

Energy Recovery from Cashew Waste: Advancing Circular Economy Practices in Burkina Faso

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Abstract. The cashew processing industry in Burkina Faso generates substantial quantities of lignocellulosic residues mainly composed by cashew nutshells (CNS) about 70-75%, which remain largely unexploited. Households and Small and Medium-sized Enterprises (SMEs) in the agro-industrial sector of Burkina Faso are struggling to meet their energy needs, relying on unconventional sources that contribute to deforestation and climate change. This study assesses the energetic valorisation of cashew nutshell into biofuel, within the framework of a circular economy. Twelve circular economy scenarios have been assessed including close loop recovery and open loop scenario. In the closed loop scenario, SMEs produce their own byproducts (CNS) and convert it locally to biofuel (biochar or briquettes) that they will use. In the opened loop scenarios, CNS are produced by SMEs and sold to others for their energy supply. A multicriteria decision making approach based on hybrid Analytical Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) methods have been developed to assess the scenarios based on economic, environment and social criteria. The findings revealed that profit was the most influential criterion (49.6%) in selecting the best scenario, followed by production cost (27.8%), carbon footprint (16.0%), and job creation (6.7%).

Introduction

Minimizing the environmental impacts of industrial processes has become a central concern for both national and international institutions, faced with growing requirements related to energy access and long-term sustainability. In developing countries, biomass plays a vital role in energy production, traditionally used for cooking and heating in rural households and small-scale industries. However, the over-reliance on traditional biomass, such as firewood and charcoal, relies in environmental challenges, including deforestation, soil degradation, and greenhouse gas emissions, ultimately contributing to climate change.

Burkina Faso is a landlocked country in West Africa; this involves challenges related to energy supply as fuel is imported. Moreover, almost 86% of its energy consumption is derived from biomass, with wood and charcoal being the main sources.

The energy crisis is further exacerbated by low electrification rates, which stand globally at 19.5% as of 2022, 3.4% in rural areas and 60.5% in urban centers and creates major barriers economic development [1]. This energy deficit has a substantial impact on small and medium-sized enterprises (SMEs), particularly those in agro-industrial sectors which form the backbone of the country's economy. They heavily rely on conventional biomass, especially firewood, to meet the energy needed

for heating and drying operations. As a result, deforestation in Burkina Faso has reached alarming rates, with approximately 105,500 hectares of forest lost annually [2]. Due to the sustainability challenges associated with firewood, the valorisation of agricultural and agro-industrial residues such as sugarcane bagasse, rice husks, coffee grounds, peanut shells, and cashew nutshells (CNS), has emerged as a sustainable alternative as in many developing countries. Among these residues, CNS represents a particularly abundant and underutilized resource with significant energy potential in this country.

1.1 Cashew sector in Burkina Faso

The cashew production in Burkina Faso has experienced significant growth, from 50,000 tons in 2012 to over 100,000 tons in 2021. As cashew nuts are processed (*Fig. 1*), a substantial amount of waste is generated, with cashew nutshells accounting for approximately 60-72% of the total weight of the nuts [4]. The calorific value of CNS (21.3 MJ/kg) is notably higher than that of traditional firewood (17.9 MJ/kg) [4]. Furthermore, CNS can be use in various forms, such as biochar, briquettes, or direct thermal energy recovery, offering a sustainable alternative to conventional biomass. However, despite these advantages, CNS remains largely underexploited. Up to 20% of CNS are used as

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fuel, the remaining is stored in nature, either in areas controlled by the town hall or in illegal dumps for a fee. Inefficient combustion practices and improper disposal not only waste this valuable resource but also pose environmental and health risks due to the presence of Cashew Nutshell Liquid (CNSL), which represents 30–35% of its mass. CNSL, a dark brown, highly acidic, and corrosive oil but with potential to replace synthetic phenols in various industrial applications [14]. This underscores the need for a transition to a circular economy (CE) model, which aims to minimize waste and optimize resource use by reintegrating by-products like CNS into the production cycle. *Fig. 1* presents the products from cashew sector.



Fig. 1. Products from cashew sector

1.2 Objective of the study

In Burkina Faso, recovering cashew nut shells (CNS) as fuel for SMEs and households could significantly reduce reliance on traditional biomass, lower greenhouse gas emissions, and mitigate deforestation. However, according to this research, achieving these outcomes requires approaching stakeholders in the agro-industry to identify and evaluate priority criteria for adopting this policy. Hence, this research aims to evaluate the circular economy (CE) opportunities of cashew nutshell recovery as fuel for SMEs in Burkina Faso using a multi-criteria decision-making (MCDM) framework. MCDM approach is used by several researchers when trying to decide among several alternatives and criterion of choice. For example, to determine a set of good alternatives for concrete production, considering environmental and economic criteria [6], select suitable biomass resources for bioenergy production in Burkina Faso [3]. By applying a multi-criteria decision-making (MCDM) framework, this research seeks to evaluate the sustainability trade-offs of various CNS CE scenarios. The findings will provide critical insights for policymakers and stakeholders to develop evidence-based strategies for integrating CNS into Burkina Faso’s energy systems, ultimately contributing to a sustainable and inclusive energy transition.

The study began with a review of existing literature on cashew waste management, followed by interviews with experts from the cashew industry and other SMEs capable of recovering Cashew Nut Shells (CNS) waste and supporting policy implementation. Twelve circular economy (CE) scenarios for CNS were defined,

considering various valorization options such as mechanical extraction of Cashew NutShell Liquid (CNSL), combustion for energy generation, cogeneration of electricity, and the production of biochar and briquettes [5].

2 Methodology of the study

To achieve the objective of this study, the selection criteria for the valorisation of cashew nutshells (CNS) has been defined. It is the criteria that can be adopted by cashew nut processing plants, as they are the primary generators of this waste. Additionally, different circular economy (CE) scenarios have been explored to meet the energy needs of small and medium-sized enterprises (SMEs) in Burkina Faso. Transparency, communication, and multi-stakeholder involvement were fundamental to this process [7].

Given the diversity of selection criteria and the need to prioritize them based on stakeholder responses, a Multi-Criteria Decision-Making (MCDM) approach is adopted to ensure a structured and systematic decision-making process. Since expert judgments inherently introduce subjectivity, the Analytic Hierarchy Process (AHP) is employed due to its ability to integrate subjective assessments while enhancing decision-maker engagement and consistency verification. Moreover, considering the nature of criteria, applying multiple analysis methods before final decision-making is essential [8]. Therefore, to complement AHP, the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is used, as it enables compensatory trade-offs, correct comparison of criteria with varying scales, and effectively integrates qualitative and quantitative factors [9]. Therefore, this study adopts a hybrid AHP-TOPSIS approach, which has been identified as the most effective classification methods [10]. The methodological framework of this approach is illustrated in *Fig. 2*.

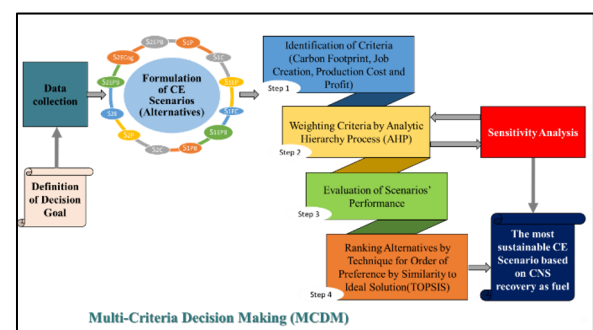


Fig. 2. AHP-TOPSIS methodology for CNS circular economy selection in Burkina Faso

2.1 Study Area

Burkina Faso is a landlocked country in West Africa. The country is a significant producer, processor, and exporter of cashew nuts (CN), exporting approximately 90% of its annual production due to high processing costs. Locally, only 10% of raw cashews are processed annually, primarily into whitened or cooked kernels, generating an estimated 7,300 tons of recoverable waste

for energy purposes [4]. Burkina Faso hosts 23 CN processing plants in 2021, including 11 semi-industrial and industrial facilities, with the remainder operating at a small-scale artisanal level. These plants are distributed mainly across three regions: Hauts-Bassins, Cascades and Boucle du Mouhoun representing respectively 76.7%, 23% and 0.3% of the country's processing capacity. Given its accessibility and processing capacity, the study was conducted in Bobo-Dioulasso, a major industrial hub in the Hauts-Bassins region of Burkina Faso. Bobo-Dioulasso hosts 66% of the country's cashew nut (CN) processing capacity, including one large and three medium-sized processing units [11], and many other SMEs that rely on firewood, even butane gas and CNS for their process

2.2 Data source and collection

This study relied on both primary and secondary data. Primary data were obtained through surveys, including interviews and questionnaires, while secondary data were gathered from databases and previous studies.

Primary data collection involved ten key stakeholder groups: cashew nut (CN) factories, cashew nutshell liquid (CNSL) extraction plants, oil mills, briquette producers, dried mango producers, artisanal butter producers, artisanal soap producers, mango sector professionals, CN sector professionals, and households. Stakeholders were interviewed to examine CNS (cashew nutshell) waste management practices in CN factories and related industries and to assess their perspectives on adopting a circular economy (CE) approach, particularly for CNS waste recovery.

The interviews with CN factories focused on identifying the criteria influencing the recovery of CNS as fuel within a CE framework. Four key criteria were identified as the most significant. To analyze these criteria, a questionnaire was designed based on Saaty's fundamental pairwise comparison scale [12]. Experts evaluated the four criteria through face-to-face interviews, and their responses were analyzed using the Analytical Hierarchy Process (AHP) to determine the relative weight of each criterion.

Another questionnaire collected general information about operations, energy needs, energy sources, and policies for adopting new energy sources. Data from these questionnaires, combined with insights from the literature, were used to define and compare CE scenarios for CNS recovery as fuel. These scenarios were then evaluated using the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method.

2.3 Circular Economy Scenarios definition

To develop applicable Cashew Nutshell (CNS) energy recovery scenarios for Small Medium Sized Enterprises (SMEs), this study examines valorization pathways for dry lignocellulosic biomass that have been either adopted by some SMEs in Burkina Faso or explored in the literature. The identified methods include biochar production, CNS briquetting, CNSL (cashew nutshell

liquid) extraction, thermal energy recovery (heat), and cogeneration of electricity. The biofuels considered in these scenarios are biochar, press cake, and briquettes.

The formulation of these scenarios considers the entire value chain, including CNS collection, preparation, transformation and distribution. Twelve CE scenarios are formulated and categorized into two groups:

- **Group S₁ (from S_{1C} to S_{1PB}):** In situ valorization within CN processing plants.
- **Group S₂ (from S_{2C} to S_{2PB}):** Industrial symbiosis, where CNS is processed externally in collaboration with other SMEs.

2.3.1 In situ valorisation scenarios

This category includes scenarios where cashew nutshells (CNS) are collected immediately after separation from the kernels (**Fig. 3**) and reused on-site for energy production and by-product recovery.

Scenario S_{1C}: CN processing plant burns, CNS in a boiler to generate the heat required for a new almond production cycle.

Scenario S_{1P}: CNS undergoes pyrolysis, producing biochar and heat resulting is required for a new almond production cycle. Biochar can be distributed to employees or sold as a sustainable fuel alternative, reducing reliance on wood, charcoal, and gas.

Scenario S_{1EP}: CNSL is extracted from CNS and sold to industries. The remaining press cake is used for biochar production, and the resulting heat is required for a new CN almond production cycle, with biochar recovered as a by-product for sale.

Scenario S_{1EC}: CNSL is extracted from CNS and sold to industries, press cake undergoes complete combustion to generate heat required for a new almond production cycle.

Scenario S_{1EPB}: CNSL is extracted, the remaining press cake is pyrolyzed, and the resulting biochar is processed into briquettes. These briquettes, sold to households and SMEs, serve as a substitute for fossil fuels and firewood.

Scenario S_{1PB}: all CNS generated by the plant is used for biochar production, which is further processed into briquettes.

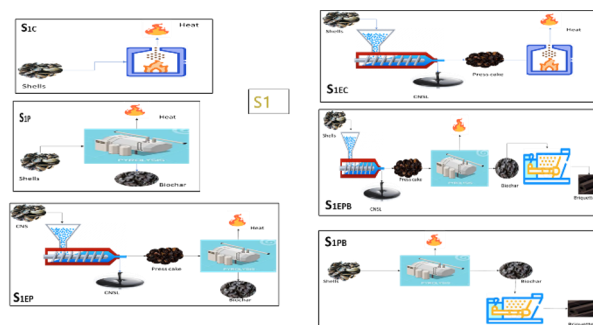


Fig. 3. In situ valorisation scenarios model

2.3.2 Industrial symbiosis valorisation scenarios

This category includes scenarios in which cashew nutshells (CNS) are collected and transported for use by other agro-industrial plants requiring energy for their operations (e.g., dried mango producers, rice producers, breweries, shea butter processing units). The concept follows the industrial symbiosis model, where waste from one industry becomes a valuable input for another. Six scenarios have been defined (Fig. 4).

Scenario S2C: CNS are purchased by an agro-industrial plant, transported to the facility, and burned in a boiler to generate heat.

Scenario S2P: An agro-industry (e.g., dried mango producer) purchases CNS for pyrolysis and biochar production, then the heat resulting substitutes butane gas (for mango drying for example), while biochar is distributed or sold.

Scenario S2E: CNS are purchased by a plant which mechanically extracts CNSL before selling both CNSL and press cake as separate by-products. Press cake can be used as an alternative to butane gas or firewood for SMEs.

Scenario S2EPB: CNS are purchased by a Briquette-Producing Plant, where CNSL is extracted and sold to industries. The remaining press cake is used for biochar production, which is processed into briquettes for households and SMEs.

Scenario S2ECog: A cogeneration plant purchases CNS to produce both heat and electricity. CNSL is extracted and sold to industries, while the remaining press cake is burned in a boiler to produce heat for the water connected to the boiler to generate steam that drives a turbine connected to a generator to produce electricity.

Scenario S2PB: CNS are purchased by a briquette-producing plant, where pyrolysis generates biochar and heat. The biochar is transformed into briquettes for households and SMEs.

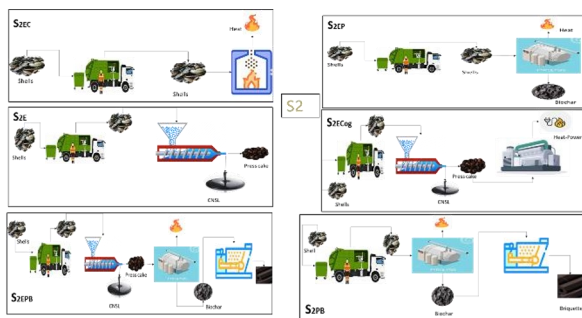


Fig. 4. Industrial symbiosis valorisation scenarios model

2.3.3 Criteria definition

Identifying evaluation criteria is crucial for aligning project objectives with stakeholders' interests. These criteria serve as parameters to differentiate between options, such as the 12 scenarios previously defined.

During interviews with CN experts, their interests were mostly focused on four criteria, which are part of sustainable development aspects summarized in Table 3. Pairwise comparison results. These criteria were then subjected to the AHP (Analytic Hierarchy Process)

method to verify the consistency of the experts' judgments as they compared the importance of criteria pairwise and assigned a preference order

According to stakeholders' opinions, the adoption of a CE scenario depends on achieving the lowest production cost for recovering cashew nutshell (CNS) waste as fuel while ensuring the highest profit.

Table 1. Evaluation criteria and objectives

Sustainability aspect	Criterion [Unit]	Description
Economical impact	Production cost [USD]	Sustainable scenario involves low production cost associated to CNS recovery as fuel.
	Profit [USD]	Sustainable scenario generates more revenue than costs required from value-added byproduct.
Environmental impact	Carbon footprint [tCO ₂ -eq]	Sustainable scenario produces less CO ₂ emission.
Social impact	Job creation [qualitative measure]	Sustainable scenario improve the quality of life of community.

Equations 1 to 5 are used to calculate the quantitative values for each criterion and Table 2 presents the details of the used parameters.

- Energy produced E_{th}

$$E_{th} = \eta \times Q_i \times NCV_i \quad (1)$$

- Production cost

$$Cost_{production} = Cost_{fixe} + Cost_{variable} \quad (2)$$

- Profit

$$Profit = Total\ Revenue - Total\ Production\ Costs \quad (3)$$

- Carbon footprint

$$C_{FTSc} = Em_{Trans} + Em_{fuel\ cons} + Em_{Process} \quad (4)$$

with $Em_i = Q_i \times EF_i$

- Job creation (number of equivalent jobs (TNE/year))

$$Total_{labour} = \sum_j N_{emp\ j} \times t_{work\ j} \quad (5)$$

Table 2. Equations parameters

Parameter	Definition
η	Efficiency of the conversion equipment
Q_i	the mass of fuel i
NCV_i	Net Calorific Value of fuel i
$Cost_{fixe}$	Fixed costs include expenses that do not vary with production levels, such as rent, permanent staff salaries, insurance, and depreciation
$Cost_{variable}$	Variable costs are those that fluctuate with production levels, such as raw materials (CNS, water, other feedstock), transportation, loading/unloading, and utilities
$Total\ Revenue$	revenue cost is the whole cost of a good or service
$Total\ Production\ Costs$	
Em_{Trans}	GHG emissions of transporting 1 unit of feedstock (CNS, and others) type f from supply source i to location j (kgCO ₂ -eq per amount of feedstock)
$Em_{fuel\ cons}$	GHG emissions of pre-processing 1 unit of biomass type f in supply source i for use in biorefinery (kg CO ₂ -eq per amount of feedstock)
$Em_{Process}$	GHG emissions (non-heat or electricity related) of converting 1 unit of biomass in technology or process l (kg CO ₂ -eq per amount of feedstock)
Em_i	the amount of GHG emitted
i	type of biomass
Q_i	amount of biomass or fuel i
EF_i	emission factor of biomass or fuel i
$N_{emp\ j}$	Number of employees (person) by category
$t_{work\ j}$	working time of each employee j (year).

For the modelling, our primary assumption is that cashew nutshell (CNS) waste is readily available in mills across Burkina Faso, as indicated by [3]. This supply is sufficient to meet the energy demand of cashew nut (CN) processing units, other agro-industries,

and small and medium-sized enterprises (SMEs) in the country. According to the literature, processing 80 MT/day of raw CN yields 17.6 MT/day of white almonds, requiring 61,147.56 kWh of energy. We assume that other SMEs, such as those involved in mango drying, paddy rice milling, and oil milling, have similar energy needs which serve as the baseline for evaluating their performance based on four defined criteria.

2.3.4 Decision making framework

This study uses the hybrid AHP-TOPSIS method to evaluate Circular Economy (CE) scenario alternatives for energy needs in SMEs. AHP is employed to prioritize criteria by pairwise comparisons and to evaluate the consistency of data. TOPSIS helps in determining the best CE scenario alternatives by measuring their distance from the positive-ideal solution and the negative-ideal solution.

Each scenario is therefore evaluated based on the previously defined criteria, including production cost, profitability, CO₂ emissions, and job creation. The results obtained from these calculations will be used to compare the scenarios using the TOPSIS method for decision-making.

TOPSIS ranks the alternative scenarios using AHP-derived weights by measuring their distances from the positive-ideal and negative-ideal solutions. The best alternative is closest to the positive-ideal solution and farthest from the negative-ideal one [8]. The positive-ideal solution maximizes beneficial criteria and minimizes non-beneficial ones, while the negative-ideal solution does the opposite. Beneficial criteria are profit and job creation. Non-beneficial are production cost and carbon footprint.

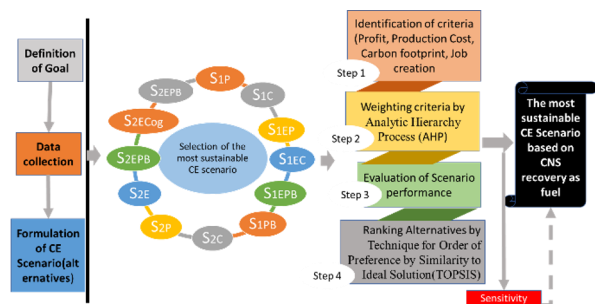


Fig. 5. Hybrid AHP-TOPSIS decision making framework

3 Results and discussion

3.1 Pairwise comparison of criteria using the Analytic Hierarchy Process method

As indicated in the previous section, four criteria were selected and scored by experts during data collection. The comparison matrix built from the experts' scores which is used to determine the weights of the four criteria considered using AHP is presented in Table 3; the consistency ratio (CR) less than 0.1.

Table 3. Pairwise comparison results

PAIRWISE COMPARISON				
Criteria	Profit	Production cost	Job Creation	Carbon footprint
Profit	1.00	3.00	5.00	3.00
Production cost	0.33	1.00	4.00	3.00
Job creation	0.20	0.20	1.00	0.30
Carbon footprint	0.33	0.33	3.33	1.00

Consistency Ratio (CR) < 0.1

After normalizing the geometric means, the results in Fig. 6 indicate that among the four criteria, Profit ranks first, followed by Production Cost, while Carbon Footprint and Job Creation rank third and fourth, respectively. This ranking reflects expert judgments based on pairwise comparisons using the Saaty scale

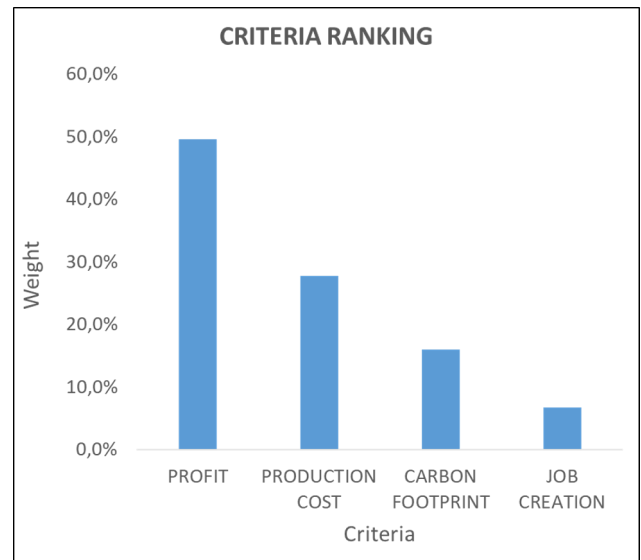


Fig. 6. Criteria ranking using AHP

This outcome aligns with the primary objective of the circular economy (CE), which prioritizes economic prosperity over environmental and social considerations. Similarly, carbon footprint, as an environmental criterion, ranks lower than profit and production cost, both economic factors. This explains the tendency of factories to overlook environmental issues associated with CNS landfilling and improper disposal. [13] further emphasizes the importance of balancing production costs and revenue to ensure economic viability, which remains the primary concern for cashew nut processing plants. Given the high investment costs associated with biofuel technologies, assessing long-term benefits is crucial for determining their financial feasibility.

3.2 Performance of scenario across the four criteria

This section presents the evaluation of each scenario based on the previously defined criteria, including production cost, profitability, CO₂ emissions, and job creation. The results obtained from these calculations will be used to compare the scenarios using the TOPSIS method for decision-making (Fig. 7).

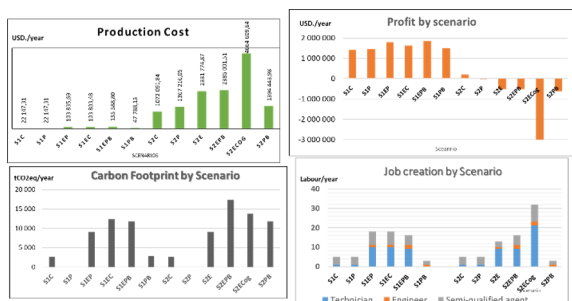


Fig. 7. Scenarios comparison using TOPSIS Method

Among the S1 scenarios, the most profitable ranking is as follows: first, S1EPB (briquette production + CNSL extraction), S1EP (CNSL extraction + biochar production)-second, and S1EC (heat production from CNS)-third. This ranking is primarily driven by the high market value of CNSL and briquettes, which outperform biochar in commercial viability. S1EPB, which produces both CNSL and briquettes, is particularly advantageous due to their superior selling prices: 305.34 USD/MT for CNSL and 152.67 USD/MT for briquettes, compared to 76.34 USD/MT for biochar. Although briquettes derived from CNS offer greater added value than biochar, their market demand remains limited.

In contrast, among the S2 scenarios, S2E is the most profitable, followed by S2EPB in second place. However, S2Cog incurred a loss of USD (-) 1,740,988.51 in its first year of operation. Despite this initial setback, it could become profitable in subsequent years if the return on investment is accounted for.

3.3 Selection of Alternatives

The comparative evaluation of the alternatives was conducted by combining the scenario values with the criteria weights derived from AHP. This integration provided a structured approach for informed decision-making, identifying the most sustainable options. The results of the Hybrid AHP-TOPSIS analysis (Fig. 8) indicate that the most sustainable scenarios for CNS recovery belong to Group 1 (S1), where the CNS processing plant recovers and revalue CNS before releasing the by-products to the market.

S1EP, which processes CNS into CNSL and biochar, ranks as the most sustainable scenario. This approach generates two valuable by-products: biochar, which can replace wood in SMEs and households or be used as a soil amendment, and CNSL, which has industrial applications, including in the oil and gas industries, adhesives, and biodiesel production, contributing to reduced reliance on fossil fuels. By recovering waste for multiple uses, S1EP aligns with circular economy

principles, promoting job creation and environmental sustainability.

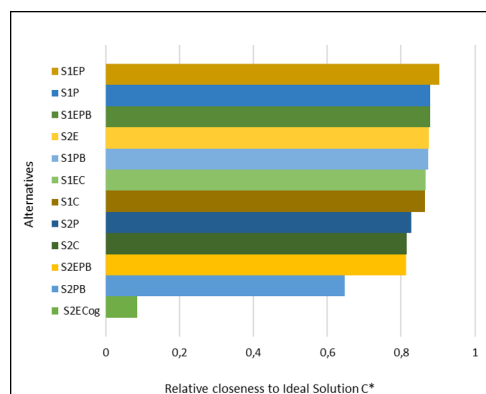


Fig. 8. Final alternative scenarios ranking

These findings align with [15], who identified biochar production as the most effective strategy for managing agricultural by-products due to its economic, environmental, and social benefits. Although S1EP has a lower calorific value compared to raw CNS for heat generation, the large daily availability of CNS compensates for this limitation. Therefore, S1EP remains a viable and sustainable CNS recovery strategy, meeting SMEs energy needs and advancing a circular economy in Burkina Faso.

Additionally, among the scenarios in Group 2 (S2), where other SMEs collect CNS from cashew processing factories to generate their own energy and by-products, S2P and S2C emerge among the most favourable. This confirms the initial hypothesis that CNS waste, which is increasingly available in Burkina Faso due to rising cashew production, can effectively be used to meet the energy needs of SMEs, reducing reliance on wood.

The result of Series 2 shows that when the weight of profit varies from 49.6% to 39.6%, S1EP ranks first. However, when the difference between the weight of profit and production cost is negligible, i.e., when the weight of profit decreases, S1P ranks first and S1EP ranks second. Furthermore, when the weight of profit becomes lower at 19.6%, S1P is still the first, S1C second, third S1PB and S1EP the fourth. This situation demonstrates how important the inclusion of other criteria apart from profit and production cost is to making an optimal choice among the 12 CE scenarios based on CNS recovery in Burkina Faso, which were defined in this work.

4 Conclusion

This study examines circular economy (CE) opportunities, focusing on the sustainable recovery of cashew nut shellnutshell (CNS) as fuel to meet the energy needs of small and medium-sized enterprises (SMEs) and households in Burkina Faso. The research used the hybrid AHP-TOPSIS method for decision-making to evaluate the sustainability of twelve scenario of CE across economic, environmental, and social dimensions through four criteria: production cost, profitability, carbon footprint, and job creation. Based on expert judgment, these criteria were identified as

those influencing the adoption of CE practices by agro-industrial SMEs in Burkina Faso. Twelve CE scenarios were defined, with six involving in-situ valorization in CN processing plant and six representing industrial symbiosis. The results showed that the most sustainable scenario is S1EP, which entails in-situ recovery of CNS where cashew nut shell liquid (CNSL) is extracted from CNS and the remaining press cake is utilized to produce biochar to supply household and other SMEs, and the thermal energy generated during this process is utilized in the new transformation process of cashew nuts, which in turn produces new cashew nutshells (CNS) as waste. This approach aligns with the circular economy principle by minimizing environmental impact. It helps to reduce deforestation by providing households with an alternative to wood and butane gas. It, addresses environmental issues related to the improper disposal and dumping of cashew nutshells (CNS), generates additional revenue for the factory through the sale of CNS oil (CNSL) and biochar, and creates jobs. To implement this scenario, an investment of 567,347.14 USD per year is required to recover the CNS and produce biochar, leading to a profit of 1,330,043.32 USD annually. However, this process would result in the emission of 9,046.98 tCO₂eq, and 18 people could be employed. This scenario presents a viable strategy to contribute to achieving SDGs 7, 8, 12, and 13 in Burkina Faso.

References

- World Bank. *Access to electricity (% of population) - Burkina Faso*. World Bank. Retrieved in February 2024 from <https://data.worldbank.org/indicator/EG.ELC.ACC.S.UR.ZS?locations=BF>
- A. Bado, Collecte et analyse de données pour l'aménagement durable des forêts. Rapport d'étude sur les données du bois-énergie au Burkina Faso, 1999.
- F. Zoma, M. Sawadogo, A multicriteria approach for biomass availability assessment and selection for energy production in Burkina Faso: A hybrid AHP-TOPSIS approach. *Heliyon*, **9** (10), 2023, e20999. <https://doi.org/10.1016/j.heliyon.2023.e20999>
- J.B. Sawadogo, N. Barsan, M. Nikiema, E. Mosnegutu, D. Dianou, A.S Traore, A. S Ouattara, & V. Nedeff, Anaerobic co-digestion of agro-industrial cashew nut wastes with organic matters for biogas production: case of cashew nut hull and cashew almond skin. *International Journal of Biological and Chemical Sciences*, **17** (1), 220–232, 2023. <https://doi.org/10.4314/ijbcs.v17i1.16>
- M. Sawadogo, S. T. Tanoh, S., Sidibé, S., Kpai, N., & Tankoano, I. (2018). Cleaner production in Burkina Faso: Case study of fuel briquettes made from cashew industry waste. *Journal of Cleaner Production*, **195**, 1047–1056. <https://doi.org/10.1016/j.jclepro.2018.05.261>
- S. Suárez Silgado, L. Calderón Valdiviezo, S. Gassó Domingo et X. Roca, « Multicriteria decision analysis to assess the environmental and economic performance of using recycled gypsum cement and recycled aggregate to produce concrete: the case of Catalonia (Spain) », *Resources, Conservation and Recycling*, vol. 133, p. 120–131, 2018. <https://doi.org/10.1016/j.resconrec.2017.11.023>
- N. M. O. Ezech, N. a. D. Ogbu, N. a. H. Ikevuje et N. E. P. George, « Stakeholder engagement and influence: Strategies for successful energy projects », *International Journal of Management & Entrepreneurship Research*, vol. 6, n° 7, p. 2375–2395, 024. <https://doi.org/10.51594/ijmer.v6i7.1330>
- M. Sahabuddin et I. Khan, « Multi-criteria decision analysis methods for energy sector's sustainability assessment: Robustness analysis through criteria weight change », *Sustainable Energy Technologies and Assessments*, vol. 47, 2021. <https://doi.org/10.1016/j.seta.2021.101380>
- E. Pagone, K. Salonitis et M. Jolly, « Automatically weighted high-resolution mapping of multi-criteria decision analysis for sustainable manufacturing systems », *Journal of Cleaner Production*, vol. 257, 2020. <https://doi.org/10.1016/j.jclepro.2020.120272>
- D. Sharma, D. Claudio et S. Sridhar, « Comparison of AHP-TOPSIS and AHP-AHP methods in multi-criteria decision-making problems », *International Journal of Industrial and Systems Engineering*, Inderscience Enterprises Ltd, vol. **34** (2), pages 203–223, 2020.
- S. Villard, A. Bamogo, J. Artigas Sancho, Conseil Burkinabé de l'Anacarde, Fúnteni Installations et Conseil, et Nitidæ, *Etude de faisabilité Valorisation de la coque de noix de cajou Burkina Faso*, (2023). https://www.nitidae.org/files/5951da84/rapport_final_de_l_etude_coquenstock_sur_la_faisabilite_de_la_valorisation_de_la_coque_de_noix_de_cajou_au_burkina_faso.pdf
- T. L. Saaty et J. M. Katz, « How to make a decision: The Analytic Hierarchy Process », dans *European Journal of Operational Research*, vol. 48, 1990.
- B. S. H Sengar, S. S. Patil A et D. Chendake, « Economic Feasibility of Briquetted Fuel », *Global Journal of Researches in Engineering Chemical Engineering*, Vol. **13**, Issue 1 Version 1.0, 2013.
- M. L. Adekanbi et T. T. Olugasa, « Utilizing cashew nut shell liquid for the sustainable production of biodiesel: A comprehensive review », *Cleaner Chemical Engineering*, vol. 4, 2022. <https://doi.org/10.1016/j.clce.2022.100085>
- W. A. M. A. N. Illankoon, C. Milanese, A. K. Karunarathna, K. D. H. E. Liyanage, A. M. Y. W. Alahakoon, P. G. Rathnasiri, M. C. Collivignarelli et S. Sorlini, « Evaluating Sustainable Options for Valorization of Rice By-Products in Sri Lanka: An Approach for a Circular Business Model », *Agronomy*, vol. **13**, n° 3, p. 803, 2023. <https://doi.org/10.3390/agronomy13030803>