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The Strategic Role of Bioenergy

In Amazon Biome Development

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Brazil's Bioenergy Leadership

44.1%

Renewable energy in domestic supply

~29%

Agro bioenergy in total energy supply

75 GW

Biomass power technical potential

43B L

Biofuels production in 2023

Agribusiness accounts for ~60% of all renewable energy in Brazil (FGV Agro, 2025)

Sources: EPE 2024; IRENA 2025; IEA Bioenergy; FGV Agro - Dinâmicas de Demanda e Oferta de Energia pelo Agronegócio (2025)

Diverse Biomass Feedstocks

Primary Sources (Current)

• Sugarcane bagasse & straw	~60%	*Bioelectricity*
• Black liquor (pulp & paper)	~20%	*Industrial heat*
• Wood chips & pellets	~10%	*Heat & power*
• Agricultural residues	~10%	*Multiple uses*

Emerging Sources (Potential)

→ Animal manure → Biogas

→ Vinasse (ethanol residue) → Biogas

→ Rice husks → Combustion

→ Corn stover → Bioethanol

→ Coffee husks → Energy

→ Municipal solid waste → Biogas

Underutilized residues represent 16,000+ PJ theoretical potential by 2050

Sources: ScienceDirect 2026; Brazil biomass market; IRENA Country Report

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Amazon Bioenergy Potential

Available Feedstocks

Agricultural Residues

Cassava peels, rice husks, corn stover, açaí pits (70% of fruit weight; 19.77 MJ/kg)

Livestock Waste

Biogas from manure; Pará alone: 527M m³/yr potential (Instituto Escolhas)

Forest Residues

Sawmill residues; Brazil nut shells (21.07 MJ/kg); 1.7M t/yr açaí output (UFLA)

Native Products

Babassu shells; palm oil (5t oil/ha/yr; 250k ha in Pará; 72% GHG reduction vs diesel)

Strategic Value for Amazon Development

- ✓ Rural energy access;
- ✓ Income diversification;
- ✓ Waste valorization;
- ✓ GHG emission reduction;
- ✓ Energy security;
- ✓ Circular economy integration.

Sources: FGV Agro - Bioenergia Tropical (2025); UFLA; Instituto Escolhas; Abrapalma; Embrapa

Amazon’s Diesel Challenge

96%

Fossil fuel share in Amazon isolated systems

1.9 million people depend on diesel generators

~3M

People in areas off the national grid (SIN)

~1M lack any formal access to electricity (IEMA)

R$ 5B

Investment needed for Amazon energy transition

211 locations targeted by Energias da Amazônia program

1.5M t

CO_2 avoided by 2030 through diesel replacement

Target: 70% oil dependency reduction (Decreto 11.648/2023)

The Amazon produces 26% of Brazil’s electricity — yet millions of its people still rely on diesel

Sources: MME - Energias da Amazônia; CPI - Rivers of Diesel; EPE 2021; IEMA 2020; FGV Agro - Bioenergia Tropical (2025)

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Brazilian Bioenergy Policy Landscape

RenovaBio (2017) — *Active*

Promotes biofuel production across fuel types (biodiesel, biomethane, bioethanol, biokerosene)

Future Fuels Program (2021) — *Active*

Increases sustainable fuel participation; targets 10% biogas by 2036

Green Diesel Program (PNDV) — *Active*

Promotes renewable biomass diesel with 3% minimum blend

Fuel of the Future Law (Lei 14.993/2024) — *In effect since Aug 2025*

- **Biodiesel:** B15 (2025) → B20 by 2030 | legal range 13–25%; **Ethanol:** E30 mandatory since Aug 2025 | legal range 22–35%
- **SAF:** 1% by 2027 → 10% by 2037 (progressive scale); **Biomethane:** 1% GHG reduction from 2026, scaling to 10%
- **Green Diesel:** up to 3% mandatory blend of renewable diesel

Sources: Lei 14.993/2024; IEA Bioenergy Country Report 2024; EPE; CNPE Resolution No. 7/2021

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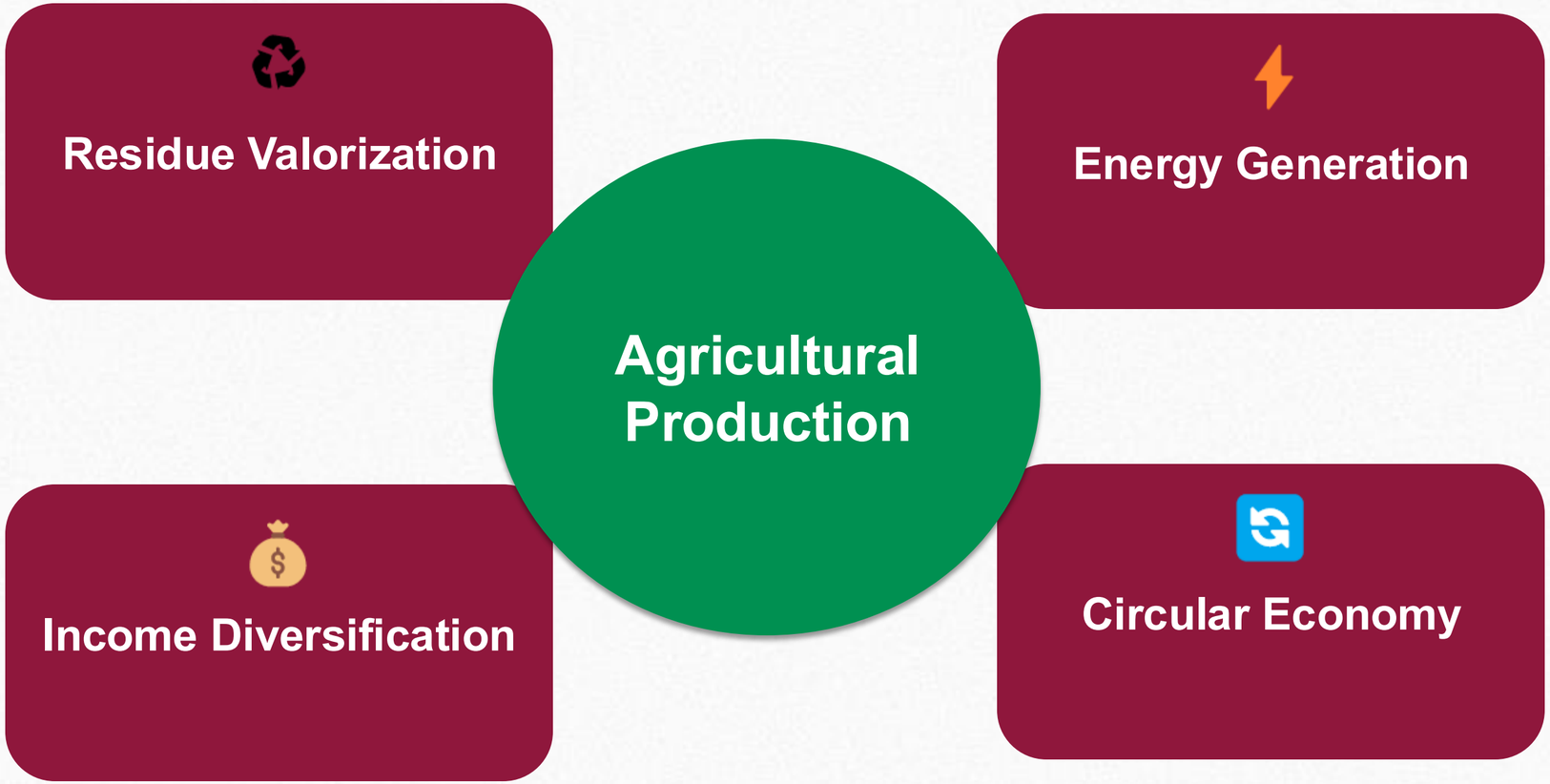
Bioenergy-Agriculture Integration

Energy-Food Nexus in the Amazon



Integrated systems maximize economic and environmental returns

Source: FGV Agro analysis

Economic Impact for Amazon Communities

Local Energy Access

- 96% of isolated systems run on diesel — 1.9M people affected (MME);
- Energy costs up to 10x higher than SIN-connected areas (EPE);
- Potential to cut diesel dependency by 70% by 2030 (Energias da Amazônia).

Income Generation

- Palm oil sector: 20,000 direct jobs, 240,000 people involved in Pará;
- Job creation in collection/processing;
- Value addition to agricultural production.

Environmental Co-Benefits

- Up to 1.5M tons CO_2 avoided by 2030 through diesel replacement (MME).

Sources: FGV Agro (2025); MME - Energias da Amazônia; EPE; Abrapalma; CPI

Evidence of Transformation

110 MWp

Solar + Storage

Huawei/Aggreko hybrid system + 120 MWh BESS for isolated Amazon communities

37M liters diesel saved; 104K t CO_2/yr avoided

200+

Community Solar

Families benefiting from FAS/BNDES Carauari project; 24h vs 6h daily supply

Decentralized model scalable to 600+ riverside communities

250K ha

Palm Oil Biodiesel

Palm oil planted in Pará; 5t oil/ha/yr yield; 72% GHG reduction vs fossil diesel

20,000 direct jobs; 240,000 people in supply chain (Abrapalma)

21 MJ/kg

Biomass Research

Brazil nut shells energy density (UFPA/UFLA); açaí pits at 19.77 MJ/kg for biochar

1.7M t/yr açaí output — waste-to-energy at industrial scale

From pilot projects to systemic transformation — the Amazon energy transition is underway

Sources: FGV Agro (2025); Huawei/Aggreko; FAS/BNDES; Abrapalma; UFPA; UFLA; Embrapa

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Implementation Challenges

Technical

- Collection/logistics infrastructure;
- Scale economies for small operations.

Financial

- High upfront investment costs;
- Limited access to rural credit;
- Price competitiveness with fossil fuels.

Policy/Regulatory

- Grid connection bureaucracy;
- Lack of specific Amazon incentives;
- Limited technical assistance.

Market

- Uncertain demand for biogas;
- Fragmented supply chains;
- Competition for residues (other uses).

Source: FGV Agro analysis; Brazil biofuel industry review

Strategic Pathways Forward

HIGH **Targeted Incentives**

Develop Amazon-specific bioenergy programs with differentiated support for small-scale producers

HIGH **Infrastructure Investment**

Support collection, processing, and distribution infrastructure in priority municipalities

MED **Technical Assistance**

Deploy extension services for bioenergy technology adoption and residue management

MED **Finance Mechanisms**

Create specialized rural credit lines for bioenergy investments with favorable terms

LOW **Market Development**

Establish guaranteed purchase agreements and grid connection facilitation

Source: FGV Agro recommendations

Bioenergy: A Pillar of Sustainable Development

Strategic bioenergy deployment in the Amazon can catalyze rural development, enhance energy security, and support climate goals—turning agricultural residues into economic opportunity.

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