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Market potential of biobased chemicals: a qualitative network analysis of adoption dynamics in South Africa's bioeconomy

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Abstract: The premise of a bioeconomy is the replacement of nonrenewable and unsustainable fossil-derived resources and associated technologies with more sustainable alternatives. The adoption of biobased chemicals contributes toward the growth of a bioeconomy and is dependent on market and industry requirements. A network analysis-based qualitative study was conducted to understand the drivers and barriers that influence the adoption of biobased chemicals in South Africa, the largest and most industrialized economy in Africa. Stakeholders were selected based on their knowledge and experience in the biobased chemicals sector in South Africa and were interviewed on key themes that affect acceptance and adoption of biobased chemicals: business opportunities for biobased chemicals, market forces, product value chains, competitiveness, supply chain collaboration, financing, value chain governance, and policy. Network analysis identified bioethanol, lactic acid, and acetic acid as key products. Major drivers of the adoption of biochemicals included global market demand and the availability of biobased feedstock. Key barriers related to product price competitiveness and weaknesses in national policy implementation. The results indicate that substantial institutional investment across the biobased value chain is required to foster local and regional market demand. © 2026 The Author(s). *Biofuels, Bioproducts and Biorefining* published by Society of Industrial Chemistry and John Wiley & Sons Ltd.

Key words: biobased products; bioeconomy; biobased chemicals; biofuels; stakeholder analysis; industrialization; South Africa

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Introduction

The adoption of biobased chemicals, which account for approximately 2% of global chemical production, signals a shift towards a bioeconomy, which aims to replace nonrenewable fossil-derived resources with biological alternatives, reducing the environmental impacts of industrial processes and fostering sustainable economic growth.[1–5] This transition from a linear, fossil-based economy to a circular bioeconomy is driven by population growth, the need to address global warming, concerns over the sustainability of natural resources, and the environmental repercussions of conventional industrial practices.[6–10]

The bioeconomy encompasses all sectors and systems that rely on biological resources together with their functions and principles. Sustainability and circularity are central to the bioeconomy, underpinning industrial renewal, modernization of primary production systems, environmental protection, and the enhancement of biodiversity.[11] Bioeconomy strategies integrate goals such as biotechnological advancement, carbon emission reduction, conservation, waste reduction, and the development of biobased sectors to support communities and industry. More recent strategies have expanded to emphasize broader sustainability considerations, circular economy principles, renewable resources, resource efficiency, and system resilience.[12] The bioeconomy is closely aligned with several United Nations Sustainable Development Goals (UN SDGs), particularly Goals 9, 12, 13, and 15. Biorefineries serve as a fundamental unit within this framework, addressing pressing global challenges such as climate change, biodiversity loss, and resource depletion.

South Africa, as the most industrialized country[13] and the largest economy in Africa,[14] presents a unique opportunity for the market development of biobased products, with implications for the broader sub-Saharan region. Despite the establishment of the South African Bioeconomy Strategy, few studies have assessed market and stakeholder requirements for the adoption of biobased technologies in South Africa, particularly using network analysis. However, this is a key step that precedes technology adoption, provides insights into the drivers and barriers, and guides technology development and commercialization efforts.[15–17] Most studies have focused on technical and sustainability performance assessments to address challenges such as scaling from laboratory to commercial production,[18,19] feedstock selection,[20] and end-of-life treatment of biobased products.[5,21] However, technology adoption encompasses technology selection, purchase of the technology, and commitment to future uptake by stakeholders. These are driven by a set of criteria that allow the acceptance of the technology.[22] In developing countries like South Africa, external factors that influence corporate sustainability significantly include pressures from civil society groups.[23,24] While literature is available on the market potential of various platform chemicals, it is limited with respect to understanding critical strategic dimensions involved in the development and deployment of these technologies.

The current study employed a qualitative approach using a single-round Delphi methodology, prioritizing the quality of expert respondents over quantity. The aim of the Delphi method was to identify convergent themes from an expert panel that was familiar with the South African biobased chemicals landscape. Adopting these insights enabled an in-depth assessment of the market potential of biobased chemicals in South Africa.

The novelty of the study lies in its use of multidimensional network analysis to examine market potential, in contrast to the predominantly quantitative approaches used in most market potential studies.[18,19] The study evaluated the key factors and criteria influencing the adoption of biobased chemicals in South Africa through stakeholder interviews supported by a targeted literature assessment.

Specifically, the study (i) identified key criteria for assessing markets and stakeholders, (ii) qualitatively evaluated these criteria based on expert input, (iii) identified the various drivers and barriers to adoption, and (iv) discusses the key takeaways from the study. The US Department of Energy has identified potential biobased chemical substitutes, emphasizing the need for new strategic opportunities aligned to market needs.[25,26] These opportunities can be realized through the establishment of biorefineries that produce platform chemicals positioned within the value chain, facilitating the diversification of product portfolios.[25,26]

Using the South African biobased chemicals industry as a case study, this research links technical and financial feasibility with market viability. A conceptual framework comprising eight key themes and 26 criteria was used to collect stakeholder responses. These responses were evaluated qualitatively to assess the robustness of inductive and deductive codes, and the main drivers and barriers to adoption were identified. The study provides insights into the market attractiveness of biobased technologies and complements conventional assessments. Considerations such as market trends, opportunities for waste valorization, scale, socio-economic impacts, profitability, available support mechanisms, and adoption drivers and barriers are critical for advancing the bioeconomy in South Africa.

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Literature review

Biorefineries and biobased chemicals

Biorefineries are integrated facilities that convert biomass feedstocks into multiple products through physical, chemical, biochemical, and thermochemical processes. They are analogous to crude oil refineries. They form a subset of the bioeconomy, producing diverse high-value chemicals and materials, such as nutraceuticals, pharmaceuticals, and polymers, which offer greater market value than energy products. This economic potential drives biorefinery development, positioning them as key enablers of the bioeconomy.[11] Their advancement supports several United Nations Sustainable Development Goals, particularly Goal 9 (industry, innovation, and infrastructure), Goal 12 (responsible consumption and production), Goal 13 (climate action), and Goal 15 (life on land), by promoting sustainable industrialization, resource efficiency, climate mitigation, and biodiversity conservation.[27,28]

Investment in biobased chemical production is increasing, with major advancements in Europe and growing technical progress in the USA, Asia, and Brazil, particularly in facilities that utilize sugar and starch feedstocks.[29] The diversity of feedstock and conversion technologies suggests that integrated biorefineries could be pivotal in the sugar industry. The competitiveness of the European industry against counterparts in the USA, Brazil, and China has been evaluated based on criteria such as policy, financing, public perception and consumer acceptance, research and development (R&D) activity, commercial activity, feedstock availability and cost, and other production costs.[29,30] Technical barriers, including product yields, energy demand, and process scale up, as well as nontechnical barriers, such as policy, public perception, investment, and feedstock availability, have been identified.[30] Similarly Dessi *et al.*[22] conducted a content analysis with European stakeholders to identify factors promoting or inhibiting the acceptance of biofuels, examining four clusters: intrinsic technology characteristics, economic and market features, policy and administration aspects, and social psychological factors.

Biomass resources for biobased chemical production

In response to growing concerns over climate change, many countries are promoting the industrial use of biomass as a sustainable alternative to petrochemical resources.[31,32] Biomass can be converted into bioproducts in two main categories: bioenergetic and nonbioenergetic applications. By 2027, an estimated 19.2% of biomass will be used for bioenergetic purposes, such as biofuels and biopower.[33] The nonbioenergetic sector, which includes biobased chemicals, has shown significant growth, with projections suggesting that 23.4% of all biomass (excluding raw wood) will be directed toward biobased chemicals and materials by 2027.[33,34]

The feasibility of producing biobased chemicals is influenced by the cost of raw material extraction, making careful selection of feedstocks essential. Biomass resources such as agricultural residues, dedicated energy crops, and waste streams offer viable options for producing a variety of biobased chemicals, with lignocellulosic biomass, including sugar cane bagasse and corn stover, being particularly promising due to its abundance and lower competition for land use.[35] Countries like Brazil and the USA lead in renewable chemical production, leveraging their abundant biomass resources.[33,34]

In our literature review,[36] we identified several biobased chemicals of interest that can be produced from biomass resources, highlighting potential opportunities to convert waste into valuable products at an industrial scale in South Africa. Approximately 26 million tonnes of agricultural and forestry residues are generated annually in South Africa, presenting substantial opportunities for the biofuels and biochemical industries.[35] The South African government's biofuels strategy aims to stimulate the rural economy and create sustainable jobs, suggesting that converting a significant portion of available biomass could meet a substantial share of the country's liquid fuel requirements. As the global market for biobased chemicals expands, South Africa can enhance its economic viability and contribute to sustainability goals. Understanding market dynamics and stakeholder requirements will be essential for navigating this transition and ensuring the effective commercialization of biobased products.

Market and stakeholder requirements for biobased chemicals

The criteria for acceptance and adoption of a technology can be broadly categorized into five factors: (i) technology features; (ii) economic and market aspects; (iii) environmental considerations; (iv) policy and administration aspects, and (v) social-psychological factors.[22] Understanding these factors is essential for stakeholders as they navigate the complexities of integrating biobased chemicals into existing markets. The market potential of new products requires continuous product development and should be aligned to the market and customer needs. New products must also compete on price and performance with products derived from fossil fuels.[26]

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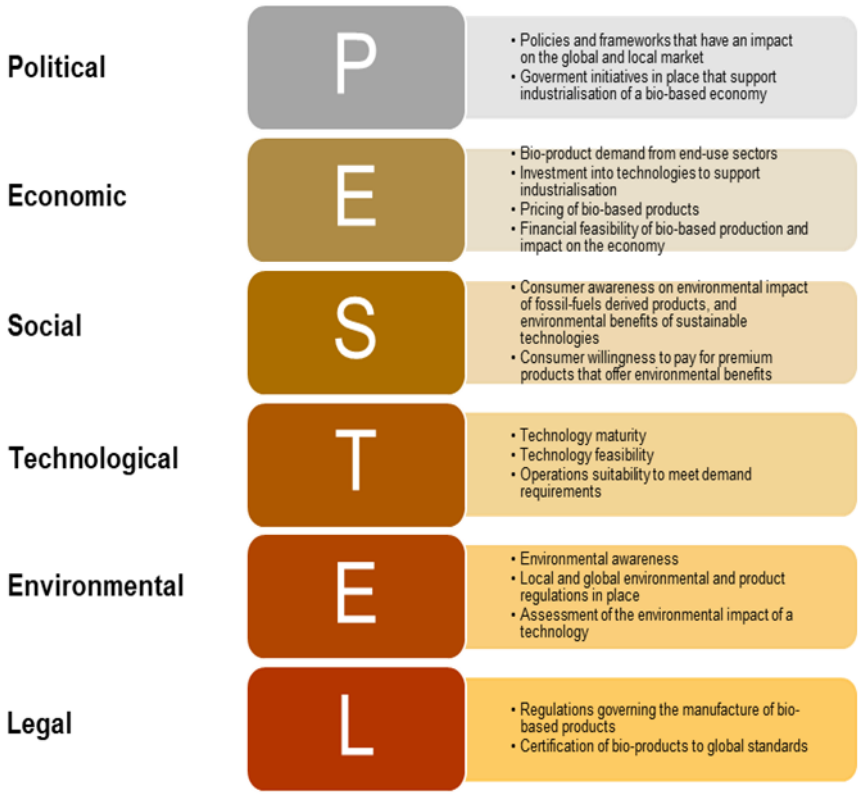

Figure 1. PESTEL framework for the industrialization of biobased chemicals. Source: Adapted from de Sousa, G.C. and Castañeda-Ayarza, J.A. (2022) PESTEL analysis and the macro-environmental factors that influence the development of the electric and hybrid vehicles industry in Brazil. Case Stud Transp Policy, 10, 686–699.[42]

In the survey conducted by Jernström *et al.*,[26] industry challenges that were identified included inadequate infrastructure, investor reluctance, and the need for different competencies during two phases of development, namely, technology upscaling and commercialization. These challenges highlight the importance of strategic planning and stakeholder engagement in the transition to biobased chemicals. Bomtempo *et al.*[25] suggested that platform chemicals must meet six strategic dimensions to be attractive: their position in the value chain, chemical structure flexibility, potential for transformation into cost-competitive products, alignment with innovation agents across the value chain, governance of the value chain, and scalability. Porter's five forces framework is a tool for developing business strategies, considering the competitive forces within an industry that affect profitability.[37,38] Studies have applied this framework to the biorefinery sector, assessing the market attractiveness of various biobased products, including bioethanol.[39–41] Helal *et al.*[38] proposed an algorithmic methodology to assess biobased products using Porter's five forces, in which qualitative assessments can be translated into a set of data requirements and questions relevant to the biobased chemical industry. The interactions between these five forces shape competition in an industry and threaten the success of an organization. In contrast, the PESTEL framework assesses segments within the macro-environment, and is less focused on market dynamics or competitive strategies (Fig. 1).[42]

South Africa is one of the few African countries to have established an integrated bioeconomy strategy.[4,43–46] Adoption of bioeconomy principles requires consideration of factors such as equity, sustainable biomass supply, land use, biodiversity or ecological risks, and social impacts.[47–51] Aligning bioeconomy strategies with the United Nations Sustainable Development Goals is essential to ensure contributions to global sustainability, particularly in reducing poverty (Goal 1), promoting sustainable livelihoods (Goal 8), and addressing climate change (Goal 13). Despite existing policy and governance frameworks, factors beyond the political and scientific domains remain insufficiently investigated.[50]

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Table 1. A summary of the factors and criteria used to conduct the stakeholder needs analysis, and corresponding literature references.

	Factors or themes	Criteria	References
1	Business opportunity for biobased chemicals	Target products	[38]
2		Market opportunity	[38]
3	Business forces	Pressure from partners	[26]
4		Regulation (environmental, product, other)	[26,41]
5		Pricing (raw materials, fluctuations, stability)	[26]
6	Product value chain	Intermediate position in chemical value chain	[25]
7		Flexibility of the chemical structure to be transformed	[25]
8		Number of potential products	[25]
	Competitiveness	*Current products in the market*	
9		Substitute products	[37]
10		Imported products	[37]
11		Local products	[37]
12		New potential entrants	[37]
		Product offering biobased chemicals	
13		Potential market share per product	[41]
14		Novelty of the chemical	[26,38]
15		Customer willingness to pay	[25]
16	Supply chain collaboration – creating value	Supply side economies of scale	[37,38]
17		Demand side economies of scale	[37,38]
18		Profitable economies of scale (ROI)	[25]
19	Financing the business	Investor interest	[38,39]
20		Product diversification investment	[39,58]
21	Governance of the value chain	Access to innovation agents in the value chain (R&D)	[25]
22		Operational suitability to implement at scale (production)	[25]
23		Governance mechanisms to implement at scale (sustainability)	[25]
24	Policy	Government policy	[26,37–41]
25		Government regulation	[26,37–41]
26		Government support mechanisms	[26,37–41]

(Continues)

Methods

Our study aimed to assess qualitatively the industry need for biobased chemicals in South Africa. The approach was based on a single round Delphi methodology, which involved engaging experts in the field to gather insights and perspectives. The objectives were to identify key criteria for understanding industry needs, conduct a qualitative assessment of stakeholder views and literature, and determine the main drivers and barriers to adoption. Semistructured interviews enabled an in-depth exploration of challenges and interpretations, capturing respondents' perspectives on specific topics.[22,52,53]

Data analysis employed a hybrid method, combining deductive and inductive techniques, executed in two stages.[53–55] Initially, a deductive approach was applied, using an existing theoretical framework and a top-down development process.[55] This involved creating a coding scheme prior to analysis to align the research with existing theories and knowledge.[54] Thereafter, an inductive approach was applied, allowing themes to emerge naturally from the data through open coding.[56,57] This bottom-up method facilitated the discovery of new subthemes and ensured that preconceived theories did not overly constrain the research findings.

Framework for assessment of criteria

Based on a review of the literature, and following the approach of Jernström *et al.*,[26] eight factors or themes and 26 criteria were selected to conduct the stakeholder needs analysis, as outlined in the framework in Table 1.

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Stakeholder interviews

The stakeholders approached for interviews included experts from industry, academia, and other institutions (organizations or government entities). Stakeholders were identified using purposive sampling to ensure relevance to industry sectors or research related to biobased chemicals, as outlined in the literature review.[36] Of 22 experts invited from different geographic regions across South Africa, nine (40.9%) agreed to participate, six (27.3%) declined, and seven (31.8%) did not respond to the invitation. Given that the bioeconomy industry is relatively small in South Africa, this context is indicative of the limited response rate we encountered. A total of nine semistructured interviews were therefore conducted with all participants providing written informed consent using a consent form.

Data collection

Data were collected through semistructured interviews using a questionnaire comprising 26 structured and open-ended questions, aligned with the predefined framework (Table 1). The questions were leading in nature and were answered based on respondents' knowledge of specific biobased chemicals or products of interest, as well as their broader expertise across multiple chemicals or sectors. Interviews were conducted via MS Teams, lasting 30 to 90 minutes each. All sessions were recorded and subsequently transcribed for analysis.

Data analysis

Primary data for the qualitative analysis were obtained from the interview transcripts[23] and secondary data from literature-supported key statements and conclusions about factors influencing the adoption of biobased technologies in South Africa.[59] Using a deductive approach, an initial coding scheme of themes, subthemes, and codes was developed (Table 1). Text data were then coded using Atlas.ti software, a nonhierarchical tool capable of handling complex textual analysis.[52,56,60] Relevant words, phrases, sentences, or sections of the transcripts were first coded according to this scheme. An inductive approach was subsequently applied to identify new criteria when transcript segments did not match predefined codes. All codes were then reviewed, merged where appropriate, and relationships within key themes were derived using the network feature in Atlas.ti. Finally, themes, subthemes, and codes were consolidated into the final coding scheme. Systematic triangulation was employed to evaluate the data and finalize the main outcomes of the study (Fig. 2).

Results and discussion

A network diagram generated using Atlas.ti software identified key biobased chemicals of interest based on stakeholder input (Fig. 3). No new themes emerged during the interviews, confirming those identified in the literature. A total of 61 codes were used for content analysis: 16 were derived deductively and 45 inductively, as shown in the Appendix A. Inductive codes arose from positive or negative sentiment analysis, new emerging criteria, and rewording of existing codes. Following Dessi *et al.*,[22] coded text extracts aligned with specific themes were interpreted as indicating positive or negative sentiment toward biobased chemical acceptance and adoption. The total number of extracts corresponding to each code (groundedness) was summarized for each theme or subtheme and are presented in the figures 4–13.

Business opportunity for biobased products

Targeted products

The main focus was on bioethanol, lactic acid (LA), acetic acid (AA), furfural, and xylitol. Stakeholders also mentioned broader categories such as multiple targeted chemicals, volatile fatty acids (VFAs), and bioplastics. Most stakeholders showed particular interest in bioethanol, LA, AA, and multiple targeted chemicals.

Overall market opportunity

Stakeholders recognize both local and global market potential for biobased chemicals (Fig. 4). Local opportunities in South Africa are limited due to the emerging stage of the industry, insufficient infrastructure, and underdeveloped supply chains.[61] Local technologies are not yet commercially viable, resulting in high costs that deter market interest and investment. There is also limited awareness of biobased products and sustainability issues in South Africa.

Globally, biobased chemical and polymer production is substantial, with an estimated 50 million tonnes produced annually and generating over USD 5.4 trillion.[61] Major economies drive the implementation of sustainable technologies in developing countries. For example, South Africa's bioethanol industry has been shaped by global policies

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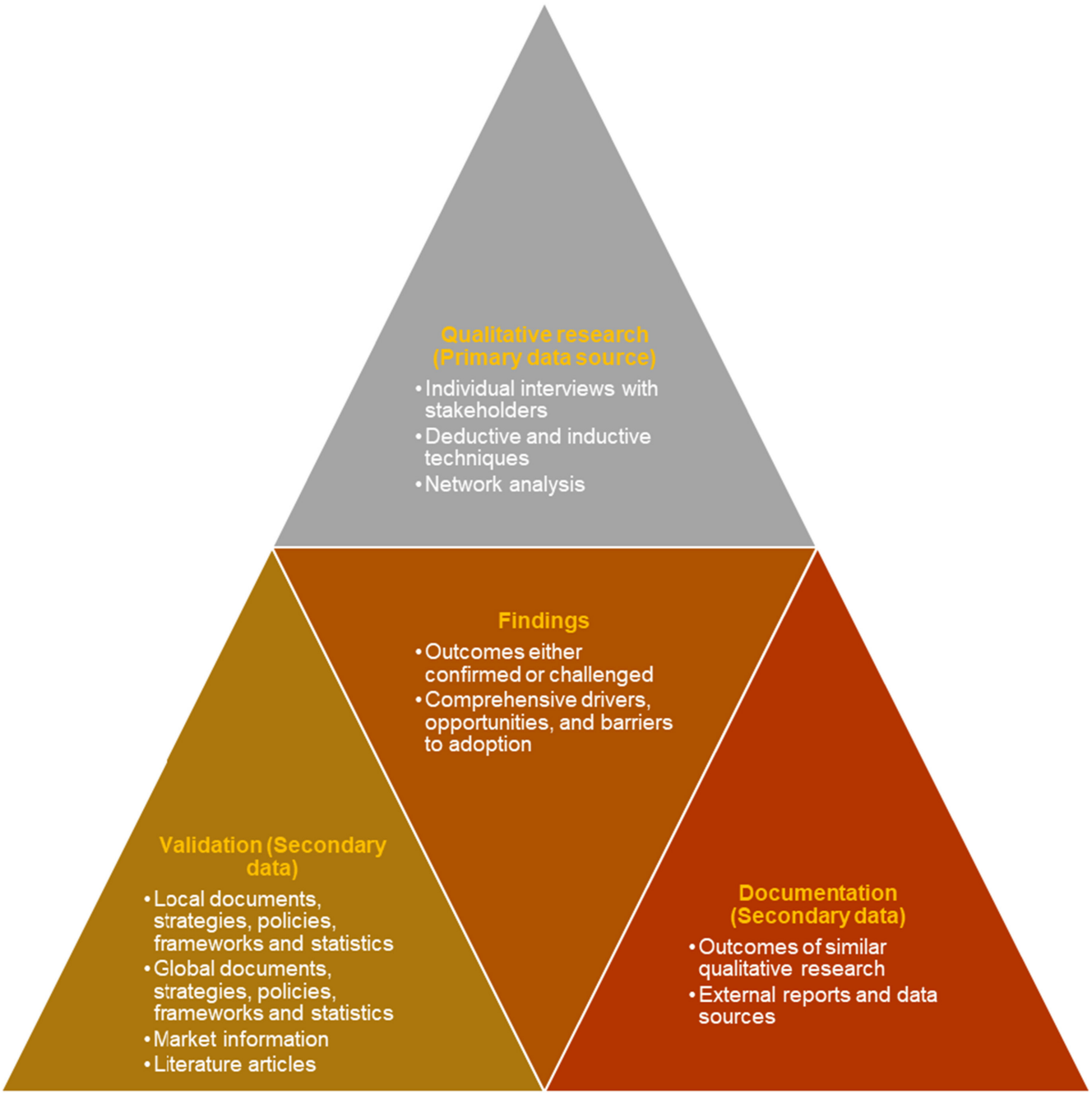

Figure 2. Systematic approach for evaluation of primary and secondary data.

and frameworks established in the early 2000s to promote biofuel production and consumption.[62] Key legislation includes the European Union's Fuel Quality Standard, Renewable Energy Directive (RED), and the USA's 2007 Energy Independence and Security Act and Renewable Fuel Standard, all designed to increase biofuel use. Despite these efforts, recent changes in US domestic demand and European legislation have limited opportunities for biofuel imports from developing nations.

Business forces

Most stakeholders agreed that the adoption of biobased chemicals is influenced by pressure from partners, stakeholders, and regulations. Key drivers include local environmental regulations, global pressure and environmental regulations (Fig. 5). Pricing factors also play a role (Fig. 6), with high product prices and global price stability being significant concerns. Local product

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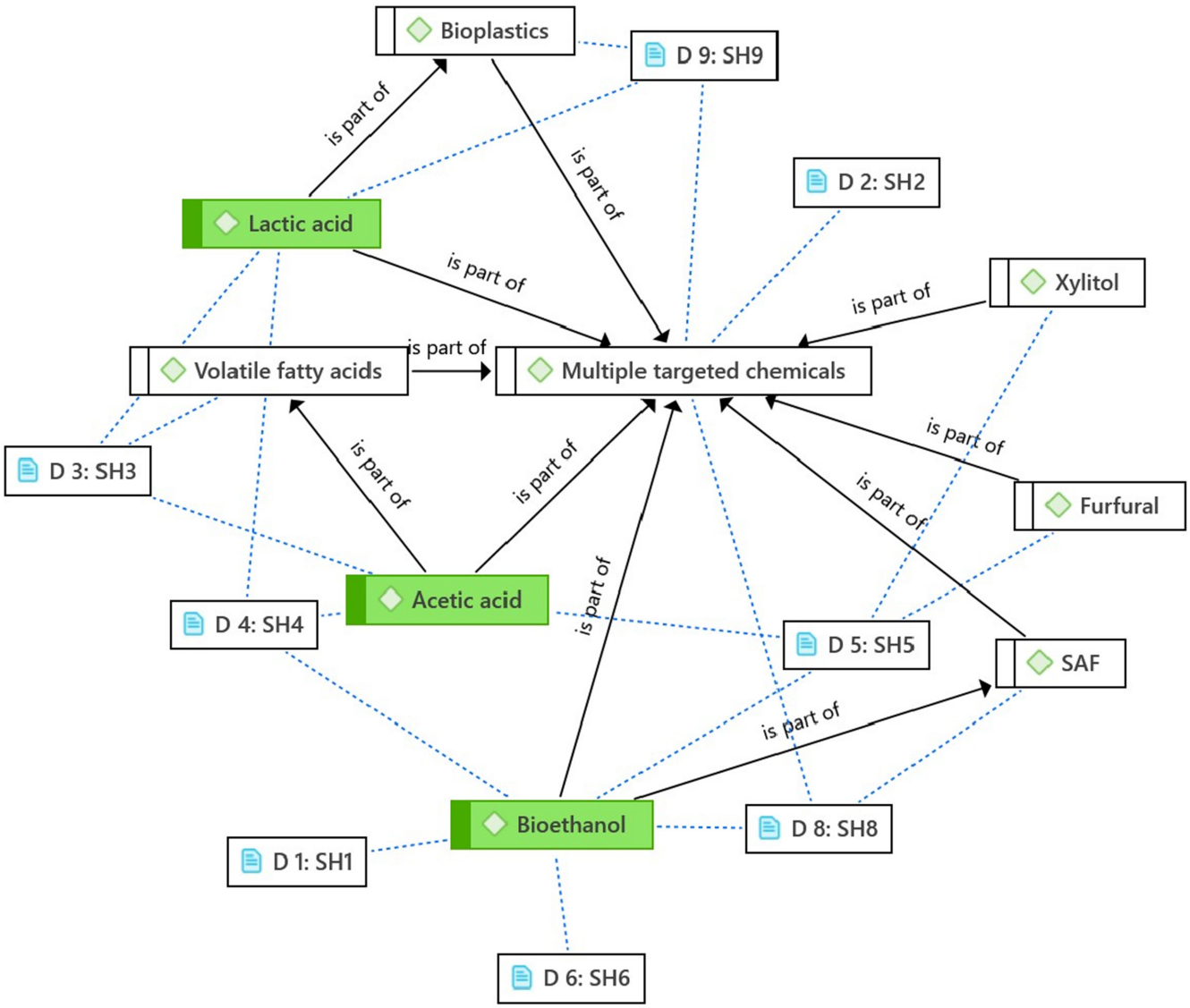

Figure 3. Summary of the targeted products emanating from the stakeholder analysis. A blue-dotted line indicates the product or biobased chemical that was mentioned in the interview. Black solid lines indicate the relationships between the codes. D indicates interview number for each stakeholder. SH indicates stakeholder and number. SAF refers to sustainable aviation fuel.

prices and the cost of raw materials also affect adoption.

Pressure from partners and stakeholders, and regulation

A global paradigm shift and global trends are driving the transition toward more sustainable operations, and this is based on climate change… *[SH1]*

…there may be pressure for South Africa to comply from a global perspective even though the country may not yet be ready from a regulatory perspective. *[SH3]*

Global forums and market leaders, such as the UN Climate Change Conferences (COP), are driving the adoption of biobased chemicals and sustainable technologies. At COP21, South Africa set a target for a 4.5% CO_2 reduction by 2030, and COP27 saw the release of the Framework for a Just Transition in South Africa by the Presidential Climate Commission.[63] Laws and regulations are key drivers for sustainability practices.[23] In developing countries, stakeholder pressure for corporate social responsibility (CSR) reporting is often driven by parent companies and international buyers.[23]

Stakeholders highlighted several key local environment regulations in South Africa that were aligned with research findings: mandated biofuel blending rates (2% to 10%

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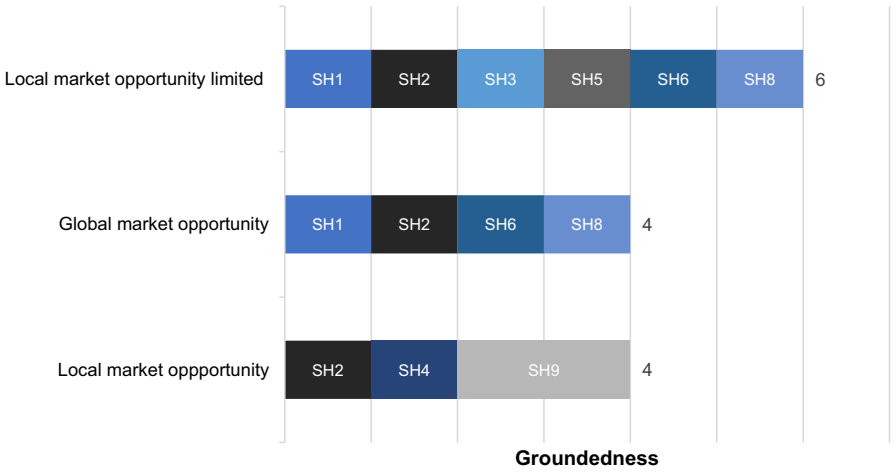

Figure 4. Codes associated with the overall market opportunity.

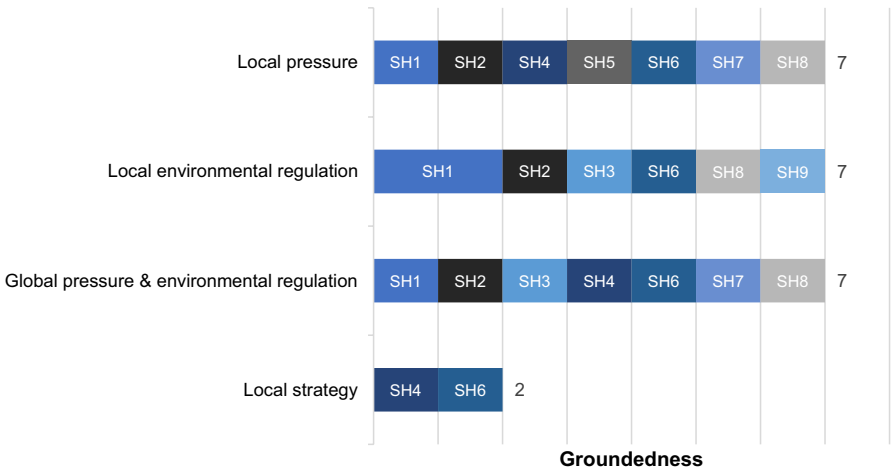

Figure 5. Codes associated with pressure from partners, stakeholders, and regulation.

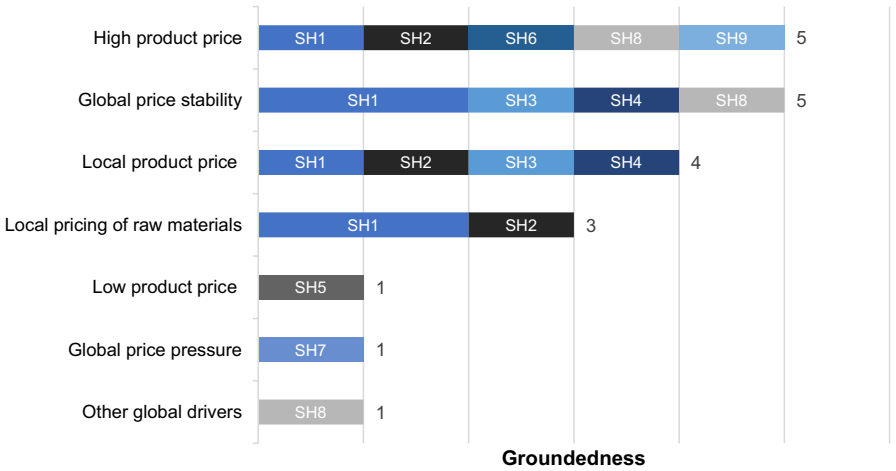

Figure 6. Codes associated with the pricing of raw materials, price fluctuations, and price stability.

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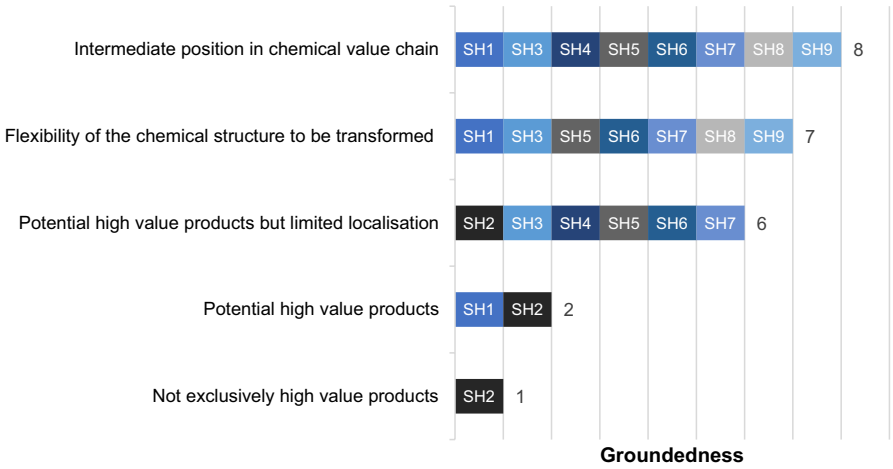

Figure 7. Codes associated with the product value chain.

for bioethanol),[64] a feedstock protocol aligned to biofuels production and food security,[65] regulation on landfilling, allowable waste types and volumes, and replacement of plastic bags with reusable, biobased, or compostable bags.[66] The feedstock protocol excludes staple crops like maize but has faced criticism for excluding potential impacts on maize prices and biodiversity.[67] Regulations also mandate alternative waste management practices and have banned certain liquid and hazardous wastes from landfill.[68,69] Amendments to plastic bag regulations require specific postconsumer recycled content until January 2027.[66]

Despite financial constraints slowing adoption,[70] there is positive focus on alternative waste treatment solutions and regulatory reforms, including the Extended Producer Responsibility (EPR) Regulations.[71] Public concerns over plastic pollution[72] also highlight a need for more legislation on biodegradable and compostable materials and their postconsumer management.[73]

Pricing of raw materials, price fluctuations, and price stability

I don't see the fossil prices going up so rapidly that they are making the biobased prices suddenly very attractive, therefore the fossil prices are not a driver to transition… [SH8]

…the pricing of green alternatives is higher than petrochemical products therefore [the] market must be willing to pay the premium price…There is work being done on the cost of the raw material. [SH2]

…it may only be feasible to sell the bioethanol if the government subsidizes the 1G production costs… [SH1]

Most of the stakeholders agreed that the high price of biobased products, compared with fossil fuel-based products, is a significant barrier to the adoption of biobased chemical technologies. They believed that the global price of fossil fuel-based products was not currently driving the adoption of biobased alternatives, as petroleum price fluctuations were not drastic enough to make fossil fuels more expensive than biobased products. Stakeholders suggest that subsidizing the production costs of biobased chemicals could make these products more cost competitive.

Product value chain

There was consensus from the stakeholders that the chemicals or products of interest had an intermediate position in the chemical value chain, had the potential to be transformed, and were associated with potential high value products but limited localization (Fig. 7).

In general, the biobased industry will need to adopt the same intermediates as the fossil-based industry, due to significant investment made into the fossil-based value chain… [it would] make more sense to sell the intermediate that can then be used by an existing value chain. [SH8]

However, technologies to get to the higher value products may not yet be localized or commercialized in South Africa… [SH2]

Stakeholders are optimistic that focusing on intermediates and conversion to various end products could offer better market opportunities than establishing fully fledged end-to-end industries. High-value products identified by stakeholders include bioethylene, sustainable aviation

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fuel (SAF), mono ethylene glycol (MEG), volatile fatty acids (VFAs), biogas, products of anaerobic digestion, pharmaceutical industry products, LA, AA, polylactic acid (PLA), bioplastics, farnesene, xylitol, furfural, and biolubricants. These products align with market and literature findings.[61,72,74–79] The following biobased chemicals and products are part of the top 25 sugar platform products:[30]

- acetic acid – a volatile fatty acid;
- bioethylene, produced from bioethanol;
- bioethanol, used in the production of SAF or biolubricants;
- lactic acid, used to produce PLA or bioplastics;
- furfural;
- xylitol;
- farnesene.

Sustainable aviation fuel, a drop-in fuel for the aviation industry, appears closest to market realization based on existing facilities in South Africa. The International Air Transport Association (IATA) aims for the global air transport industry to achieve net-zero carbon emissions by 2050, with SAF production contributing 65% to this goal. Bioethanol remains the dominant sugar platform product, followed by significant markets for *n*-butanol, AA, and LA.[30] The strongest growth is expected for secondary chemicals like PLA, polyhydroxyalkanoates (PHAs), and bioethylene, which are used to manufacture bioplastics.[34]

Competitiveness

Stakeholders showed some consensus that factors related to existing products and market competition that affected the

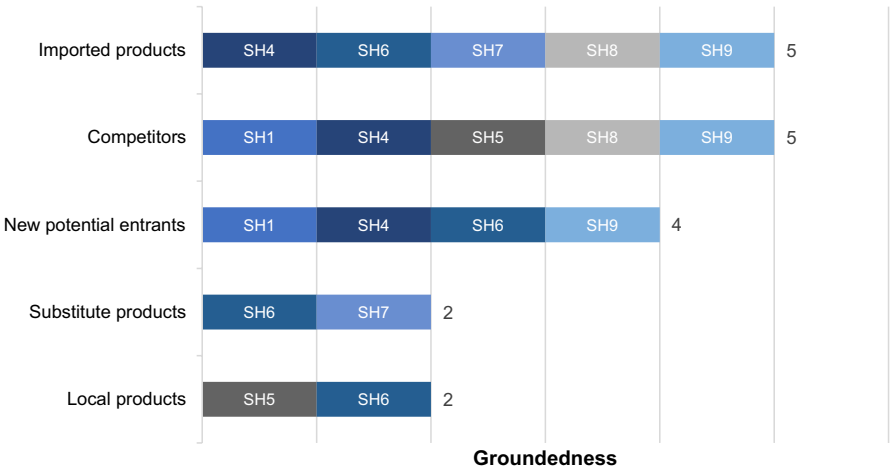

Figure 8. Codes associated with current products and competitors in the market.

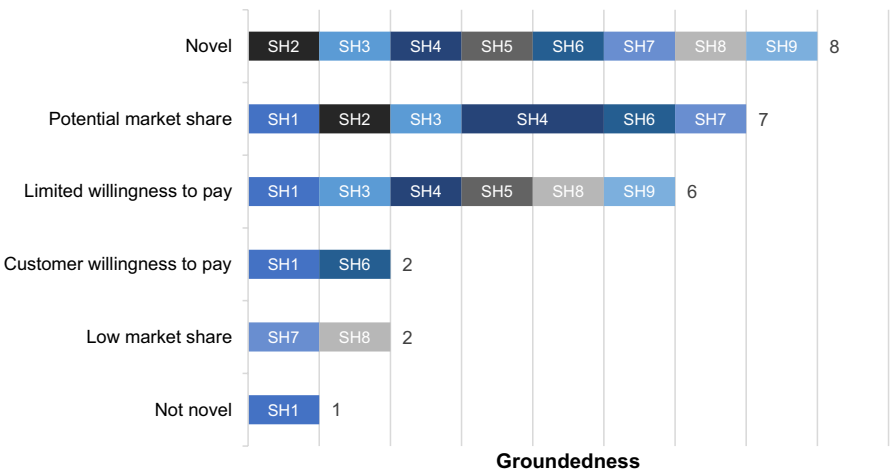

Figure 9. Codes associated with the market opportunity for product offerings.

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adoption of biobased chemicals included imported products and competing offerings in the market (Fig. 8). The majority of stakeholders indicated that current product offerings have market potential, largely due to the novelty of the biobased chemical or product, and the potential market share that can be captured (Fig. 9). The main barrier to adoption was the limited customer willingness to pay for the current product offerings.

Current products and competitors in the market

Global producers can produce at scale and therefore can produce cost-competitive products. Also competing with subsidized products globally… *[SH6]*

The sugar industry. For other chemicals, competitors include conventional petrochemical producers or importers. *[SH5]*

A major player in the petrochemical industry is currently in the market for green hydrogen…Once they secure the technology, they will dominate the industry due to the value chain in place…Other new players would be the biomass processing industries…paper and pulp industry and the sugarcane industry… *[SH8]*

Despite the significant contribution of the chemicals sector to South Africa's GDP, the country remains a net importer of chemicals, including both petrochemically derived and biobased chemical intermediates.[80] Biobased chemical intermediates are a small fraction of the total chemicals imported but, according to stakeholders, they continue to be imported due to the lack of local manufacturing infrastructure and high production costs. For instance, there is no PLA production plant in South Africa, or Africa, making access to PLA for bioplastics production difficult due to the gap between high demand and low supply.[81] Global producers who can produce chemicals at scale are seen as barriers to adopting biobased alternatives. Local competition varies depending on the perspective of the stakeholder; small, medium, and micro enterprises (SMMEs) view competition in a different way from academics. Stakeholders identified imports and the sugar, petrochemical, and paper and pulp industries as competitors to local biobased chemical production.

Market opportunity for product offerings

The novelty is the circular approach, especially if it's from organic waste; novelty is in the technology and the materials being used. *[SH3]*

Specifically biolactic acid, it is possible to capture [the] South Africa market (such as the food industry etc.)… *[SH4]*

…there is potential especially if blending is enforced, but I can't see the bioethanol market being established by small business alone. It has to be established together with feedstock supplier… *[SH4]*

None of the products and none of the local markets we've looked at are willing to pay that premium… *[SH8]*

The production of biobased chemicals involves innovative approaches at various stages, from feedstock preprocessing to bioconversion. Carolin *et al.*[82] and Machado *et al.*[83] explored different waste and hybrid feedstocks, as well as preprocessing techniques. Process modifications and optimizations, including hybrid methods and integration with petrochemical processes, are key to improving yields and are considered novel.[82,84] Wild-type biological strains are commonly used in bioprocesses, but when they fall short of the desired economic production levels, metabolic engineering is employed to enhance output through methods like pathway amplification, byproduct deletion, or creating new synthetic pathways.[85] These engineering strategies, which encompass traditional metabolic engineering, synthetic biology, and systems metabolic engineering, contribute to the novelty of the production process. This novelty allows smaller producers to compete in the market without infringing existing patents or trademarks. Despite these advancements, stakeholders expressed concerns over the current price points of biobased chemicals, which may not be competitive in the market, even with novel production aspects.

Supply chain

Most of the stakeholders recognized supply side economies of scale for the biobased chemicals or products but were concerned about supply constraints (Fig. 10). Stakeholders recommended using sugarcane byproducts such as molasses for biobased chemicals production, suggesting a redirection of the sugarcane crop towards production of these sustainable alternatives.

Due to regulation in place, there is opportunity to produce the specified feedstock and introduce other entrants into the market via the supply chain. *[SH1]*

Raw materials are sufficient but also dependent on the chemical to be produced: looking at a niche market where smaller feedstock amount is required versus high volume commodity chemical…In general, there is currently a

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surplus amount of sugar produced in South Africa and therefore diversification becomes important for the future sustainability of the industry. [SH2]

The sugar industry has identified redirection of their feedstock as a priority because we can't compete with imported sugar prices… [SH4]

There are varying reports on the amount of feedstock available. Reliable numbers may not be available… [SH5]

Feedstock security could be challenging based on the type of product. Commodity type products require large scale… challenge from a climate perspective; quality concerns with agricultural feedstock. [SH7]

The Sugar Act and Sugar Industry Agreement are being reviewed to diversify the sugar sector beyond conventional products. The Sugarcane Value Chain Master Plan supports using sugarcane-derived ethanol for SAF production. If South Africa allocates 50% of its sugarcane for ethanol, it could yield approximately 433 million L of SAF annually.[77] Stakeholders acknowledge supply-side economies of scale but note that studies to determine plant capacities for market demand are in progress. For example, data on available volumes of invasive alien plants (IAPs) in South Africa are lacking. Despite the complexity and estimated R9 billion investment needed for liquid fuel production from IAPs, South Africa is believed to have sufficient IAP reserves for the next 20 years.[77]

The supply-demand analysis for a project is an important part of the project that would ultimately determine feasibility or profitability. [SH2]

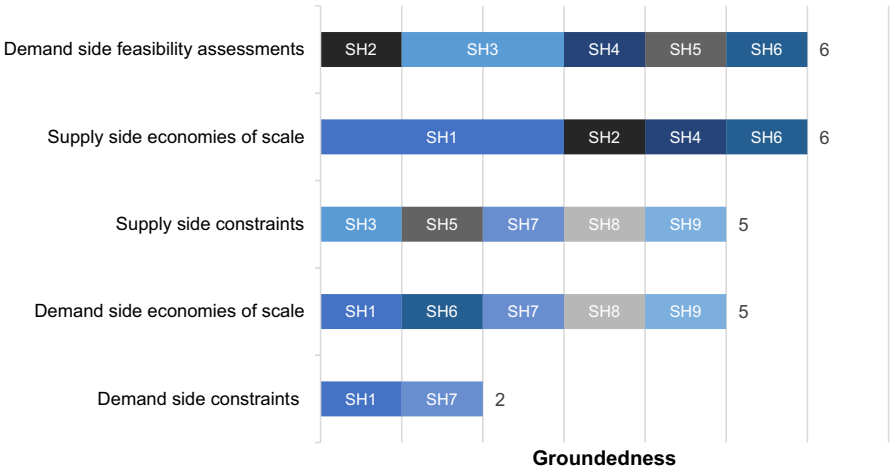

Figure 10. Codes associated with the supply chain.

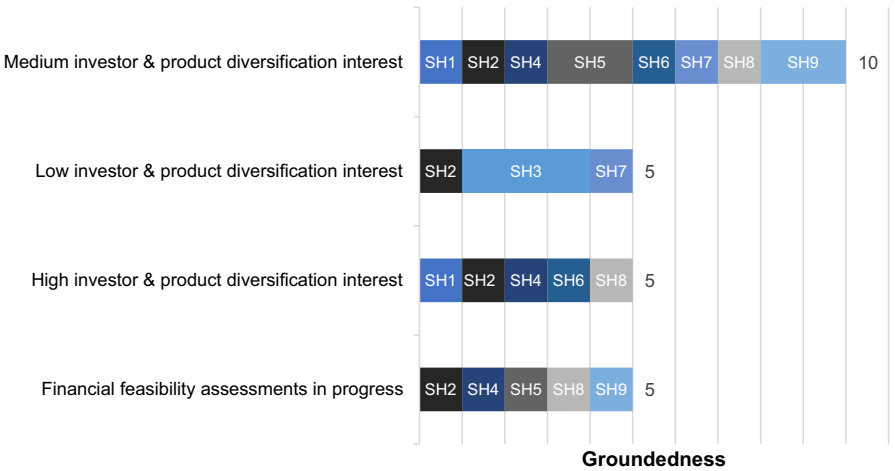

Figure 11. Codes associated with financing the business.

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Export markets are big enough; in our models we ensure that the local production plant doesn't exceed more than 10% of global demand for a particular product. [SH8]

There is currently enough capacity to support the demand due to biobased products coming in as a substitute to the conventional products…channels that already exist… [SH9]

Stakeholders generally agreed that there was a significant demand for biobased chemicals and products yet they indicated a lack of comprehensive feasibility studies that evaluate both supply and demand economies of scale and factors influencing market adoption.

Finance

Stakeholder feedback indicates a moderate interest in investing and diversifying in the biobased chemical sector (Fig. 11), with investment sentiment ranging from low to high depending on the product's maturity. Most stakeholders are currently evaluating the financial viability of such investments.

Significant investor or institution interest will always be there, but full commercial commitment [is] only realized as you progress through the project development stages, as the project moves to bankable feasibility. [SH2]

…paper and pulp and sugarcane industries. They are both looking at diversification to some extent. It's probably a lot more urgent in the sugarcane industry … There is the sugarcane master plan that has clearly said there's only two futures for this industry, it's either decrease the sugar industry substantially, or make it more diversified. [SH8]

Number of assessments for in-licensing of technologies, which is seen as an affordable option for South African companies to get in technologies versus investing (setup costs, feasibility etc.). [SH4]

The government and several companies were identified as significant investors. The paper and pulp and sugarcane industries have expressed interest in product diversification to drive financial growth. South Africa's annual sugar production has declined by approximately 25% over two decades, paralleled by a 60% reduction in sugarcane farmers and a 45% decrease in industry jobs.[86] The current sugar industry is unsustainable, prompting the establishment of the 2030 Sugarcane Value Chain Master Plan. This plan includes a task team dedicated to diversification strategies, exploring opportunities in bioethanol for fuel, biojet fuel, pharmaceutical-grade bioethanol, electricity from biomass,[87] biogas, low-calorie sweeteners, and biobased chemicals and polymers for various industries.[86]

Stakeholders indicated that detailed feasibility studies are required before investing in product diversification and suggested that licensing in of technologies may be preferable to local development.

The challenge still remains in investment around the proof of concept… [SH3]

The best two examples would be the 1,3-propanediol [1,3 PDO] and 1,3-butanediol [1,3 BDO] that I mentioned, which are global examples…Except for 1,3 PDO, all the other biochemicals are still dependent on what we call the green premium. [SH8]

…ethanol that can be produced from a group of organic wastes presently going to landfill, so that is a potential platform chemical industry…similar to the economics of producing ethanol from grains or from sugarcane… [SH8]

Extensive studies have been done on costing…specifically with respect to packaging. The financial assessments are not yet finalized. [SH9]

Investor and product interest in biobased chemicals fluctuates over the project life cycle; however, it increases substantially once feasibility has been demonstrated. The viability of chemicals depends on raw materials, technology, scalability, and market value. Stakeholders are assessing the financial feasibility of various biobased chemicals, including ethanol. Global studies on chemicals like 1,3 PDO and 1,4 BDO suggest potential applications in South Africa. However, adoption depends on the local market's willingness to pay a 'green premium' due to higher costs than fossil-fuel derived products. A subsidy model or exporting to markets that are willing to pay the premium may be necessary.

Governance

Most stakeholders agreed that, although there are operational tools for scaling up technologies, they may not ensure full commercialization (Fig. 12). A review of equipment, infrastructure, and integration for large-scale biobased chemical production is needed. Access to innovation agents is available for assessing technology feasibility before commercialization.

This is part of the project and development. It is dependent on whether coupling or partnering with an existing sector or whether it will be a completely greenfield application. [SH2]

Government [is] currently pushing for biochemical innovation; however because it hasn't been done in Africa, mechanisms

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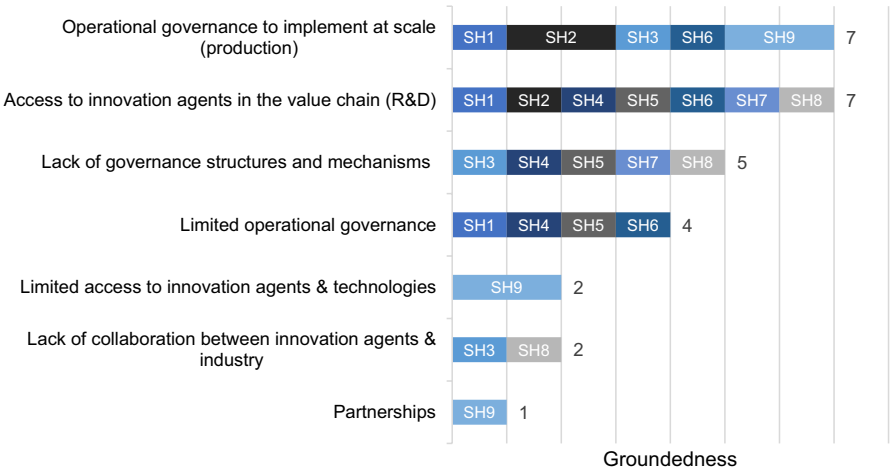

Figure 12. Codes associated with governance.

may not be in place at the scale of operation. Various controls would need to be looked at, e.g. hazardous chemicals… [SH4]

In [the] context of producing chemicals from a sugar mill, it will be a significant step away from the current operations and current governance systems which are adapted to the sugar industry. [SH8]

Any producer of plastic bags, bottle[s], containers, using the same equipment can produce biobased products without the need to invest further. [SH9]

…well regulated (South African Investment Regulatory Framework) to protect investors or funders. However, not yet well understood by the investor in terms of technology, therefore, from a funding institution perspective, there hasn't been a lot of time spent understanding how to mitigate the risk. [SH9]

The technology landscape suggests that leveraging existing infrastructure and partnerships could aid in producing biobased products, but raw material pretreatment is essential. Biomass beneficiation is a key consideration for climate change and sustainable development given the abundance of agricultural byproducts and the environmental, economic, and societal impacts of technology.[88] Circular economy challenges include raw material beneficiation, aligned to sustainable waste management and producing high-value products. Land governance for crop cultivation is another hurdle.[88]

In the sugar industry regulatory support is required for small-scale sugarcane growers to ensure safety and address other considerations.[77] Governance in Africa should focus on policies for technology adoption with economic benefits, using local expertise for new technologies, workforce training, and sustainable financing.[88]

Globally, initiatives have included South African and broader African stakeholder participation, such as the adoption of the Global Framework on Chemicals and the Bonn Declaration at the International Conference on Chemicals Management (ICCM5).[89,90] However, gaps remain in South Africa's governance frameworks for biobased chemical adoption. Stakeholders emphasized existing processes, but placed less emphasis on the necessary governance mechanisms for sustainable commercialization. Effective governance is crucial for a bioeconomy's success, and although relevant strategies exist, their effectiveness in practice is unclear.[91] Governance frameworks should enable business innovation and sustained economic performance, and effective dissemination by multiple actors is necessary to support successful adoption of biobased technology.

Technology development has some activity but can be at a bigger scale. Being globally leading is cost intensive. Also require enough technology licenses for technology to be viable. [SH8]

…there is a need to invest and partner, to sign license agreements, and bring in knowledge from other countries to develop know-how. [SH9]

Developing local expertise and self-sufficiency is important within an African context but access to innovation agents, collaboration, and partnerships may enable more seamless adoption of biobased technologies. This includes licensing in of technologies that already exist globally. The optimum mix of locally developed and licensed-in technologies that will still ensure effective socio-economic development has not yet been fully understood.

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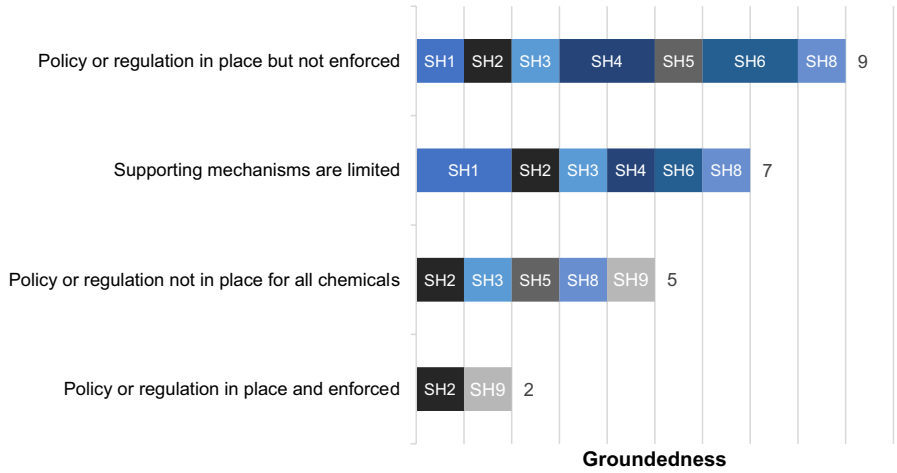

Figure 13. Codes associated with policy.

Policy

The stakeholders indicated that, although South Africa has policies for biobased technology, these are not enforced and supporting mechanisms are insufficient, which limits industrialization (Fig. 13). Existing policies mainly cover bioethanol and bioplastics, with other biobased chemicals needing more policy development.

> *For bioethanol, there is a biofuels strategy, and mandatory regulatory frameworks already in place in South Africa. [SH2]*

> *…change of fossil fuels to biobased, e.g. plant-based bottles, well supported by government. [SH9]*

> *Policies or regulations are there, however [there is] limited enforcement such as in the waste sector. [SH5]*

In the late 2000s, Southern Africa's biofuel industry was initially driven by the prospect of exporting to the EU, but limitations on using food crops for fuel and certification requirements reduced this potential. Declines in EU agricultural commodity prices also led to increased local biofuel production, reducing import needs. In the USA, bioethanol blending is capped at 10% because of engine and manufacturer constraints. The resulting fixed domestic demand, combined with substantial corn feedstock availability, has positioned the country as a major bioethanol exporter with minimal imports. As a result, southern African countries face limited export opportunities to the EU and USA, which necessitates a focus on domestic or regional strategies to enhance competitiveness.

Several major funding initiatives, including the Africa–EU Renewable Energy Cooperation Programme (RECP) and the US-led Powering Agriculture: Energy Grand Challenge, do not support first-generation biofuel projects. Support for the renewable energy sector through the Africa–EU RECP also excludes biofuel projects. International policies therefore continue to influence local policy development. In particular, SAF must be certified against International Civil Aviation Organization recognized standards and comply with sustainability and greenhouse gas (GHG) emission criteria to qualify for public funding.[77]

The South African Bioeconomy Strategy, a collaborative effort among the departments of Science and Innovation; Trade, Industry and Competition; and Agriculture, Land Reform, and Rural Development, has been criticized for its perceived gaps and limited strategic direction despite having some policy elements in place.[43] Most developing countries have bioeconomy strategies that focus on specific sectors like bioenergy but lack a comprehensive approach, which may diminish the effectiveness of national action plans.[43] South Africa's biofuels strategy, which includes a blending mandate, aims to boost the rural economy and create jobs. Approximately 70% conversion of the biomass available in South Africa would meet 24% of the country's liquid fuel requirement as bioethanol equivalent.[35] Despite the introduction of a biofuels mandate ranging from E2 to E10 in October 2015, it has not been enforced.[62] In contrast, although Mozambique and Zambia also have unenforced targets, Malawi and Zimbabwe have successfully enforced and met their biofuels mandates. Legislative efforts thus far have fallen short in fostering sustainable biofuel production and consumption due to factors such as volatile energy and commodity markets, competition with conventional fuels, and the challenges of implementing land-intensive feedstocks.[62]

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There are strategies for biofuels or hydrogen but not necessarily for specific biobased chemicals. [SH3]

In producer policy framework, [the] government mention[ed] subsidizing 1G technologies but not 2G technologies, disparity in the approach between 1st and 2nd generation technologies. [SH1]

What needs to be triggered to enable biofuels uptake is a biofuels incentives or subsidies, [and] date for mandatory blending, then [a] regulatory regime is in place. [SH2]

In 2015, South Africa changed from fixed subsidies to competitive bidding for biofuel companies due to low oil prices. This change, together with food security concerns and the policy framework, has stalled further policy development for biofuels.[57] The perceived failure in the market of renewable-based businesses or technologies can be attributed to several factors including monopolistic competition, foreign effects, and information asymmetry.[57] Aste *et al.*[92] argued that an environment conducive to emerging technologies depends on future policies that prioritize integrated solutions over a narrow focus on specific technologies. Regional collaboration, as seen in the political commitment between South Africa, Namibia, Ghana, and Uganda for biomass supply and sustainable biodiversity management, can provide additional investment, resources, and policy support.[43] Subsidies or capital grants aligned with policy objectives and technological solutions are also critical for enabling progress.[93]

For the biofuels projects to be bankable and for a new industry to be established, the biofuels offtake prices have to be 'artificially stabilized' or 'subsidized' in addition to the enabling policy and regulatory framework for commercial-scale production of biofuels for use in transport fuels. The subsidization of biofuels manufacturing is justifiable as blending of biofuels reduces the negative environmental impact of transport fuel use and a biofuels program has other socioeconomic benefits… [65]

Sasol Ltd has committed to a 30% reduction in carbon emissions by 2030 and net zero by 2050.[77] The company plans to produce 50 000 tonnes of SAF annually using Fischer–Tropsch technology. Success depends on collaboration, funding, policy support, and green financing. South Africa's just transition strategy requires innovative feedstocks, growing energy crops on degraded land, and technologies like green hydrogen. Government support is essential to secure feedstocks for SAF and biobased chemicals. A World Wide Fund for Nature (WWF) report suggests South Africa could produce up to 4.5 billion liters of SAF.[77] However, financially strapped airlines consider the cost of fuel a major challenge that would require the development of a SAF strategy that takes into consideration offtakers, incentives for airlines, and the alleviation of market uncertainty.[77]

Summary of key drivers and barriers to the adoption of biobased chemicals

The drivers, opportunities, and barriers to adoption of biobased chemicals in South Africa are summarized for each of the key themes in Table 2 and discussed below.

The stakeholders recognized the potential to grow or establish biobased chemical businesses in South Africa, with particular interest in bioethanol, LA, AA, and other biobased chemicals. However, limitations due to technology maturity constrain export potential, especially for bioethanol. Global trends and international presence influence the development of local industry but challenges include limited local supply chains, product pricing, and social acceptance. Based on prevailing business forces, development and adoption are driven by global and local environmental pressures, regulatory frameworks, and industry strategies such as the Sugarcane Value Chain Master Plan.

South African legislation requires stronger enforcement and should be expanded to cover a broader range of biobased chemicals, accounting for factors such as food crop pricing and postconsumer management of biodegradable and compostable material. Market opportunities also exist to promote green premiums through product offerings with superior environmental benefits, and to reduce costs with 2G and 3G feedstocks, which will require supportive legislation.

There is significant potential to develop intermediates for bioplastics, such as PLA or high-value products such as SAF. However, current efforts focus primarily on intermediates rather than converting them into high-value end products. Small-scale producers face competition from large industries, and large-scale producers compete globally and with cheaper imports. Novel approaches such as metabolic engineering strategies, synthetic biology, and systems metabolic engineering strategies could improve competitiveness.

South Africa has an abundance of feedstock, and supporting strategies are encouraging its redirection towards the production of higher value products. However, supply chain challenges persist, including limited availability of reliable feedstock data, logistical constraints, restricted access to imported intermediates, and a lack of detailed feasibility studies to assess supply and demand dynamics. Investor interest remains low for conceptual or technologically immature projects. Drivers of effective governance include access to innovation agents and the presence of some operational governance mechanisms. However, governance

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Table 2. Drivers, opportunities, and barriers for adoption of a biobased chemicals industry in South Africa for key themes and subthemes from the analysis of interviews with nine stakeholders.

Theme	Subtheme	Drivers or opportunities	Barriers
Business opportunities for biobased products	Target products (South Africa)	Bioethanol, lactic acid, acetic acid, xylitol, multiple targeted chemicals, volatile fatty acids (VFAs), bioplastics Opportunities for localization of technologies	Limited export potential in the case of bioethanol. Similar would apply to other chemicals where there are major global producers
	Overall market opportunities	Global demand for biobased chemicals, international presence of global companies in South Africa	Emerging industry in South Africa, investment for developing feasible technologies, limited localization and establishment of supply chains for export, product price point, lack of awareness
Business forces	Pressure from partners and stakeholders Regulation (environment, product and other)	Local pressure, company net-zero targets by 2030, local product and environmental regulation (biofuels blending and feedstock protocol, landfilling, extended producer responsibility, plastic bags), global pressure, trends, and environmental regulation, global forums such as COP, Sugarcane Value Chain Master Plan	Local product regulation not enforced – e.g., bioethanol blending, limited feedstock consideration (e.g., maize), and the opportunity to utilize 2G and 3G feedstock, limited legislation for biodegradable and compostable materials in South Africa including responsible postconsumer management
	Pricing of raw materials and price fluctuations	'Green premiums', niche products offering environmental benefits, availability of 2G and 3G feedstock to drive down production costs, reduction of the trade deficit, lower cost per g of xylitol versus sugar	Market fluctuations, current pricing (biobased) higher than basic fuel price (petrochemical), local weak currency, high 1G feedstock production costs, lower international prices for bioproducts
Product value chain		Dominant sugar platform products (bioethanol, *n*-butanol, AA, LA), strongest growth forecast for intermediates used to produce bioplastics (PLA, PHAs, bioethylene), conversion of bioethanol to higher value products like SAF, completed assessments for technologies used to produce intermediates, strengthening of the furfural market in South Africa	Technology development to convert intermediates into higher value products
Competitiveness	Current products and competitors in the market	Biomass availability in South Africa	Global producers of chemicals and imports into South Africa, limited local production capacity (plants), e.g. PLA, petrochemical, sugar, and paper and pulp industries (conventional product offerings)
	Market opportunities for biobased chemicals	Novelty associated with preprocessing of the feedstock, modified processes, and metabolic engineering strategies, subsidies to drive down price of biobased chemicals	Global pricing of fossil fuel-derived products, high price point of the intermediate or product, limited customer willingness to pay
Supply chain collaboration		Availability of feedstock, redirection of feedstock from the sugar industry, supporting frameworks for bioethanol and SAF, potential opportunity to produce SAF at commercial scale driven by global strategy	Limited feasibility studies to understand supply–demand economics, supply-side constraints such as transportation of feedstock, and the lack of reliable data on feedstock availability and availability of intermediates that can be imported into South Africa

(Continues)

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Table 2. (Continued)

Theme	Subtheme	Drivers or opportunities	Barriers
Finance		Several product diversification opportunities, e.g. bioethanol, SAF, bioenergy, biogas, biopolymers, licensing-in of globally demonstrated technologies to improve investment opportunity	Challenging to secure investment during the conceptual phase, limited financial feasibility studies resulting in low-to-medium investor interest
Governance		Access to innovation agents, some operational governance in place such as existing protocols and equipment that can be used	Effective regulatory frameworks for dissemination and implementation of global strategies, limited assessment of equipment and infrastructure for economies of scale, limited assessment of the controls and integration required within existing production plants, requirement for strong industry partners and potential global technology providers
Policy		Local policies, regulation, and frameworks in place, cross-country collaboration, regional (African countries) availability and supply of biomass, regional policy framework development and integration. Regional support spanning infrastructure, land, skills, and socioeconomic development.	The regulations are limited to biofuels, bioplastics, and landfilling of waste; local SAF strategy required; local policies and frameworks are not yet enforced (e.g., biofuels); lack of incentives or subsidies for producers; requirement for revision of existing policies, frameworks, and supporting mechanisms due to limited export opportunities to the EU and USA; government support to liaise across the industrial sectors to secure feedstock, e.g. invasive alien plants (IAPs), agricultural residues, etc.

effectiveness is constrained by underdeveloped local regulatory frameworks, insufficient detailed feasibility assessments, and the absence of strong partnerships.

There are policies, regulation, and frameworks in place in South Africa, and evidence of cross-country collaboration with other African countries. However, policies are limited and underenforced, requiring review and expansion to support various biobased technologies. Government support mechanisms like subsidies require revision, and a stronger government role is essential to secure feedstock and to support the development of technology.

Significant investment is required for technology development, feasibility assessments, the establishment of frameworks and mechanisms to enable global competitiveness, and to establish commercial-scale industries. These challenges have also been identified in other African contexts.[94] Localizing technologies, including licensing in and strong regulatory support, are crucial to strengthen the local market and support self-sufficiency.

Conclusions

This study conducted an exploratory stakeholder needs analysis using semistructured interviews with nine experts from industry and academia. It confirmed the relevance of eight key themes derived from the literature and it identified important biobased chemicals, including bioethanol, LA, AA, and furfural, aligned with the research objective of assessing adoption potential. Key drivers such as global trends and local regulations, along with barriers such as high production costs and a limited local market, were highlighted, providing insights into the landscape for biobased chemicals in South Africa.

The study addressed the research objectives effectively by discussing the current state of the biobased chemicals market, contrasting local limitations with global opportunities, and outlining assessment criteria for stakeholder needs. It emphasized the necessity for significant investment in technology and infrastructure to develop a competitive local market. Strengthening the local market and creating

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self-sufficiency could include a viable mix of localized and licensed technologies. Strong regulatory frameworks and revisited support mechanisms for producers are essential for cost-competitive production.

The study's results can be used to inform specific plans and strategies to overcome adoption barriers. Further research with industry partners is recommended to identify initiatives that address these barriers. Future work can include technoeconomic assessment (TEA), life cycle assessment (LCA), life cycle costing (LCC), and social life cycle assessment (SLCA) to evaluate the sustainability and the technical and economic viability of biobased chemical production in South Africa.

References

1. Arif A, Chanchaona N and Lau CH, Comparing the environmental impacts of using bio-renewable and fossil-derived solvent in polymer membrane fabrications. *Adv Membr* **3**:100079 (2023). https://www.sciencedirect.com/science/article/pii/S2772823423000209
2. Gargalo CL, Yu H, Vollmer N, Arabkoohsar A, Gernaey KV and Sin G, A process systems engineering view of environmental impact assessment in renewable and sustainable energy production: Status and perspectives. *Comput Chem Eng* **180**:108504 (2024).
3. Jaiswal KK, Chowdhury CR, Yadav D, Verma R, Dutta S, Jaiswal KS *et al*., Renewable and sustainable clean energy development and impact on social, economic, and environmental health. *Energy Nexus* **7**:100118 (2022). https://www.sciencedirect.com/science/article/pii/S2772427122000687
4. Neill AM, O'Donoghue C and Stout JC, Who is talking about bioeconomy? Stakeholder and sentiment analysis using social media. *EFB Bioecon J* **3**:100055 (2023). https://www.sciencedirect.com/science/article/pii/S2667041023000101
5. Ögmundarson Ó, Herrgård MJ, Forster J, Hauschild MZ and Fantke P, Addressing environmental sustainability of biochemicals. *Nat Sustainability* **3**:167–174 (2020a).
6. Aarikka-Stenroos L, Kokko M and Pohls E-L, Catalyzing the circular economy of critical resources in a national system: Case study on drivers, barriers, and actors in nutrient recycling. *J Clean Prod* **397**:136380 (2023).
7. Hina M, Chauhan C, Kaur P, Kraus S and Dhir A, Drivers and barriers of circular economy business models: Where we are now, and where we are heading. *J Clean Prod* **333**:130049 (2022).
8. Neves SA and Marques AC, Drivers and barriers in the transition from a linear economy to a circular economy. *J Clean Prod* **341**:130865 (2022).
9. Pender A, Kelleher L and O'Neill E, Regulation of the bioeconomy: Barriers, drivers and potential for innovation in the case of Ireland. *Clean Circ Bioeconomy* **7**:100070 (2024).
10. Sturm V and Banse M, Transition paths towards a bio-based economy in Germany: A model-based analysis. *Biomass Bioenergy* **148**:106002 (2021).
11. Sadhukhan J, Martinez-Hernandez E, Amezcua Allieri MA, Zermeño Eguía-Lis JA, Castillo A, Dominguillo D *et al*., Strategic navigation of world-leading biorefineries and Mexico's policy landscape: a gateway to a sustainable circular bioeconomy. *J Clean Prod* **434**:140386 (2024).
12. D'Adamo I, Gastaldi M, Morone P, Rosa P and Sassanelli C, Bioeconomy of sustainability: Drivers, opportunities and policy implications. *Sustainability* **14**:200 (2022).
13. African Development Bank, *Africa Industrialization Index 2022* [Online]. Available: https://www.afdb.org/en/documents/africa-industrialization-index-2022 (2022). [14 July 2025].
14. IMF, *World Economic Outlook Database* [Online]. Available: https://www.imf.org/en/Publications/WEO/weo-database/2025/april (2025). [14 July 2025].
15. Döhler N, Wellenreuther C and Wolf A, Market dynamics of biodegradable bio-based plastics: Projections and linkages to European policies. *EFB Bioecon J* **2**:100028 (2022).
16. Lundmark R, Wetterlund E and Olofsson E, On the green transformation of the iron and steel industry: Market and competition aspects of hydrogen and biomass options. *Biomass Bioenergy* **182**:107100 (2024).
17. Philippidis G, Álvarez RX, Di Lucia L, Hermoso HG, Martinez AG, M'Barek R *et al*., The development of bio-based industry in the European Union: A prospective integrated modelling assessment. *Ecol Econ* **219**:108156 (2024).
18. Kichonge B and Kivevele T, Viability of non-edible oilseed plants and agricultural wastes as feedstock for biofuels production: A techno-economic review from an African perspective. *Biofuels Bioprod Biorefin* **17**:1382–1410 (2023).
19. Petersen AM, van der Westhuizen WA, Mandegari MA and Gorgens JF, Economic analysis of bioethanol and electricity production from sugarcane in South Africa. *Biofuels Bioprod Biorefin* **12**:224–238 (2018).
20. Subramaniam Y and Al-Mulali U, Biofuels, environment, and food security in Africa. *Biofuels Bioprod Biorefin* **18**:203–210 (2024).
21. Ögmundarson O, Sukumara S, Herrgard MJ and Fantke P, Combining environmental and economic performance for bioprocess optimization. *Trends Biotechnol* **38**:1203–1214 (2020b).
22. Dessi F, Ariccio S, Albers T, Alves S, Ludovico N and Bonaiuto M, Sustainable technology acceptability: Mapping technological, contextual, and social-psychological determinants of EU stakeholders' biofuel acceptance. *Renew Sust Energ Rev* **158**:112114 (2022).
23. Abdalla YA and Siti-Nabiha AK, Pressures for sustainability practices in an oil and gas company: evidence from Sudan. *Qual Res Account Manag* **12**:256–286 (2015).
24. Mzembe AN and Meaton J, Driving corporate social responsibility in the Malawian mining industry: A stakeholder perspective. *Corp Soc Responsib Environ Manag* **21**:189–201 (2013).
25. Bomtempo JV, Chaves Alves F and De Almeida Oroski F, Developing new platform chemicals: What is required for a new bio-based molecule to become a platform chemical in the bioeconomy? *Faraday Discuss* **202**:213–225 (2017).
26. Jernström E, Karvonen V, Kässi T, Kraslawski A and Hallikas J, The main factors affecting the entry of SMEs into bio-based industry. *J Clean Prod* **141**:1–10 (2017).
27. Arias A, Feijoo G and Moreira MT, Biorefineries as a driver for sustainability: Key aspects, actual development and future prospects. *J Clean Prod* **418**:137925 (2023).
28. Martinez-Hernandez E, Castillo-Landero A, Dominguillo-Ramírez D, Amezcua-Allieri MA, Morse S, Murphy R *et al*., Priorities and relevance of bioenergy sustainability indicators: A participatory selection framework applied to community-based forestry in Mexico. *Energy Res Soc Sci* **109**:103425 (2024).
29. Morone P, D'Adamo I and Cianfroni M, Inter-connected challenges: An overview of the bioeconomy in Europe. *Environ Res Lett* **17**:114031 (2022).

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30. E4tech, Re-Cord & Wur, From the Sugar Platform to biofuels and biochemicals, European Union (2015).
31. Antar M, Lyu D, Nazari M, Shah A, Zhou X and Smith DL, Biomass for a sustainable bioeconomy: An overview of world biomass production and utilization. *Renew Sust Energ Rev* **139**:110691 (2021).
32. Mensah P and Yankson E, Biomass energy as a catalyst for achieving global sustainability goals: Technological advancements and policy implications. *Acad Green Energy* **2** (2025). https://www.academia.edu/2998-3665/2/1/10.20935/AcadEnergy7556
33. BCC Research, *Biorefinery Products: Global Markets*. BCC Research, Wellesley, MA, USA (2022).
34. Gobina E, *Biorefinery Products: Global Markets*. BCC Research, Wellesley, MA, USA (2017).
35. Farzad S, Mandegari MA, Guo M, Haigh KF, Shah N and Gorgens JF, Multi-product biorefineries from lignocelluloses: A pathway to revitalisation of the sugar industry? *Biotechnol Biofuels* **10**:87 (2017).
36. Mandree P, Thopil GA and Ramchuran S, Potential opportunities to convert waste to bio-based Chemicals at an Industrial Scale in South Africa. *Fermentation* **9**:908 (2023).
37. Bruijl G, The relevance of porter's five forces in today's innovative and changing business environment (2018).
38. Helal A, Kreimerman R, Gutiérrez S and Torres AI, A market-driven algorithm for the assessment of promising bio-based chemicals. *AICHE J* **65**:e16775 (2019). https://aiche.onlinelibrary.wiley.com/doi/10.1002/aic.16775
39. Borgman D, Gaining a competitive advantage in the global bioethanol industry: Strategic options for large scale european producers. MSc. Management, Economics and Consumer studies, Wageningen University (2009).
40. Bruce SL, *Ethanol Supply Chain and Industry Overview: More Harm than Good? Master of Engineering in Logistics*. Massachusetts Institute of Technology, Boston, MA, USA (2013).
41. Stern T, Wood for food: Wood-based products in the dietary fiber additives market—a branch-analysis approach. *For Prod J* **59**:19–25 (2009).
42. de Sousa GC and Castañeda-Ayarza JA, PESTEL analysis and the macro-environmental factors that influence the development of the electric and hybrid vehicles industry in Brazil. *Case Stud Transp Policy* **10**:686–699 (2022).
43. Hlangwani E, Mpye KL, Matsuro L and Dlamini B, The use of technological innovation in bio-based industries to foster growth in the bioeconomy: A south African perspective. *Sustain Sci Pract Policy* **19**:2200300 (2023).
44. Patermann C and Aguilar A, A bioeconomy for the next decade. *EFB Bioecon J* **1**:100005 (2021).
45. Ronzon T, Piotrowski S, M'Barek R and Carus M, A systematic approach to understanding and quantifying the EU's bioeconomy. *Bio-based Appl Econ* **6**:1–17 (2017).
46. von Braun J, Exogenous and endogenous drivers of bioeconomy and science diplomacy. *EFB Bioeconomy J* **2**:100029 (2022).
47. Holden NM, Neill AM, Stout JC, O'Brien D and Morris MA, Biocircularity: a framework to define sustainable, circular bioeconomy. *Circ Econ Sustain* **3**:77–91 (2023).
48. Priefer C, Jörissen J and Frör O, Pathways to shape the bioeconomy. *Resources* **6**:10 (2017).
49. Ramcilovic-Suominen S, Kröger M and Dressler W, From pro-growth and planetary limits to degrowth and decoloniality: An emerging bioeconomy policy and research agenda. *Forest Policy Econ* **144**:102819 (2022).
50. Sanz-Hernández A, Esteban E and Garrido P, Transition to a bioeconomy: Perspectives from social sciences. *J Clean Prod* **224**:107–119 (2019).
51. Székács A, Environmental and ecological aspects in the overall assessment of bioeconomy. *J Agric Environ Ethics* **30**:153–170 (2017).
52. Ketelings L, Kremers S and de Boer A, The barriers and drivers of a safe market introduction of cultured meat: A qualitative study. *Food Control* **130**:108299 (2021).
53. Kirchner-Krath J, Morschheuser B, Sicevic N, Xi N, von Korflesch HFO and Hamari J, Challenges in the adoption of sustainability information systems: A study on green IS in organizations. *Int J Inf Manag* **77**:102754 (2024).
54. Kwok EY, Moodie ST, Cunningham BJ and Oram Cardy J, Barriers and facilitators to implementation of a preschool outcome measure: An interview study with speech-language pathologists. *J Commun Disord* **95**:106166 (2022).
55. LaPatin M, Spearing LA, Tiedmann HR, Hacker M, Kavvada O, Daniélou J *et al*., Controversy in wind energy construction projects: How social systems impact project performance. *Energy Policy* **176**:113507 (2023).
56. Al-Hail M, Zguir MF and Koc M, University students' and educators' perceptions on the use of digital and social media platforms: A sentiment analysis and a multi-country review. *iScience* **26**:107322 (2023).
57. Li R and Li S, Market analysis for sustainable energy suppliers with regulation restrictions. *J Innov Knowl* **8**:100302 (2023).
58. Tomovic R, Bulatovic R, Jovanovic J, Mijanovic Markus M, Vujovic A, Mumovic M *et al*., *Analysis of Needs of the Processing Industry in Montenegro for Establishment of the Laboratory for Industrial Design*. IOP Conference Series: Materials Science and Engineering. IOP Publishing, Serbia (2018).
59. Wilczynski M and Schanz H, The role of market perceptions in bridging the innovation gap of bio-based markets: The example of biomass-to-liquid in Germany. *J Clean Prod* **291**:125926 (2021).
60. Gulsia O and Yadav S, Conceptualizing network approaches for a successful farm entrepreneurship using ATLAS.ti®. *Sustain Technol Entrep* **2**:100026 (2023).
61. Maara C, *Alternative Chemical Products and Processing*. BCC Research, Wellesley, MA, USA (2016).
62. Henley G and Fundira T, Policy and trade issues for a future regional biofuels market in southern Africa. *Dev South Afr* **36**:250–264 (2019).
63. Novotny P-A, *COP27—A Just Transition: Viewpoint from South Africa [Online]*. Linklaters. Available: https://sustainablefutures.linklaters.com/post/102i2e3/cop27-a-just-transition-viewpoint-from-south-africa, London, United Kingdom (2022) [4 February 2023].
64. DMRE, *Published for Comments: Draft Amendment Regulations Regarding the Mandatory Blending of Biofuels with Petrol and Diesel, South Africa*. Department of Mineral Resources and Energy, Government of South Africa, Pretoria, South Africa (2021).
65. DMRE, *South African Biofuels Regulatory Framework, South Africa*. Department of Mineral Resource and Energy, Government of South Africa, Pretoria, South Africa (2020).
66. DEFF, *Amendments to the Regulations Made in Terms of Section 249d) of the Environment Conservation Act*, 1989 *(Act no. 73 of 1989)* in respect of plastic carrier bags and plastic flat bags, South Africa, Department of Environment, Forestry and Fisheries, Government of South Africa (2021).
67. WWF, *New Biofuels Regulatory Framework Falls Short [Online]*. World Wildlife Federation. Available: https://www.

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wwf.org.za/?30981/New-biofuels-regulatory-framework-falls-short, South Africa (2020) [3 March 2024].
68. DEA, *National Waste Management Strategy, Pretoria, South Africa*. Department of Environmental Affairs, Government of South Africa, Pretoria, South Africa (2011).
69. GreenCape, *Waste: Market Intelligence Report 2019*. GreenCape, South Africa (2019).
70. GreenCape, *Waste Economy: Market Intelligence Report 2017*, Basson, L., Bronkhorst, S., Mulcahy, M., O'Carroll, S. & Pineo, C. (eds.). GreenCape, South Africa (2017).
71. GreenCape, *Waste: Market Intelligence Report 2020*. South Africa, GreenCape (2020).
72. Ritzen L, Sprecher B, Bakker C and Balkenende R, Bio-based plastics in a circular economy: A review of recovery pathways and implications for product design. *Resour Conserv Recycl* **199**:107268 (2023).
73. Van Hille R, *Biodegradable and compostable Packaging: A review of the South African landscape*. The Moss Group, South Africa (2020).
74. Chavhan N, Mokashi A, Chandak S, Chaware B, Bongarde P and Bodhe S, Development of bio lubricant from castor oil via chemical softening: An ease towards sustainable substitute. *Mater Today Proc* (2023). https://www.sciencedirect.com/science/article/pii/S2214785323047235
75. Kumar A, *Global Markets for Non-sugar Sweeteners*. BCC Research, Wellesley, MA, USA (2019).
76. Pachón ER, Vaskan P, Raman JK and Gnansounou E, Transition of a south African sugar mill towards a biorefinery. A feasibility assessment. *Appl Energy* **229**:1–17 (2018).
77. RSB, *Sustainable Aviation Fuel in SA: Report on the SAF Stakeholder Meeting in South Africa*. Roundtable on Sustainable Biomaterials, Switzerland (2022).
78. Upadhyay SK, Singh G, Rani N, Rajput VD, Seth CS, Dwivedi P *et al*., Transforming bio-waste into value-added products mediated microbes for enhancing soil health and crop production: Perspective views on circular economy. *Environ Technol Innovation* **34**:103573 (2024).
79. Yong KJ, Wu TY, Lee CBTL, Lee ZJ, Liu Q, Jahim JM *et al*., Furfural production from biomass residues: Current technologies, challenges and future prospects. *Biomass Bioenergy* **161**:106458 (2022).
80. DTIC, *Chemicals [Online]*. The Department of Trade, Industry and Competition, Government of South Africa. Available: http://www.thedtic.gov.za/sectors-and-services-2/industrial-development/chemicals/, South Africa (2017) [4 March 2024].
81. Lowitt S, *Industrial Development Projects: Polylactic Acid (Bioplastics)*. Trade and Industrial Policy Strategies, South Africa (2020).
82. Carolin CF, Senthil Kumar P, Mohanakrishna G, Hemavathy RV, Rangasamy G and T MA, Sustainable production of biosurfactants via valorisation of industrial wastes as alternate feedstocks. *Chemosphere* **312**:137326 (2023).
83. Machado CFR, Araújo ODQF, de Medeiros JL and Alves RMDB, Carbon dioxide and ethanol from sugarcane biorefinery as renewable feedstocks to environment-oriented integrated chemical plants. *J Clean Prod* **172**:1232–1242 (2018).
84. He C and You F, Toward more cost-effective and greener chemicals production from shale gas by integrating with bioethanol dehydration: Novel process design and simulation-based optimization. *AICHE J* **61**:1209–1232 (2014).
85. Son J, Sohn YJ, Baritugo KA, Jo SY, Song HM and Park SJ, Recent advances in microbial production of diamines, aminocarboxylic acids, and diacids as potential platform chemicals and bio-based polyamides monomers. *Biotechnol Adv* **62**:108070 (2023).
86. SASA, *South African Sugarcane Value Chain Master Plan to 2030*. The South Africa Sugar Association, South Africa (2020).
87. Visser H, Thopil GA and Brent A, Life cycle cost profitability of biomass power plants in South Africa within the international context. *Renew Energy* **139**:9–21 (2019).
88. Fertahi S, Elalami D, Tayibi S, Taarji N, Lyamlouli K, Bargaz A *et al*., The current status and challenges of biomass biorefineries in Africa: A critical review and future perspectives for bioeconomy development. *Sci Total Environ* **870**:162001 (2023).
89. DFFE, *South Africa Welcomes the Adoption of the New Global Framework on Chemicals [Online]*. Department of Forestry, Fisheries and the Environment. Available: https://www.dffe.gov.za/mediareleases/newglobalframeworkonchemicals, South Africa (2023) [24 March 2024].
90. UNEP, *Global Framework on Chemicals—For a Planet Free of Harm from Chemicals and Waste*. UNEP, Nairobi, Kenya (2023).
91. Dietz T, Rubio Jovel K, Deciancio M, Boldt C and Börner J, Towards effective national and international governance for a sustainable bioeconomy: A global expert perspective. *EFB Bioecon J* **3**:100058 (2023).
92. Aste N, Buzzetti M, Caputo P and Del Pero C, Regional policies toward energy efficiency and renewable energy sources integration: Results of a wide monitoring campaign. *Sustain Cities Soc* **36**:215–224 (2018).
93. Yuksel I and Kaygusuz K, Renewable energy sources for clean and sustainable energy policies in Turkey. *Renew Sust Energ Rev* **15**:4132–4144 (2011).
94. Adetoyimbo A, Gupta S, Okoruwa VO and Birner R, The role of institutions in sustaining competitive bioeconomy growth in Africa—insights from the Nigerian maize biomass value-web. *Sustainable Prod Consumption* **30**:186–203 (2022).

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Appendix A

Codes derived from content analysis

Code ID	Themes	Subthemes	Codes
1			Target product
2	Business opportunities for biobased products	Target products	Acetic acid
3			Bioethanol
4			Bioplastics
5			Furfural
6			Lactic acid
7			Sustainable aviation fuel
8			Volatile fatty acids
9			Xylitol
10			Multiple targeted chemicals
11		Overall market opportunity	Global market opportunity
12			Local market opportunity
13			Local market opportunity limited
14			Alignment to sugar cane master plan
15	Business forces	Pressure from partners and stakeholders	Global pressure and environmental regulation
16			Local pressure
17		Regulation (environmental, product, other)	Local environmental regulation
18			Local strategy
19		Pricing (raw materials, fluctuations, stability)	Other global drivers
20			Global price pressure
21			Global price stability
22			High product price
23			Local pricing of raw materials
24			Local product price
25			Low product price
26	Product value chain		Intermediate position in chemical value chain
27			Flexibility of the chemical structure to be transformed
28			Potential high value products
29			Potential high value products but limited localization
30			Not exclusively high value products
31	Competitiveness	Current products and competitors in the market	Substitute products
32			Imported products
33			Local products
34			New potential entrants
35			Competitors
36		Market opportunity of product offerings	Potential market share
37			Novelty of the chemical
38			Not novel
39			Customer willingness to pay
40			Limited willingness to pay
41			Low market share

(Continues)

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Appendix A. (Continued)

Code ID	Themes	Subthemes	Codes
42	Supply chain collaboration		Supply side economies of scale
43			Supply side constraints
44			Demand side economies of scale
45			Demand side constraints
46			Demand side feasibility assessments
47	Financing the business	Investor interest and product diversification	High investor and product diversification interest
48			Low investor and product diversification interest
49			Medium investor and product diversification interest
50			Financial feasibility assessments in progress
51	Governance of the value chain		Access to innovation agents in the value chain (R&D)
52			Limited access to innovation agents and technology
53			Lack of collaboration between innovation agents and industry
54		Governance mechanisms to implement at scale (sustainability)	Lack of governance structures and mechanisms
55			Operational governance to implement at scale (production)
56			Limited operational governance
57			Partnerships
58	Policy	Government policy and regulation	Policy or regulation in place and enforced
59			Policy or regulation in place but not enforced
60			Policy and regulation not in place for all chemicals
61		Government supporting mechanisms	Supporting mechanisms are limited

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