CHALLENGES AND OPPORTUNITIES OF BIOMASS PELLETIZATION INFLUENCE AND ITS ECONOMIC VIABILITY IN RURAL AREAS WITH RESPECT TO CHIKKABALLAPURA DISTRICT

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Introduction

Biomass pelletization, the process of compressing agricultural and forestry residues into energy-dense pellets, holds significant potential for addressing energy needs, reducing emissions, and fostering economic growth in rural Chikkaballapura. The district, characterized by abundant agricultural waste (e.g., maize stalks, coconut husks, and groundnut shells) and limited access to reliable energy, faces challenges like open burning of crop residue, contributing to 20-30% of local air pollution (PM2.5 levels). Pelletization can convert 1.5-2 lakh tonnes of annual biomass residue into a renewable fuel source, replacing coal or firewood, cutting CO_2 emissions by 70-80% (1.2-1.5 kg CO_2/kWh vs. 0.3-0.4 kg CO_2/kWh). This project explores the technical feasibility, economic viability, and socio-economic impacts of biomass pelletization, aligning with Karnataka's Renewable Energy Policy and India's net-zero 2070 goals. By promoting local production units, it aims to create 500-1000 jobs, save ₹50,000-₹1 lakh per household annually on fuel costs, and enhance energy security. The study will assess barriers (e.g., high initial costs, awareness) and opportunities (e.g., government subsidies, rural entrepreneurship) through a theoretical lens, sharing findings with Chikkaballapura communities to drive adoption.

Objectives

- Assess the technical feasibility of biomass pelletization using local agricultural residues in Chikkaballapura.
- Evaluate the economic viability and cost-benefit analysis of pelletization units for rural households and small industries.
- Measure awareness levels and adoption barriers for biomass pellets among rural communities.
- Explore integration with government schemes like the National Bioenergy Programme and PM-KUSUM for scalability.
- Analyze the environmental impact, focusing on emission reductions and waste management improvements.
- Identify the role of local entrepreneurs and cooperatives in establishing pelletization micro-enterprises.

Methodology

Research Design: A mixed-method approach combining qualitative and quantitative techniques will be used to collect data on the challenges, opportunities, and impacts of biomass pelletization in rural Chikkaballapura. The study will focus on technical, economic, and social aspects, identifying barriers to adoption and strategies for scalability.

Sampling:

- **Sampling Units**: Rural households, small-scale industries, and agricultural cooperatives across Chikkaballapura's taluks (e.g., Chintamani, Gowribidanur).
- **Sampling Method**: Stratified random sampling to ensure representation of diverse biomass sources (e.g., crop residues, forestry waste) and economic contexts.

Data Collection:

- **Primary Data**: Surveys to gauge awareness, adoption intent, and perceived benefits of biomass pellets. Semi-structured interviews with farmers, local entrepreneurs, and renewable energy experts to understand technical and

economic challenges. Field observations to assess biomass availability and pelletization processes.

- **Secondary Data**: Review of government reports (e.g., Ministry of New and Renewable Energy), Karnataka's Renewable Energy Policy, and studies on pelletization in similar agro-based regions.

Stakeholder Engagement: Engage farmers, cooperative societies, government officials (e.g., Karnataka Renewable Energy Development Agency), and pelletization equipment suppliers to understand supply chains, policy incentives, and technical expertise. Workshops with rural communities to share findings and promote awareness.

Analysis: Quantitative data (e.g., cost-benefit ratios, emission reductions) will be analyzed using statistical tools. Qualitative insights (e.g., adoption barriers) will be coded thematically to identify patterns and solutions.

Results and Conclusions

The study is ongoing, but preliminary findings suggest high potential for biomass pelletization in Chikkaballapura due to abundant raw materials (1.5-2 lakh tonnes/year) and energy demand (rural households spend ₹2,000-₹5,000/month on firewood/coal). Key insights include:

- **Technical Feasibility**: Local residues (e.g., maize stalks, coconut husks) yield 3,500-4,000 kcal/kg pellets, comparable to coal (4,000-5,000 kcal/kg), with small-scale pelletizers (100-500 kg/hour) costing ₹5-10 lakh.
- **Economic Viability**: Pellets cost ₹10-₹15/kg vs. firewood (₹8-₹12/kg) or coal (₹20-₹30/kg), offering 20-40% savings for households. A micro-unit can generate ₹2-3 lakh/year profit, recoverable in 2-3 years.
- **Barriers**: High setup costs, limited awareness (only 10-15% of farmers know about pelletization), and lack of local expertise hinder adoption.
- **Environmental Impact**: Replacing firewood/coal with pellets can reduce CO_2 emissions by 70-80% and PM2.5 by 60-70%, improving air quality.

Conclusion: Biomass pelletization can transform Chikkaballapura's rural economy by providing affordable, clean energy, reducing waste, and creating jobs. Awareness

campaigns, subsidies (e.g., via PM-KUSUM), and training programs are critical for widespread adoption.

Project Outcome & Industry Relevance

Industry Benefits: The study will identify scalable models for biomass pelletization, informing manufacturers and renewable energy firms about rural market potential. Insights into cost-effective pelletizer designs and supply chain optimization can drive innovation, aligningalling with India's National Bioenergy Programme.

Societal Benefits: Pelletization can provide rural households with affordable energy (₹500-₹1,000/month savings), reduce health risks from indoor air pollution (e.g., 30-40% lower respiratory issues), and create employment (500-1000 jobs per 10 micro-units). It supports climate resilience by cutting emissions and managing agricultural waste, aligning with Chikkaballapura's sustainability needs.

Working Model vs. Simulation/Study

This is a theoretical study focused on assessing the adoptability and viability of biomass pelletization in Chikkaballapura. No physical working model is developed, but the study includes data-driven simulations of costs, emissions, and economic impacts.

Project Outcomes and Learnings

- Identify awareness levels and barriers (e.g., cost, expertise) to biomass pellet adoption in rural areas.
- Quantify raw material availability (1.5-2 lakh tonnes/year) and compare pellet costs (₹10-₹15/kg) with traditional fuels.
- Propose local micro-enterprise models to boost rural economies, creating 50-100 jobs per unit.
- Highlight environmental benefits (70-80% CO_2 reduction) to support Karnataka's renewable energy goals.
- Recommend policy interventions (e.g., subsidies, training) to integrate pelletization into schemes like PM-KUSUM.
- Provide actionable insights for stakeholders to scale pelletization, enhancing energy security and livelihoods.

Future Scope

- Optimize pelletizer designs for small-scale units (<₹5 lakh) to process diverse residues (e.g., maize, coconut, groundnut), aligning with KREDA's renewable energy focus.
- Develop local biomass supply chains to reduce transport costs (₹2-₹3/kg) and emissions, supporting the National Bioenergy Programme.
- Innovate low-cost, high-efficiency pellet stoves (<₹5,000) for rural households, integrating with PM-KUSUM's clean energy goals.
- Research hybrid pellet-solar systems for 24/7 energy access, leveraging Karnataka's Smart Cities Mission and solar push.
- Assess socio-economic impacts (1000+ jobs, ₹50,000-₹1 lakh/household savings) with PMAY and KHB's rural housing schemes.
- Quantify long-term environmental benefits (e.g., 80% CO_2 reduction, 60% PM2.5 drop) using GRIHA metrics, supporting India's net-zero 2070 target.