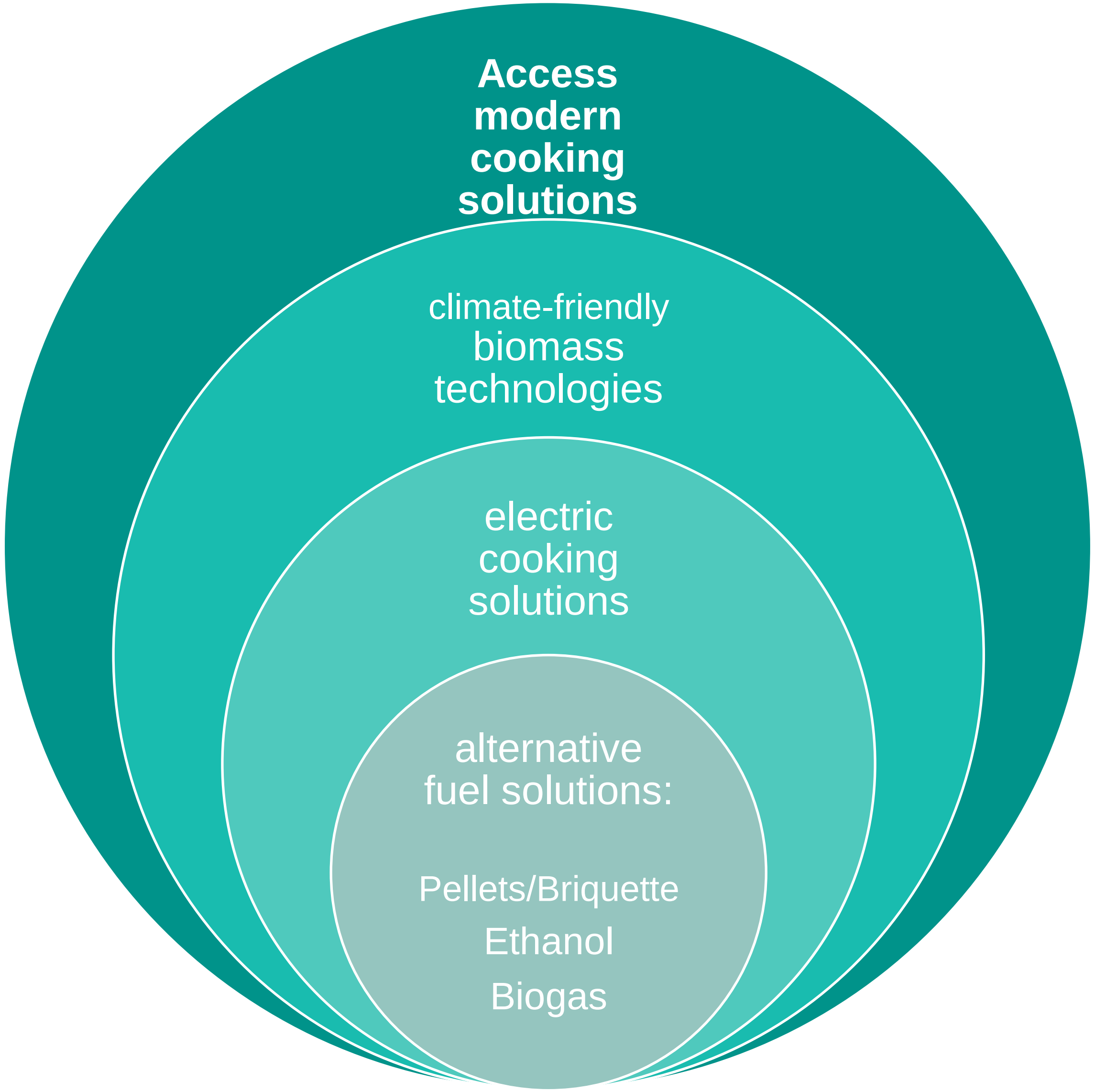
Asia

Country	Electrification	Cooking	eCooking
Bangladesh	●	●	●
Cambodia		●	●
Laos		●	●
Nepal	●	●	●

Technology mix: Electrification · Cooking · eCooking

Access modern cooking solutions

- Access to modern cooking solutions is an inclusive concept.
- The **strategic focus area: Higher-tier access** states a clear ambition towards higher tier cooking solutions.
- Within the scope of EnDev, higher tier includes electric, pellet, ethanol and biogas cooking.
- The higher tier portfolio has significantly increased over the past 5 years



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Solutions: Strategies for reducing consumption of traditional biomass

a) promotion of alternative fuels

b) acceleration of modern biomass technologies

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GREEN CLIMATE FUND

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DEUTSCHE ZUSAMMENARBEIT

Promotion of Climate-friendly Cooking: Kenya and Senegal

EnDev/GCF's contribution to the solution

Scaling markets for cooking energy:

Focus on acceleration of modern biomass technologies

Innovative business models:

How climate-friendly cooking interventions can accelerate sector growth, transform cooking markets and contribute to climate change mitigation at once!

Implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

MINISTRY OF ENERGY

CONCEPT

enda ECOPOP

enda énergie

ENERGY4IMPACT

Practical ACTION

In Cooperation with

Chambre des Métiers

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Why Climate-Friendly Cooking?

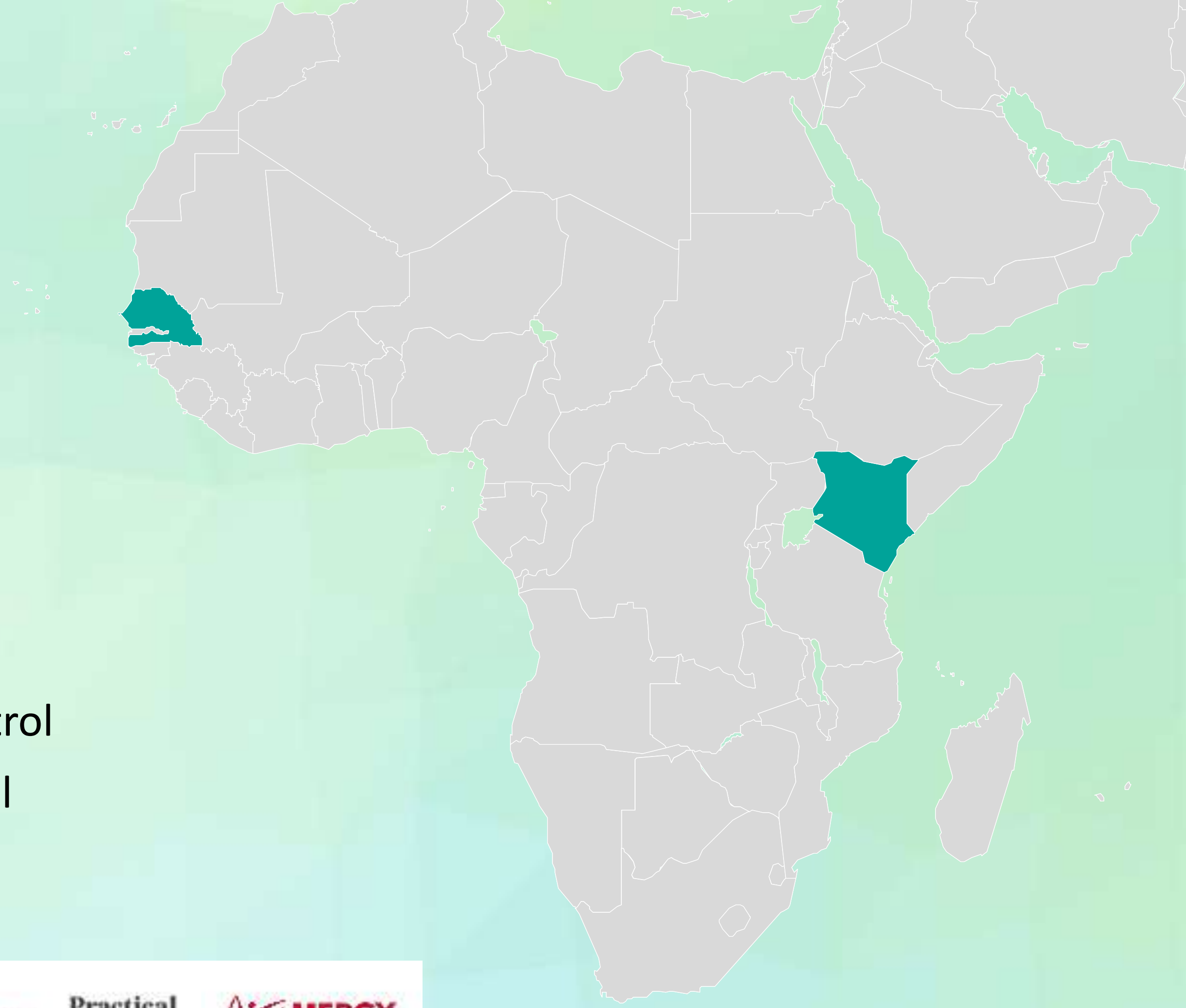
Traditional cooking practices have climate mitigation potential (targets incl. in countries' NDCs), reducing CO_2 emissions and the pressure on forests, plus gender, economic, health **co-benefits.**

Scaling of "clean" cooking with electricity or LPG requires **massive investments and time**, while still households tend to stack with biomass.

Potential for Fast scaling of national stove markets by professionalizing ICS production and establishing national MRV systems.

Promotion of Climate-friendly Cooking: Kenya and Senegal at a glance

- **Thematic focus**:
  Reducing emissions by promoting climate friendly/efficient cooking technologies
- **Components**:
  Kenya, Senegal, Global
- **Duration**: 5 years (2020 to 2026)
- **Funded by**: BMZ & Green Climate Fund (GCF)
- **GIZ**: Accredited Entity & Executing Entity
- **Political Partners**:
  - Kenya: National Treasury, Ministry of Energy and Petrol
  - Senegal: Ministry for the Environment and Ecological Transition, Ministry of Energy, Petroleum and Mines
- **Executing Enteties/Implementing Partners:**



Project Goal & Impact Indicators

- Remove market barriers to reach **exponential growth** of ICS sales
- Reduce domestic GHG emissions at a scale for **achieving NDC targets**
- Reach an **irreversible market transformation** with ODA independent market growth

	Senegal	KENYA	Total
Direct GHG Emission reductions, tCO2	**1.083.396**	**5.385.254**	**6.468.650**
Indirect GHG emission reductions, tCO2	4.318.887	20.453.486	24.772.373
Total GHG emission reductions, tCO2	5.402.282	25.838.740	31.241.023
GCF Euro/tCO2e - direct	**17**	**4**	**6**
GCF Euro/tCO2e - total	3	1	1
Direct: project life-time:			
Total # households	315.719	1.595.607	**1.911.327**
Total # beneficiaries	3.251.907	7.978.037	**11.229.944**
Total # female beneficiaries	1.609.282	3.911.351	**5.520.633**
Share of beneficiaries in total population, %	21%	16%	
Total # women-headed households	94.716	510.594	**605.310**
Total # children	1.420.736	4.148.579	**5.569.315**
Indirect: post project to 2030			
Total # households	808.482	4.366.744	**5.175.226**
Total # beneficiaries	8.327.368	21.833.718	**30.161.086**
Total # female beneficiaries	4.120.993	10.704.303	**14.825.296**
Share of beneficiaries in total population, %	54%	45%	
Total # women-headed households	242.545	1.397.358	**1.639.903**
Total # children	3.638.170	11.353.533	**14.991.704**
Leveraged financing: Revenue from sales to ICS consum	44.533.662 €	92.085.221 €	**136.618.883**

Current Results 12/2024

1,639,131 tCO2eq GHG emission reduction annually (ex-post-calculation)

1,561,303 ICS sold in Kenya and Senegal in year 2024

12,649,606 individuals with improved access to low-emission energy sources

2,647 jobs created in the ICS value chain in 2024

Success factors of the projects

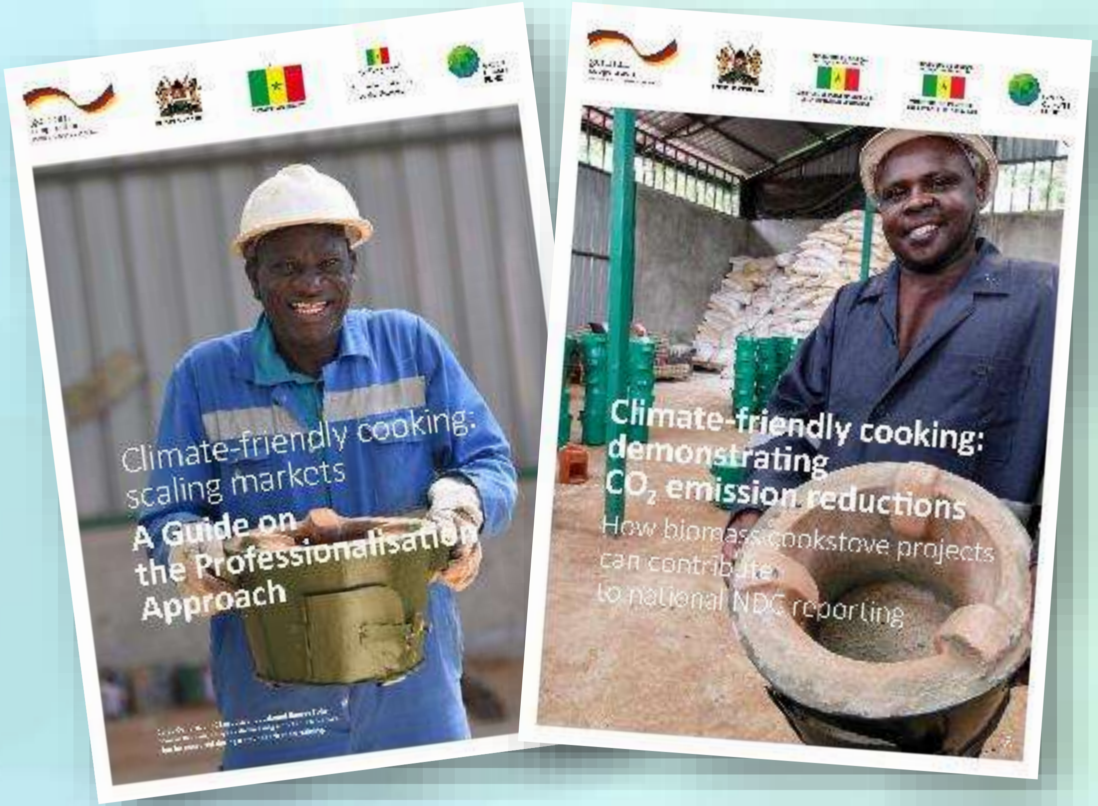
The Professionalisation Approach

- **Starting point**: hundreds of artisanal and few semi-professional stove producers.
- **Performance based** support packages.
- **Objective:** promote 5-20 producers with sufficient capacity and track record to access commercial and carbon finance.
- **Achievement 12/2024:** establishment of 30 production and distribution businesses and 40 with access to commercial finance

Robust MRV of emission reductions

- Relevant GHG emission reduction impact of biomass ICS must be demonstrated for
  - Company access to carbon finance
  - NDC reporting of countries and use of article 6 mechanism

Guides and reports available!



Lessons Learned report coming soon …

Le rapport sur les enseignements tirés de l'expérience seront bientôt disponibles…

Financed by

REPUBLIC OF KENYA

REPUBLIQUE DU SENEGAL

MINISTERE DE L'ENVIRONNEMENT ET DU DEVELOPPEMENT DURABLE

République du Sénégal

Un Peuple - Un But - Une Foi

Ministère du Pétrole et des Energies

GREEN CLIMATE FUND

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IRENA INNOVATION WEEK 2025

Presentation

Ayaka Uke

Researcher
Japan International Research Center for Agricultural Sciences (JIRCAS)

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IRENA Innovation Week 2025

Decentralised bioenergy solutions with oil palm biomass : Toward a Sustainable Bioeconomy in Agroindustry

Dr. Ayaka Uke

Researcher,

Japan International Research Center for Agriculture (JIRCAS)

More Information
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Background

Agricultural residue management in Southeast Asia

- Large volumes of lignocellulosic residues are generated by the agricultural industry as by-products of crop cultivation and processing.
- Without viable reuse strategies, these residues are often left in fields or openly burned, causing air pollution, carbon emissions, and soil degradation.
- Although policies to phase out field burning are progressing, the long-term impact will depend on establishing scalable, sustainable alternatives for managing biomass with high carbon-to-nitrogen ratios.

- **Current residue disposal practices are not sustainable - and demand urgent technological alternatives.**

Challenges of Palm Residue Accumulation in Plantations

What are the problems with leaving them in the plantation?

Excessive Microbial Proliferation

Leaving oil palm biomass, such as trunks (OPT) and fronds (OPF), on-site promotes the rapid growth of decomposer microbes and fungi.

Nutrient Immobilisation

Decomposer microbes and fungi compete with crops for plant-available form nutrients, such as nitrate and phosphate.

Crop Growth Inhibition

Consequently, young palms and other crops suffer from nutrient deficiencies, leading to soil imbalances and reduced plant growth.

Nitrogen deficiency and other physiological disorders occur, leading to excessive fertilisation.

The Integrated Biotechnology for Renewable Energy

Biomass Densification (Pelletisation)

Compressing agricultural residues into solid fuel pellets enables clean, decentralised thermal energy production. This reduces the need for fossil fuels and replaces open burning with controlled combustion.

Microbial Saccharification

Non-densifiable biomass and liquid residues undergo enzyme-free microbial hydrolysis to produce fermentable sugars and organic acids. These sugars and organic acids contribute to the production of renewable energy and bio-based products.

Soil-Enriching Agricultural Return

Residual solids enrich the soil with beneficial microbes and improve nutrient cycling. Wastewater rich in phosphorus and magnesium, which is produced during pelletisation, can also be reused as a liquid fertiliser.

Multifeedstock Pelletisation: Solving the Biomass Collection Challenge

Flexible Pellet Production from Diverse Biomass

- One of the main barriers to biomass utilisation is the difficulty of collection due to seasonality and geographic dispersion.

- By adapting a multi-feedstock strategy, the pellet system can accept various types of agricultural residues, regardless of timing or source.
- This approach eliminates the need to expand collection area or wait for specific crops.
- Residues such as oil palm trunks, empty fruit bunch, oil palm fronds, palm kernel shell, mesocarp fiber, and fibrous plant waste can all be processed into uniform solid fuel pellets.

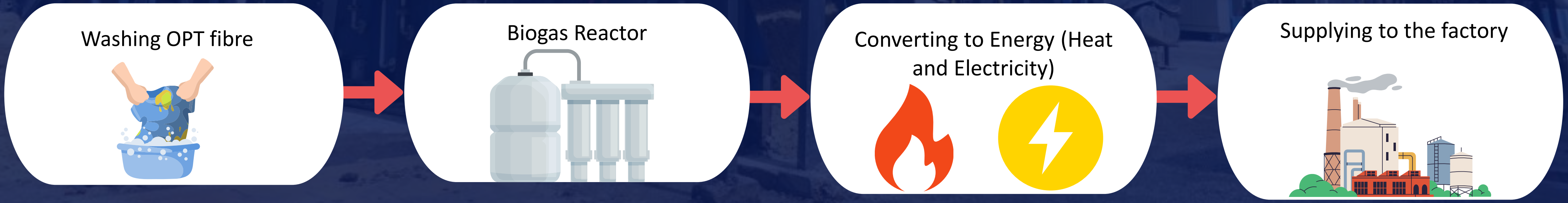
A flexible pellet system ensures continuous operation and maximises the use of locally available biomass

Biogas-Integrated Pellet Production: A Self Sustaining Energy Cycle

Energy-Positive Pelltisation through Wastewater Utilisation

- During the pellet production process, wastewater is generated - often overlooked as a resource.
- This liquid can be used in anaerobic digestion to generate biogas, which feeds back into the pellet plant, reducing or eliminating the need for external energy input.

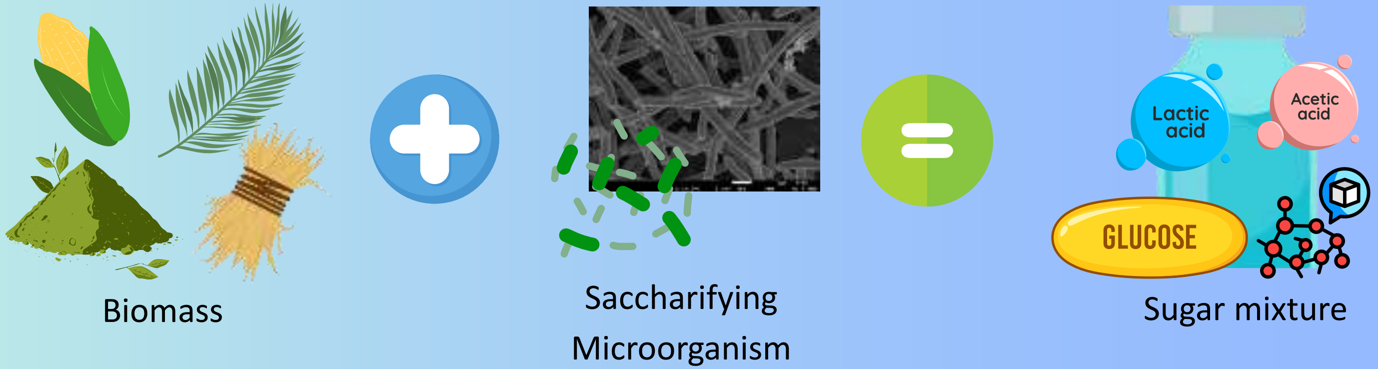
In the case of Oil Palm Trunks (OPT)



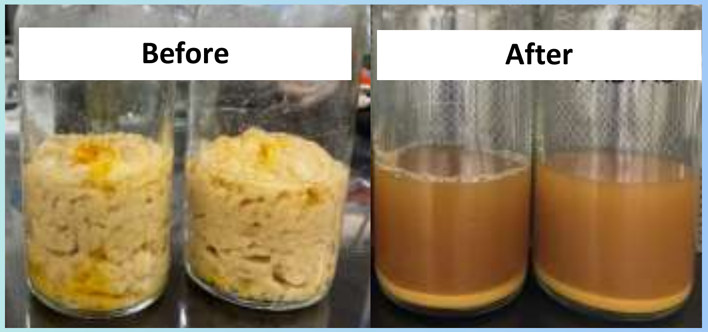
Microbial Saccharification: Converting Biomass into Liquid Energy

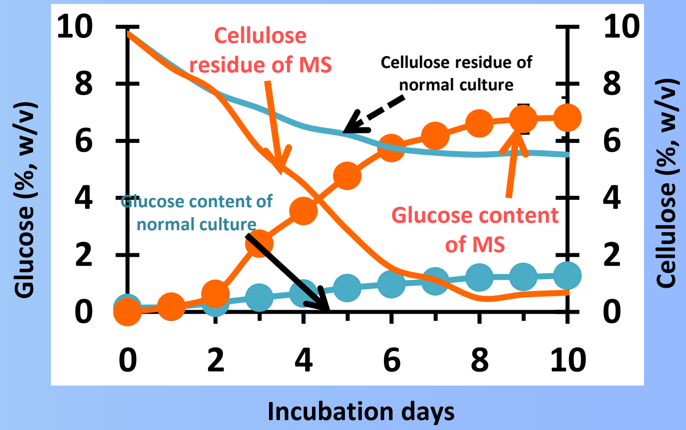
Biological Hydrolysis of Cellulosic Biomass for Energy Generation

- Microbial saccharification (MS) uses naturally occurring cellulolytic and hemicellulolytic microbes to break down the cellulose and hemicellulose fractions— together representing up to 80% of biomass — into fermentable sugars and organic acids (Prawitwong et al., 2013; Nhim et al., 2024).



- The process is cost-effective and scalable as it requires no external enzymes. As the solid biomass is converted into a sugar-rich liquid, this liquor can be used directly as feedstock for bioenergy production, for example biogas via anaerobic digestion.





Wastewater discharged during pellet production contains **fine particles** that do not form pellets.

Converting these particles into sugars and organic acids through microbial saccharification **increases gas yield**, supporting the production of pellets with a negative greenhouse gas footprint and combined energy systems.

Upcycling Sugar Liquor into High-Value Bioproducts

Multiple Pathways from Microbially Hydrolysed Biomass

The sugar-rich liquor obtained through microbial saccharification has a variety of uses. Depending on local needs and processing infrastructure, it can be upcycled into a range of valuable bioproducts.

- Bioethanol
- Bioplastics (e.g. PHAs)
- Purified glucose solutions

Soil Improvement with Residues and Nutrient Recovery

- Residues from microbial saccharification contain beneficial microbes that promote plant growth and convert residual nutrients into forms that are available to plants.

- Meanwhile, the wastewater produced by the pellets production process can be recovered and used as a liquid fertiliser rich in phosphorus and magnesium, which further supports soil fertility.

- These by-products enhance soil organic matter, nutrient balance and crop productivity, thus closing the loop in biomass use.

Biomass Upcycling:

Practice and Global Relevance

Case Study: Malaysia’s Palm Oil Industry as a Circular Bioenergy Model

In Malaysia, a pilot scheme makes use of palm oil by-products such as empty fruit bunches and trunks. To reduce the need for transport, a pellet plant has been built next to a mill, enabling local collection. The system combines pelletisation, biogas recovery and soil return in order to convert residues into energy and soil-improving outputs.

➔ A commercial pellet facility with a capacity of 20,000 tons per year is currently under constraction in East Malaysia.

Global Context: Decentralised Biomass in the Energy Transition

This approach reflects the growing global focus on biomass-to-energy in the context of low-carbon transitions. Decentralised systems provide robust, local solutions that promote climate objectives, improve access to rural energy, and foster circular bioeconomies, particularly in tropical regions.

Thank You For Your Attention

JIRCAS

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IRENA INNOVATION WEEK 2025

Panel discussion

Moderator

Bharadwaj Kummamuru

World Bioenergy Association

Panellists

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Gabriele Giannini

Eni

Verena Brinkmann

GIZ

Ayaka Uke

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Renewables and Digitalisation for a Sustainable Energy Future

Thank you!

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Coffee Break

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