I am CELISE

Sustainable production of Cellulose-based products and additives to be used in SMEs and rural areas

Deliverable D2.1. Business models and needs for SMEs and rural areas in cellulose-based products

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Table 1. Document information

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Executive Summary:	This document is issued in the framework of the CELISE project under the Marie Sklodowska-Curie Grant Agreement number 101007733 of the Horizon 2020 research and innovation programme of the European Union. It presents an overview of the necessities of SMEs and rural and vulnerable areas selected in the project and the possibilities to use the lignocellulosic materials (residuals in the case of rural and vulnerable areas) in the production of fibres, cellulose products and biofuels using the pre-treatments and processing from WP1.
Keywords	SMEs; Rural development; Bioeconomy; Indigenous and Afro-descendant communities; Sustainable Development Goals (SDGs); Renewable energy; Rural electrification; Cellulose-based products.

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4. LIST OF ABBREVIATIONS

Table 2. List of abbreviations

Acronym	Definition
A-B-C	Anchor Business Community
CAOI	Coordinadora Andina de Organizaciones Indígenas
CARED	Community, Water-Renewable Energies, Diversity
GDP	Gross Domestic Product
GPS	Global Positioning System
ICT	Information and Communication Technologies
LED	Light Emitting Diode
MFIs	MicroFinance Institutions
MTF	Multi-Tier Framework
OECD	Organisation for Economic Co-operation and Development
PAR	Participatory Action Research
PV	Photovoltaic
RCAP	Royal Commission on Aboriginal Peoples
RET	Renewable Energy Technologies
SDGs	Sustainable Development Goals
SHS	Solar Home Systems
SMEs	Small and Medium-sized Enterprises
WHS	Wind Home Systems

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5. INTRODUCTION

5.1. General purpose of the document

This deliverable provides an overview of the current context, challenges and opportunities related to the development and application of cellulose-based products, with particular attention to the needs of SMEs and rural areas. It aims to underline the importance of renewable resources as a pathway to address global challenges such as environmental degradation, fossil fuel dependency and climate change. The transition towards bio-based solutions requires coordinated efforts from industry, academia and local communities, ensuring that the benefits of innovation reach both urban and rural contexts.

Through this document, guidance is offered on how SMEs and rural stakeholders can engage in the bioeconomy by adopting sustainable practices, accessing new markets and contributing to the circular use of lignocellulosic resources. The review provides a perspective that links technological development with socio-economic realities, establishing the foundations for strengthening collaborations and partnerships that can foster inclusive and sustainable growth.

The deliverable also highlights the importance of empowering local actors, promoting knowledge transfer and supporting capacity-building strategies in rural territories. By aligning scientific progress with practical applications, the document seeks to reduce barriers, build long-term trust among stakeholders, and identify concrete opportunities where SMEs and rural communities can play an active role in the cellulose-based value chain.

5.2. Role and contribution from partners

The D2.1 is part of WP2 activities and UCC the lead company. The UCC has had the main responsiblity for this deliverable; however, the deliverable unites all of the activities related to business models for SMEs and rural areas in cellulose-based products, and the following partners are involved in these activities: UC (Universidad de Cantabria), UPM (Universidad Politécnica de Madrid), LS-IWC (Latvian State Institute of Wood Chemistry), SGGW (Warsaw University of Life Sciences), WUT (Warsaw University of Technology), IChF (Institute of Physical Chemistry, Polish Academy of Sciences), BANGOR University, AUTH (Aristotle University of Thessaloniki), TWI, INOCURE, CCC (Carbon Compost Company Ltd), ECORESOURCES, UCC (Universidad Cooperativa de Colombia), UNACH (Universidad Nacional de Chimborazo), UNL-FICH (Universidad Nacional del Litoral) and Latitud (Latitud-Fundación Laboratorio Tecnológico del Uruguay).

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6. FRAMEWORK OF ANALYSIS

6.1. Introduction

The framework of analysis for this deliverable is grounded in the broader challenges of the bioeconomy, where the sustainable use of lignocellulosic biomass plays a central role. The reliance on renewable raw materials is increasingly recognised as a response to climate change, fossil fuel dependency and environmental degradation. However, the capacity of Small and Medium-sized Enterprises (SMEs), rural communities, and indigenous and Afro-descendant populations, to participate in these value chains is often limited by structural barriers such as access to finance, technological know-how, infrastructure, and integration into larger industrial networks.

Existing literature highlights that the transition towards cellulose-based products requires an integrated approach that considers both the technological processes of biomass conversion and the socio-economic realities of the actors involved. SMEs, rural stakeholders, and traditional communities face not only technical and market constraints but also challenges linked to knowledge transfer, institutional support, and the creation of equitable partnerships. The analysis therefore situates the development of business models within a systemic perspective that combines innovation, inclusiveness and sustainability.

This deliverable also draws upon the Sustainable Development Goals (SDGs) as a guiding framework, particularly in relation to responsible production and consumption, climate action, and partnerships for the goals. By aligning the potential of cellulose-based innovations with the socio-economic contexts of rural, indigenous and Afro-descendant communities, the framework provides a basis to assess opportunities, identify barriers and propose recommendations that enhance the participation of SMEs and rural populations in the bioeconomy.

Ultimately, the framework emphasises that the success of cellulose-based business models depends not only on technological feasibility but also on the empowerment of local actors, the recognition of cultural and territorial diversity, the establishment of trust-based collaborations, and the creation of enabling conditions that allow SMEs, rural communities, and indigenous and Afro-descendant groups to thrive as part of a sustainable and inclusive bio-based economy.

6.2. Coloniality of knowledge and bioeconomy pathways

The historical processes of colonisation in Latin America have left a lasting legacy that continues to shape the ways in which knowledge, resources and development strategies are defined. Indigenous and Afro-descendant communities, whose intellectual and territorial contributions have been systematically marginalised, remain at the periphery of dominant narratives of science, technology and innovation. This enduring coloniality of knowledge is evident in the limited recognition of non-Western epistemologies and in the persistence of asymmetries of power that condition access to resources, decision-making and participation in innovative systems.

In the context of the bioeconomy, these dynamics directly affect the ability of rural, indigenous and Afro-descendant communities to engage in the development of cellulose-based value chains. Eurocentric approaches often privilege large-scale industrial models while overlooking local knowledge, traditional practices, and community-driven innovations that can contribute to sustainable and inclusive solutions. As scholars such as Quijano (2000) and Escobar (1995)

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highlight, the deconstruction of these colonial legacies is essential to enable equitable participation in the design and implementation of new socio-environmental models.

For this reason, the analysis presented in this deliverable underlines the importance of integrating diverse epistemologies and perspectives into the development of business models for cellulose-based products. By valuing both scientific and traditional knowledge, it becomes possible to design innovation pathways that not only respond to global sustainability challenges but also empower local actors, reduce inequalities, and respect the cultural and territorial rights of indigenous and Afro-descendant peoples.

6.3. The Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs) adopted by the United Nations in 2015 provide a global framework to tackle poverty, inequality and climate change while promoting sustainable production and consumption. For the purposes of this deliverable, the SDGs are particularly relevant as they set the basis for connecting cellulose-based innovation with inclusive and equitable development pathways.

In the context of SMEs, rural territories, and indigenous and Afro-descendant communities, several SDGs are of direct importance. **Goal 1 (End poverty in all its forms)** highlights the urgency of addressing socio-economic inequalities that disproportionately affect rural populations. **Goal 5 (Achieve gender equality and empower all women and girls)** underlines the need to integrate women into bioeconomy initiatives, ensuring that innovation contributes to empowerment as well as to sustainability. **Goal 7 (Affordable and Clean Energy)** is directly linked to the role of renewable energy sources **derived from biomass**, including biofuels and biogas, providing opportunities for rural and community-based energy autonomy while contributing to decarbonisation. **Goal 10 (Reduce inequality within and among countries)** stresses the importance of bridging structural gaps between large industrial actors and smaller rural or community-based stakeholders, which often lack equal access to resources and markets.

From an environmental perspective, **Goal 12 (Ensure sustainable consumption and production patterns)** and **Goal 13 (Take urgent action to combat climate change and its impacts)** are central to the development of cellulose-based products. These goals emphasise the reduction of waste, the efficient use of natural resources, and the mitigation of environmental degradation. In particular, biomass valorisation, biofuels, and circular bioeconomy models can contribute significantly to achieving these targets.

By aligning cellulose-based innovation with the SDGs, this deliverable seeks to promote business models that not only advance technological solutions but also strengthen community resilience, enhance local livelihoods, and contribute to inclusive and sustainable development. The SDGs thus serve as both a guiding principle and a practical benchmark for ensuring that SMEs, rural communities, and indigenous and Afro-descendant populations are actively engaged in, and benefit from, the bioeconomy.

6.4. Decolonising the approach

Decolonising the approach to business development within the bioeconomy is essential in order to recognise and integrate the perspectives of indigenous, Afro-descendant and rural communities. As Halvorsen (2019) notes, decolonisation involves challenging abstract hierarchies and power structures that have historically excluded non-Western epistemologies. In

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the context of cellulose-based innovation, this means acknowledging that knowledge is not solely produced in laboratories or industries, but also within local communities whose practices and worldviews are equally valid sources of innovation.

Introducing a decolonial perspective allows for a broader understanding of what constitutes a successful business model for sustainable community development. This involves shifting from externally imposed assumptions of "progress" and "growth" towards locally defined aspirations that prioritise well-being, cultural continuity and respect for territories. As Mignolo & Walsh (2018) underline, decoloniality encourages ways of thinking, being and knowing that foster coexistence, solidarity and re-existence, thereby creating space for diverse actors to shape bioeconomy strategies.

In practice, decolonising the bioeconomy aligns with the philosophy of *Buen Vivir*, which has already been articulated by several Latin American indigenous organisations. This perspective questions the universality of Western paradigms of development and instead proposes alternative frameworks where life, nature and community are central. Within cellulose-based business models, *Buen Vivir* offers a lens to design innovation pathways that respect sovereignty, integrate traditional practices, and enhance the social and ecological fabric of territories.

Therefore, recommendations for the development of cellulose-based value chains must ensure that indigenous, Afro-descendant and rural communities are not passive beneficiaries but active co-designers of initiatives. Decolonial approaches require that external stakeholders – whether from academia, industry or government – engage on equal terms, recognising local rights and worldviews. Only by embedding decoloniality into the design of business models can the bioeconomy contribute to sustainable, just and inclusive futures.

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7. SUSTAINABLE BUSINESS AND COMMUNITY DEVELOPMENT

7.1. Introduction

The fundamental approach of this section is grounded in the principle of *Buen Vivir*, as articulated by the Coordinadora Andina de Organizaciones Indígenas (CAOI) in 2010, which provides a baseline definition from a South American and indigenous perspective. This framework is highly relevant for the development of sustainable bio-based business models, as it offers guidance on how to avoid replicating historical patterns of exclusion and conflict between non-indigenous and indigenous populations. Instead, it seeks to promote constructive and equitable relationships that strengthen the inclusion of indigenous and Afro-descendant communities within the bioeconomy.

This deliverable also incorporates lessons learned from international experiences and case studies that have examined the interaction between governments, local communities and industry. For example, research has shown that conventional business development approaches often reproduce asymmetries of power and relations of dependency, echoing patterns of colonisation. By contrast, community-centred approaches have demonstrated the potential to foster long-term trust, inclusiveness and resilience.

Therefore, the purpose of this introduction is to frame biofuels and cellulose-based products not only as technological innovations but also as vehicles for inclusive development. By recognising cultural diversity, respecting territorial rights and promoting co-created business models, it becomes possible to align bio-based strategies with the aspirations of rural, indigenous and Afro-descendant communities. This approach reinforces that sustainability must go beyond environmental considerations, embedding social justice, equity and community well-being at the heart of the bioeconomy.

7.2. Rural, Indigenous and Afro-descendant Community Economic Development

The current global economic model, largely shaped by extractivism and capital accumulation, has contributed to profound environmental and social imbalances, including deforestation, pollution, biodiversity loss and the marginalisation of rural and traditional communities. From the perspective of indigenous and Afro-descendant organisations in Latin America, such as the Coordinadora Andina de Organizaciones Indígenas (CAOI, 2010), there is a call for alternative paradigms that value harmony with nature, community reciprocity and the preservation of life.

One such paradigm is articulated in the concept of *ayllu*, an Andean system of social organisation which places the community, the family, and nature at the centre of decision-making. The complementary economy of *Suma Qamaña* emphasises reciprocity with Mother Earth and prioritises well-being over the accumulation of capital. Applied to the bioeconomy, these principles provide a framework for designing business models in which biofuels and cellulose-based products are not only technological innovations but also tools for strengthening local economies, preserving cultural identities and supporting ecological balance.

International experiences reinforce the value of this community-centred perspective. For instance, the OECD (2016) recognises indigenous entrepreneurship as a driver of self-determination, where new ventures are created not only for profit but also for social benefits to the community. Similarly, the Royal Commission on Aboriginal Peoples (RCAP, 1996) stresses that self-government without an economic foundation risks being unsustainable. In Canada, the

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First Nations and Inuit economy has been estimated to represent an additional potential contribution of CAD 3.67 billion to national GDP (NAEBD, 2017). These examples highlight how indigenous business development can reduce dependency, create revenue for public goods, and generate multiplier effects that strengthen autonomy.

For rural, indigenous and Afro-descendant communities in Latin America, the development of cellulose-derived biofuels and related bioproducts presents an opportunity to replicate these dynamics by promoting economic resilience, energy autonomy and environmental sustainability. Such approaches contribute directly to the SDGs, especially Goal 1 (End poverty), Goal 7 (Affordable and Clean Energy, derived from biomass), and Goal 13 (Climate Action).

In this sense, community-based economic development must be seen not only as an alternative to conventional business models but as a transformative pathway for inclusive and sustainable bioeconomy systems. By integrating traditional practices with technological innovation, these communities can actively shape the future of renewable energy and cellulose-based industries, ensuring that economic progress is inseparable from social justice and ecological stewardship.

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8. SUSTAINABLE ECONOMIC DEVELOPMENT APPROACH

8.1. Introduction

When addressing sustainable economic development in rural, indigenous and Afro-descendant communities, the opportunities available are strongly influenced by a series of contextual factors. These include the size and characteristics of the population, their proximity and accessibility to urban centres, the availability of natural and productive resources, the community's capacity to meet local needs, and the strength of local institutions that support development.

The market context can be both internal, focused on providing solutions and services that respond to the immediate needs of community members, and external, oriented towards connecting to regional, national or international markets. Hybrid models are particularly relevant in the bioeconomy, where the balance between local consumption and participation in global value chains ensures both resilience and economic growth.

For rural territories, the proximity to cities and the integration of tradable sectors play a decisive role in determining the scope of sustainable economic development initiatives. However, beyond geographical or infrastructural considerations, the essence of this approach is that economic progress must directly enhance the well-being of communities and contribute to social cohesion, cultural recognition and environmental sustainability.

8.2. Areas of support that may be delivered by institutions

Institutional support is essential to enable sustainable economic development pathways for SMEs, rural actors, and indigenous and Afro-descendant communities. A fundamental starting point is the creation of trust-based partnerships, where both academic and external institutions engage with communities in a manner that respects their sovereignty, histories and perspectives. Without such trust, even well-designed initiatives risk reproducing patterns of dependency or exclusion.

The experience of community-based participatory research highlights key recommendations for institutional engagement:

- acknowledge personal and institutional histories;
- understand the historical context of the community;
- ensure active presence within the territory;
- recognise the expertise of all stakeholders;
- and maintain transparent communication of expectations and intentions.

Transparency is a cornerstone for ensuring that institutions can build meaningful relationships with communities. This includes recognising past experiences of exploitation, stereotyping or extractive research, and instead promoting collaboration based on equality and reciprocity. Institutions must be attentive to the boundaries set by communities, as well as to their social, environmental and geographical realities.

Ultimately, institutional support must aim not only to deliver technical or financial resources but also to strengthen local governance capacities and to empower communities to define their own economic futures. Successful partnerships therefore go beyond project implementation:

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they foster long-term resilience, autonomy, and trust, enabling rural, indigenous and Afro-descendant communities to position themselves as active agents in the bioeconomy.

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9. RURAL ELECTRIFICATION MODELS

9.1. Developing rural electrification in Colombia

Colombia has the vast majority of its population interconnected to the central electricity grid (around 90%). Despite this high level of electrification, approximately 30% of the national territory remains unconnected. These non-interconnected areas are typically the most economically disadvantaged and, in many cases, overlap with regions affected by conflict.

Expanding access to electricity in such areas is equivalent to providing opportunities for economic development and improved quality of life. Electrification should not be viewed merely as a binary condition – connected or not connected – but rather as a progressive process that begins with the provision of basic energy services and gradually expands according to affordability and local needs (EU Regional Water and Energy Workshop, 2015).

In this sense, rural electrification is not only about infrastructure deployment but also about creating the enabling conditions for inclusive growth. Access to reliable, affordable and sustainable energy is a prerequisite for rural and indigenous communities, as well as SMEs and Afro-descendant populations, to actively participate in the bioeconomy. Energy access underpins productive use, education, healthcare, and the establishment of local business models, including those derived from biomass and biofuels.

9.1.1. Community Business Approach

The **A-B-C model** (Anchor Business Community) promoted by the World Bank focuses on electrification projects with productive use. It seeks to enhance sustainability by:

- Providing power to existing uses (e.g., telecom towers using renewable sources).
- Supplying power to new productive users (e.g., local workshops).
- Ensuring affordable supply for households with limited purchasing power.

This approach requires a technical service provider to ensure quality and maintenance, while promoting local productive activities that generate income to reinvest in the system. However, studies highlight that its implementation often depends on public intervention (cross-subsidisation, spatial planning, and stakeholder engagement).

9.1.2. Private Business Approach

Private-sector models for rural electrification typically involve partnerships between microfinance institutions (MFIs), technology providers, and energy companies. They include:

- **One-hand models** where the same entity handles financing, installation, and after-sales.
- **Two-hand models** separating microfinance from technical provision.
- **Fee-for-service / pay-as-you-go models** allowing flexible payments.
- **Lease or hire-purchase models** enabling consumers to progressively acquire assets.

These models improve access by combining affordability with technical support, but long-term sustainability depends on credit recovery, consumer capacity, and market stability.

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9.1.3. Public Institution Business Approach

When private investment is limited, public-sector-led models are implemented through Ministries of Energy and Rural Electrification Agencies, often supported by donors. The process generally includes:

- **Co-funding mechanisms** with bilateral and multilateral partners.
- **Master planning** for rural electrification.
- **Donor-supported installation and maintenance agreements**.

This model ensures broader social equity and large-scale coverage, though it may create dependency on external funding and face delays due to bureaucratic processes.

9.2. Rationale for Rural Electrification Energy Systems

The development of rural electrification requires a differentiated and context-sensitive approach, as isolated areas often face unique challenges such as geographical dispersion, limited population density, low demand, and restricted financial capacity. To address these, two principal strategies are considered: **stand-alone systems** and **mini-grids**. Both aim to expand access to reliable energy while balancing cost-effectiveness, technical feasibility, and long-term sustainability.

Stand-alone electrification

Stand-alone systems are typically applied in remote or sparsely populated regions, far from existing transmission infrastructure. Central planners recommend such solutions for households or clusters located beyond priority loads and where grid extension is not economically viable in the short or medium term.

- **Technology options**: solar home systems (SHS), wind home systems (WHS), pico-hydro units, battery storage, and hybrid diesel–renewable energy systems.
- **Constraints**: electrification in these areas is often delayed for decades due to high costs, logistical barriers, and dispersed loads (e.g., fewer than 20 customers per site).
- **Implementation model**: private operators may be responsible under universal access policies, ensuring delivery of basic services to consumers.

This approach provides essential services such as household lighting, communication charging, and in some cases, small productive loads. While modest in scope, stand-alone systems contribute significantly to improving quality of life, health, and education in rural communities.

Mini-grid electrification

Mini-grids are suitable where loads are more concentrated, for example in rural villages or community centres. They enable a broader spectrum of services and offer a stronger platform for local economic development.

- **Shared benefits**: all households, including those with limited purchasing power, gain access to electricity for drinking and irrigation water, street lighting, health posts, schools, refrigeration, and agro-processing.
- **Cost distribution**: the residual cost of generation, after applying subsidies, is distributed among all connected customers, making electricity more affordable.

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- **Quality of supply**: determined by initial system design and the affordability criteria established at community level.
- **Regulatory framework**: mini-grids often require both a generation and distribution licence, which can be administered partially at local level to encourage community involvement.

Enabling technologies and efficiency

To maximise the impact of rural electrification, hybrid systems integrating photovoltaic (PV), wind, hydro, batteries, and diesel back-up are recommended. These systems replicate grid-like functionalities by offering:

- **Load management**: enabling independent steering, prioritisation of essential loads, and tariff flexibility.
- **Remote operation**: monitoring and control through GPS and ICT interfaces.
- **Phased deployment**: gradual expansion of systems based on evolving community demand and financing capacity.

A central element is **energy efficiency**. Replacing incandescent lamps with LED technology can reduce consumption by 50–85%, effectively unlocking the "energy ladder" and allowing communities to access higher levels of service at reduced cost.

Decision-making framework

The process of selecting an electrification pathway follows a structured rationale:

1. **Distance from the grid** – evaluating whether grid extension is technically and economically feasible.
2. **Size of demand** – identifying whether loads are concentrated (productive uses, village centres) or dispersed (households only).
3. **System choice** – grid extension, off-grid stand-alone systems, or community mini-grids.
4. **Technology options** – renewable energy technologies (RET: wind, solar PV, biomass gasifiers, hydro), diesel back-up, or hybrid solutions, selected according to resource availability, income levels, and equipment access.
5. **Community organisation** – assessing whether the local population can manage, co-finance, and sustain the system in the long term.

Conclusion

This rationale underscores the importance of tailoring electrification models to local realities. Stand-alone systems are effective for dispersed households, while mini-grids foster community-wide benefits and support productive uses. Hybrid and renewable technologies enhance system resilience, reduce dependency on diesel, and contribute to climate objectives. Energy efficiency remains a cross-cutting enabler, reducing costs and increasing the reach of available power.

By applying this systematic decision framework, rural electrification programmes can ensure **socio-economic inclusion, technical sustainability, and alignment with global energy transition goals**.

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9.3. Measuring Impact and Progress of Rural Electrification

Assessing the impact of rural electrification requires the use of measurable indicators that capture not only the level of access but also the quality and sustainability of the service. The following key metrics are applied:

- **Electrification rate**: proportion of the population with effective access to electricity compared to the total population (or total number of households).
- **Electricity access rate**: percentage of the population living in electrified localities relative to the total population.
- **Electricity coverage ratio**: number of electrified localities relative to the total number of localities.
- **Electricity service or penetration rate**: share of the total population in electrified areas that has actual access to electricity.

To capture progress beyond binary measures of access, the **Multi-Tier Framework (MTF)** is applied, classifying households into tiers based on attributes such as peak power capacity, duration of supply, evening availability, reliability, quality, affordability, legality, and safety.

The continuous spectrum of tiers ranges from **Tier 0** (no access, reliance on kerosene or candles) to **Tier 5** (full access, sufficient capacity for high-power appliances). Progression through these tiers reflects incremental improvements in household consumption, affordability, and technology deployment:

- **Tier 1–2**: basic lighting and phone charging, often supported by solar lanterns or stand-alone home systems.
- **Tier 3**: medium-scale access, enabling productive uses and small appliances, usually via mini-grids.
- **Tier 4–5**: reliable, grid-level supply supporting modern services and high-power appliances.

The MTF therefore provides a **granular assessment of service delivery**, enabling policymakers to measure not only connections but also the degree to which electrification improves living standards, productivity, and socio-economic development.

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10. WAYUU-URIANA CLAN: CURRENT BUSINESS MODEL

10.1. Framework of Analysis

With Uriana's Clan, we have developed the framework *"Community, Water-Renewable Energies, Diversity" (CARED)*, grounded in the principles of Participatory Action Research (PAR). Its central actors are the Wayuu community, approached through the Ethno-educational Institution La Paz. This methodology is rooted in principles of communal relationships, where ethics prevail as "the search for the best conditions for everyone to live in the present and for future generations" (Benavides et al., 2015). This perspective goes beyond a simple demonstration of equality and moves towards responsibility for the Other, inspired by Emmanuel Lévinas' philosophy and adapted to Latin America by Enrique Dussel. In this approach, any action without responsibility towards the Other does not arise from genuine solidarity (Dussel, 2002).

Economic thinking within Wayuu communities is also framed by recognising the interdependence between ecosystems and culture. Ángel (2013) argues that this relationship reflects a profound and mutual impact between cultural practices and the natural environment. Within the CARED framework, territory is regarded as sacred: not merely land, sand, rivers or sea, but a *powerful relational space* where physical and symbolic exchanges create lived habitats (Benavides et al., 2015). To inhabit the territory poetically is to honour its essence—not only as a resource, but as an enchanted landscape (Noguera, 2004), woven into narratives that interlace ancient traditions with contemporary existence.

The Wayuu term *waayu* means "the being of a person". Their worldview is embedded in myths reflecting ancestral wisdom. For example, Juyá (rain) embodies the life-giving force that quenches thirst and sustains both humans and nature. In Wayuu cosmology, fire is another key myth: Maleiwa, the creator, gifted fire through Ka'ashimá ("he has fire"), enabling humans to cook food and defend themselves. These myths encapsulate the sacred ties between natural elements and survival.

For the Wayuu, life, water, and energy are inseparable. Their cosmogony recreates myths of origin that connect humans, animals, and the natural environment, raising the central question: *what can be considered sacred, and what sustains life?*

The Uriana Clan settled in the indigenous community of La Paz, composed mainly of descendants of elder Petronila Uriana, 7 km from the town of Manaure in La Guajira (Colombia). They live in traditional *rancherías*, where communal living is central. Families share territory and cultural practices but remain autonomous in caring for their members. Daily life is strongly linked to the semi-desert ecosystem of La Guajira, shaped by fishing, herding, and craftwork.

Economic activity centres on weaving, particularly the Wayuu mochila (backpack), recognised for its cultural significance and economic value. Wayuu women, as tradition bearers, weave hammocks and bags as both practical and symbolic labour. This artisanal practice reflects intergenerational knowledge, cultural resilience, and women's roles as custodians of tradition. The mochila is not only an object of commerce but also a representation of cosmology, carrying meaning, stories, and identity.

In recent decades, weaving has evolved from a domestic activity into a commercial enterprise. Mochilas are sold in regional markets on the Colombian Caribbean coast such as Riohacha, Santa Marta, and beyond, with some pieces fetching significant value. However, the commercialisation process often diminishes their cultural meaning, reducing them to mere objects of fashion. This

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raises concerns about exploitation, inequitable trade, and the undervaluation of Wayuu women's labour.

Despite these challenges, the mochila remains a core element of cultural identity and community sustainability. Within the CARED framework, it symbolises the integration of cultural heritage, economic survival, and renewable energy initiatives, pointing towards models of development that respect both tradition and innovation.

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11. CONCLUSIONS

This deliverable has examined the opportunities and challenges associated with developing business models and addressing the needs of SMEs and rural areas in cellulose-based products.

The analysis has shown that the bioeconomy, when anchored in renewable resources such as lignocellulosic biomass, provides significant potential for addressing global challenges including climate change, fossil fuel dependency, and socio-economic inequalities.

A key conclusion is that sustainable business models must be **inclusive**, ensuring that SMEs, rural stakeholders, and indigenous and Afro-descendant communities are not only beneficiaries but also active co-creators of innovation. Embedding traditional knowledge and cultural practices alongside scientific and technological development strengthens the legitimacy, resilience and acceptance of bio-based initiatives.

The framework of analysis has highlighted the importance of addressing the **coloniality of knowledge**, recognising diverse epistemologies and respecting cultural and territorial rights. Decolonial approaches, such as those inspired by the philosophy of *Buen Vivir*, demonstrate that alternative models of progress are possible—ones that prioritise well-being, reciprocity with nature, and long-term sustainability over short-term economic gain.

The integration of the **Sustainable Development Goals (SDGs)** into this work provides a guiding framework for aligning bio-based innovation with global and local priorities. Goals 1 (No Poverty), 5 (Gender Equality), 7 (Affordable and Clean Energy derived from biomass), 10 (Reduced Inequalities), 12 (Responsible Consumption and Production) and 13 (Climate Action) are particularly relevant, underlining the multi-dimensional benefits of cellulose-based strategies.

The exploration of **rural electrification models** further illustrates the transformative role of bio-based energy solutions. Community, private and public institutional approaches demonstrate different pathways to expand access to energy, each with strengths and limitations. Importantly, decentralised systems such as mini-grids and stand-alone renewable technologies contribute not only to electrification but also to economic development, education, health, and gender empowerment.

Finally, the case study of the **Wayuu-Uriana Clan** shows how local communities integrate cultural identity, artisanal production, and sustainable resource management into their economic practices. The Wayuu mochila is not only a product of commerce but also a cultural symbol that embodies intergenerational knowledge, resilience and identity. This example highlights that innovation in the bioeconomy is as much about people and traditions as it is about technologies and markets.

In conclusion, sustainable and inclusive development in cellulose-based products requires a holistic vision where SMEs, rural actors, indigenous and Afro-descendant communities, academic institutions, and policymakers collaborate to co-design equitable and culturally sensitive business models. By aligning local realities with global sustainability frameworks, the bioeconomy can become a driver of both technological innovation and social justice, ensuring that no community is left behind in the transition towards a greener and fairer future.

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