

Sustainable bioenergy pathways in Latin America

Promoting bioenergy investment and sustainability



Workshop, São Paulo,
17 March 2023

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EXECUTIVE SUMMARY

Sustainable bioenergy is one of the most interesting and competitive energy alternatives for promoting the energy transition, storing solar energy efficiently and achieving a low-carbon footprint. Bioenergy also potentially improves energy security, reduces air pollution, generates employment and economic development, and boosts countries' agricultural sectors. These qualities of bioenergy explain the projections of its increasing prevalence in global energy scenarios. As indicated in the International Renewable Energy Agency's (IRENA's) *World Energy Transitions Outlook 2022*, the energy contribution of biomass from sustainable sources will increase five-fold by 2050 compared with current use, and biofuel uses will need to increase six-fold in the transport sector.

Latin America offers suitable climate conditions, and availability of water and land, to expand biomass production without affecting agricultural production for domestic consumption and export, and without impinging on forested or protected areas if implemented with careful management. It also has a robust agricultural industry, which provides synergies for the development of bioenergy, as has been recognised in various studies by international agencies and development banks.

However, Latin America's bioenergy potential has been only partially developed, with some countries boasting significant production bases and well-established markets, while others are only beginning exploration. This brief, based on a dedicated workshop, identifies barriers and suggests strategies to promote investment and the development of sustainable bioenergy markets in the region. The workshop was held in São Paulo in March 2023 with the participation of representatives of public and private institutions, and national and multilateral stakeholders in the region. This workshop discussed the national bioenergy programmes of Argentina, Brazil and Colombia in depth, as these countries offer more visible development than the rest of the Latin American region. Representatives of industry, financial institutions and global bioenergy platforms presented their views on how to attract investment in the bioenergy sector in the region. Key findings from the presentations and discussions in the workshop include:

1. **An adequate legal and regulatory framework is essential.** Suitable biophysical conditions for biomass production and attractive economic development are not sufficient for bioenergy production in the region. The bridge between this resource and its sustainable exploitation is provided by private companies, and at the same time, promoted and regulated at the governmental level. Therefore, it is essential to have a sustained, adequate and stable legal and regulatory framework that defines and promotes with sufficient certainty the evolution of the demand for biofuels and/or bioelectricity, and that allows its commercialisation under sufficiently remunerative conditions and with legal certainty, in a differentiated way by type of biofuel, in order to minimise the financial risk in bioenergy investments.
2. **Evaluating the economic worth of reducing greenhouse gas emissions through biofuels has proven to be a successful approach.** The positive outcomes attained by the RenovaBio programme in Brazil over recent years serve as a compelling demonstration that assessing and assigning economic value to the mitigation of greenhouse gas emissions can yield significant benefits. The transparent and consistent methodology and modelling adopted in RenovaBio can be implemented in the region relatively quickly, with significant economic and environmental results, enabling compliance with national decarbonisation targets for the fuels used in the transport sector.
3. **Co-operation among countries is important.** In Latin America, countries that have developed significant bioenergy systems in their economies co-exist with countries with similar natural and historical conditions that are still trying to promote bioenergy, without managing to overcome the barriers, prejudices and bottlenecks among the population and economic agents. Dialogue between governments, involving industry, financial institutions and multilateral agencies, could improve the knowledge base and provide

benchmarks for countries interested in promoting bioenergy to meet social and environmental demands, stimulating investment in bioenergy systems.

These issues reveal the most significant barriers and opportunities for achieving actions that foster implementation of sustainable domestic biofuel markets in the region, especially in countries with incipient markets. Based on these core areas, we can outline steps to promote the expansion of the bioenergy sector in the region:

- 1. Define an appropriate legal framework.** Considering the challenges and opportunities of the energy transition in the region, the first necessary step is to establish a sustainable bioenergy law, with objectives consistent with local potential and conditions. This should consider an institutional basis with sufficient scope and autonomy to define, detail and implement strategies and policies to promote bioenergy. It must be capable of guaranteeing sustainability and overcoming the barriers to the investment needed to develop the production and use of biofuels and bioelectricity.
- 2. Implement a bioenergy market.** An institutional structure must be introduced based on this proposed sustainable bioenergy law that defines how goals consistent with medium- and long-term strategies will be implemented and by whom. This must include comprehensive financial and fiscal incentives, including a balanced tax framework, in line with the mandates and obligations, recognising the externalities associated with biofuels and bioelectricity. This is in addition to monitoring measures to support research and technological development, marketing and infrastructure, training of human resources and capacity building, and to provide reliable information services and improve public awareness, within a framework of action that strengthens the governance and sustainability of the bioenergy market.
- 3. Progressively develop and diversify products and markets.** Given the diversity of bioenergy technologies and biofuels, it is important to start by considering the implementation of bioenergy production and use systems, starting in markets that are considered limited, using low levels of blending. The use of ethanol/gasoline and biodiesel/diesel blends with up to 10% of properly specified biofuel (E10 and B10) is well proven in fuel logistics systems, with millions of vehicles on the road already using such blends. These blends can be adopted quickly in the region. Higher levels of blending would require prior market assessments or even adapting engines for the use of pure biofuels. The biofuels market is expanding and consolidating steadily. This enables countries that have not yet embraced biofuels to gain confidence by looking at the experience of benchmark countries in the region. This highlights the opportunities for co-operation.

More advanced and promising technologies are maturing. These include ethanol from cellulosic waste (second-generation ethanol), biomethane from biogas from various biomasses, and aviation biofuels, but their wide adoption is still incipient.

Participants in the morning sessions of the IRENA Sustainable Bioenergy Pathways in Latin America workshop, São Paulo, 17 March 2023.



BACKGROUND

The energy transition – comprising the entire process of shifting energy production and use systems towards renewable sources with low or zero atmospheric emissions of fossil carbon – reflects a real and urgent demand from society in the face of increasing climate risk and in pursuit of the effective sustainability and resilience of production systems. Ambitious global decarbonisation targets have been set for 2050. These require accelerated and significant changes, in both the energy sources used and the raw materials consumed in industrial processes.

Fundamentally aligned with the energy transition, the International Renewable Energy Agency (IRENA) has developed a comprehensive information and knowledge base on global energy resources, technologies and prospects, seeking the foundations for the construction of a desirable future for all, in which bioenergy is promoted alongside other forms of renewable energy. IRENA's *World Energy Transitions Outlook* suggests that bioenergy could play a major role in the energy transition to limit global temperature increases to 1.5°C, requiring biomass from sustainable sources to increase 2.5-fold by 2050, from about 58 exajoules (EJ) in 2020, with the share of biofuels in transport increasing more than fourfold over the same horizon (IRENA, 2023).

However, this expansion of bioenergy requires the adoption of strategies and policies capable of guaranteeing its sustainability and overcoming barriers to investment. This means developing an adequate institutional structure and implementing consistent goals and clear long-term strategies for the components of bioenergy systems, within a framework of productive dialogue between public and private stakeholders (IRENA, 2022).

This issue is particularly interesting in Latin America, which has attractive conditions for developing sustainable production and use systems of biofuel and bioelectricity. The region benefits from its suitable climate and land availability for bioenergy crops without affecting agricultural production for domestic consumption and export, and without occupying forested or protected areas when careful management is put in place. As an indicator of its bioenergy potential, the use of 1% of Latin America's 3.17 million hectares of pastureland for sugar cane cultivation – which is very familiar in the region and one of the most efficient plants for the photosynthetic conversion of solar energy – would enable production of more than 253 million tonnes (Mt) of sugar cane per year. This would be sufficient to manufacture 21.5 billion litres of ethanol at competitive prices, which could, in turn, mitigate annual emissions of 29 Mt of carbon dioxide (CO₂) (Trindade *et al.*, 2022). Equally importantly, promoting bioenergy can improve energy security, reduce air pollution in large cities, generate employment and income, and boost the agricultural sectors in the countries.

Argentina, Brazil and Colombia are currently major producers of biofuels and bioelectricity, serving their domestic markets and exporting surpluses. However, other countries in the region still have undeveloped or underutilised bioenergy potential. This leads to the core questions explored in this workshop:

If Latin America has great potential for the development of sustainable bioenergy, which urgently needs to be developed to meet global decarbonisation targets and local socio-economic development needs, why are there still countries where this remains a mere possibility while biofuels and bioelectricity are already a significant reality in other countries? And how do we expand the production and use of modern bioenergy?

OBJECTIVE OF THE WORKSHOP

The workshop was intended to bring together major decision makers, key stakeholders and leading bioenergy experts from the main bioenergy-producing countries in the Latin American region, providing a platform for industry players, governments and institutes to evaluate the main technological pathways and opportunities for deploying bioenergy, assessing the challenges and barriers, and the possibilities related to sustainability and the roll-out of bioenergy investment in the region.

FORMAT AND PARTICIPANTS

The workshop provided a space for discussion of policies and specialised measures to promote bioenergy in the Latin American context. It was held in a hybrid format. The morning featured presentations by representatives of public and private institutions, with some discussion and online access for external participants. In the afternoon, discussion was reserved for presenters and guests to explore the issues in depth.

The workshop was attended by leading stakeholders in the bioenergy industry in Latin America from both the private and government sectors, especially from the main producing countries. The participants included representatives of regional organisations, governmental institutions, bioenergy associations, chambers of industry and sector experts in the bioenergy industry in Latin America. Such a diverse mix made it possible to explore different perspectives and seek convergence and common ground. The programme and a list of participants (in-person and online) are provided in the appendices to this report.

SUMMARY OF THE SESSIONS

The following conclusions and recommendations were prepared considering the basic question, the objective of the workshop, the contributions of the participants in their presentations, and the discussions during the workshop. The conclusions and recommendations are grouped based on the topics of the sessions and the questions addressed to the participants. These conclusions consider not only the perspectives and situations of forerunning countries, but also countries that are just starting to pursue sustainable bioenergy.

Important note: This policy brief has been compiled based on inputs and discussions provided by workshop participants. The views and opinions expressed herein are solely those of the contributors and do not necessarily reflect the official stance or views of IRENA. The Agency holds no responsibility for the content, conclusions or implications presented in this document.

TOPIC 1. GOVERNMENT PERSPECTIVES ON THE DEVELOPMENT OF BIOENERGY POTENTIAL

What are the targets for biofuels and bioelectricity production in the countries?

Biofuel consumption in Latin America has increased by 80% over the last decade, and it is expected to grow by 37% in the next five years, while global demand for biofuels could increase by 20% in the same period,¹ according to the International Energy Agency (IEA). This means bioenergy is expected to grow almost twice as fast in the Latin American region as in other regions.

However, this growth is still very uneven. In some countries, such as Argentina, Brazil and Colombia, bioenergy has a significant presence in the energy matrix. However, there is less information in other countries in the region, with the adoption of regulations for biofuel blending still being considered, and no production and consumption targets.

As an example of a favourable governmental environment for bioenergy, in Brazil, the domestic energy supply expanded by 4.5 times between 1970 and 2021, to 301 million tonnes of oil equivalent (Mtoe), with renewable sources representing 45% of the total energy supply in 2021, according to the Empresa de Pesquisa Energética (EPE, Energy Research Office). This year, the various forms of bioenergy accounted for just over two-thirds of total renewable energy, or 30.9% of domestic energy supply, with the bioenergy largely from sugar cane derivatives. This share is becoming consolidated through diversification of biofuels and expansion of their production, in line with national goals for decarbonisation, environmental protection and economic development. Total energy supply of around 384 Mtoe is expected in the next decade, with 105 Mtoe from bioenergy.² The planned production capacities and investment needs to meet this target are detailed later in this report.

Providing a broad vision of the potential and barriers from the governmental point of view, OLADE, the Latin American Energy Organisation, recognises the existence of barriers that are impeding the development of bioenergy in some Latin American countries. These barriers may be political, infrastructure-related, specific to the energy system (such as the weak integration of electricity systems) or specific to the development of new projects.

¹ "Liquid biofuels in Latin America", presented by Ana Alcalde, IEA, at the workshop.

² "Situation and outlook for bioenergy in Brazil", presented by Solange O. da Costa, EPE, at the workshop.

Policy barriers are often the most significant. Such barriers include lack of continuity in energy policy, which, together with legal uncertainty, increases risk for investors, the institutional weakness of the energy authority, difficulty in aligning state players and co-ordinating actions, and bureaucratic obstacles.

These barriers must be identified case by case in the countries and overcome through inclusive and effective dialogue.³

The experience of Argentina's government in developing bioenergy in electricity generation highlights the barriers noted by OLADE, adding needs: for medium- and long-term plans; to train project developers in new technologies; to improve the conditions for access to financing; and to adjust the regulatory environment for independent generators.⁴

How can sustainable bioenergy contribute to meeting national greenhouse gas emissions reduction commitments?

In addition to its positive impacts in the energy field, such as diversifying energy supply and improving energy security, and in the economic field, promoting economic activity, decentralisation, employment and income generation, the participants noted that bioenergy can make a substantial contribution to reducing emissions of polluting gases with local effects. In particular, it can contribute to reducing greenhouse gas (GHG) emissions, through efficient and economic replacement of oil derivatives, because its CO₂ emissions are biogenic, rather than fossil in origin. Bioenergy is essentially solar energy stored chemically in plant products. This energy can be released when needed, with no need for back-up or storage systems.

As experience with the RenovaBio programme in Brazil over the last three years shows, the contribution of bioenergy to reducing GHG emissions can be achieved relatively quickly and with significant results. This programme uses a consistent and open methodology in which production units are certified by third parties, accounting for emissions from biofuels (ethanol, biodiesel and biogas) over their life cycle, compared with emissions from oil derivatives. This enables the issue of biofuel decarbonisation credits (CBIOs, equivalent to one tonne of CO₂ not emitted) that distributors of fossil fuels must acquire to meet the emissions reduction targets set in response to Brazil's climate commitments,⁵ as shown in Figure 1.

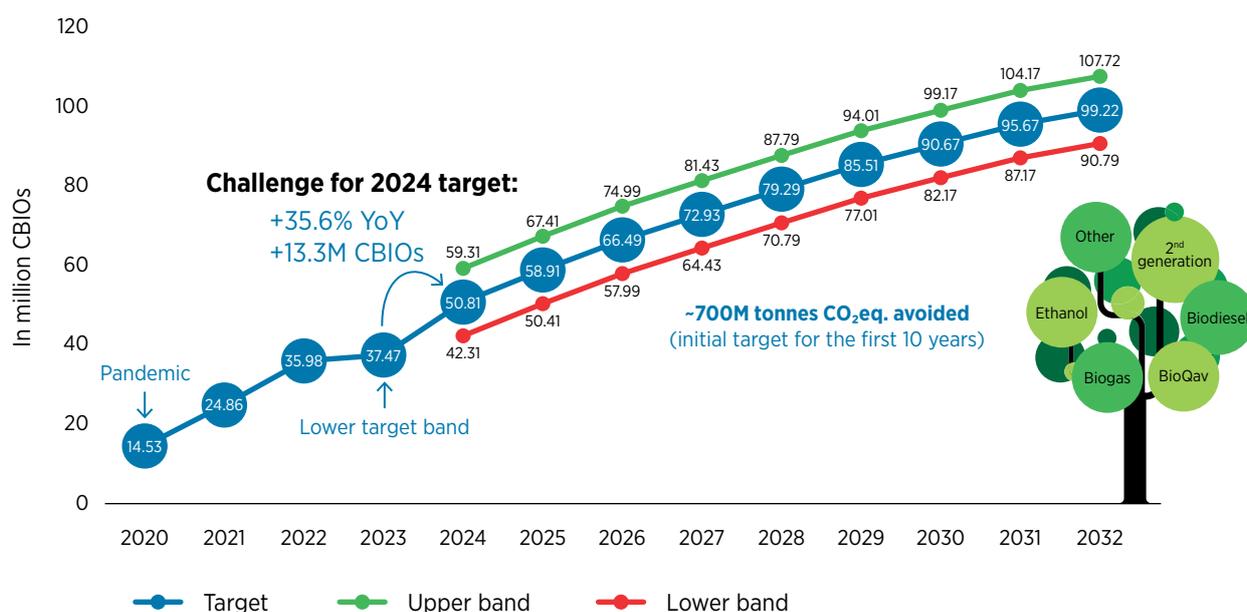
The assessment of emissions avoided – amounting to 36 MtCO₂ in 2022 and expected to reach a total of 100 MtCO₂ by 2032 – has fostered the introduction of more efficient methods and processes in the agro-industrial chain for biofuel production, leveraging investment and the expansion of activities, in a virtuous-cycle process. New biofuels, such as sustainable aviation fuels (SAF), hydrogenated vegetable oils (HVO) and hydrogen from biomass, are intended to be included in the programme in the near future.

³ "Barriers to renewable energy", presented by Medardo Cadena, OLADE, at the workshop.

⁴ "Energy Secretariat/Argentina, 2023. Government perspectives on the importance of bioenergy investment in Argentina: perspectives, priorities, lessons learned and outlook", presented by Juan Ignacio Paracca at the workshop.

⁵ "Bioenergia sustentável e os compromissos nacionais de mitigação das emissões de GEE [Sustainable bioenergy and national commitments to mitigate greenhouse gas emissions]", presented by Marcelo A. Boechat Morandi, Empresa Brasileira de Pesquisa Agropecuária, at the workshop.

Figure 1 Achievement of emission mitigation targets promoted by RenovaBio



Notes: YoY = year over year; CO₂eq = carbon dioxide equivalent; CBIO = biofuel decarbonisation credit; values in black circles correspond to CBIOs, i.e. annual targets in millions of tonnes of CO₂ not emitted. Source: “Ethanol: Solution for global challenges”, presented by Evandro Gussi, União da Indústria de Cana-de-Açúcar e Bioenergia (UNICA), at the workshop.

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TOPIC 2. PRIVATE SECTOR PERSPECTIVES ON THE DEVELOPMENT OF BIOENERGY POTENTIAL

What are the main barriers that have hindered the development of markets for biofuels and bioelectricity in Latin America?

It is recognised that there is significant potential to develop bioenergy resources in an economically competitive and environmentally sustainable manner in the region. However, from the private sector perspective, the main barrier to this is **the absence of an adequate and stable legal and regulatory framework with sufficient certainty that defines and promotes the development of demand** for biofuels (e.g. national or subnational programmes for the adoption of blends) and/or bioelectricity (e.g. through capacity [megawatts] or energy [megawatt hours] purchase guarantee programmes), enabling marketing under sufficiently remunerative conditions. This increases investment risk and reduces the attractiveness of investment. This perspective was unanimous among the representatives of the private sector at the workshop. Other interesting related topics discussed follow.

In Argentina, where sugar cane and corn make similar contributions to biofuel production, sub-sector entities⁶ agree on the need for national bioenergy strategies and proposing actions to foster public recognition of the positive externalities of ethanol use, such as emissions reduction and Sustainable Development Goals (SDGs), and the design of a strategic plan for bioethanol. They also highlight the difficulties in obtaining finance for projects, the possibility and appropriateness of implementing public policies for bioenergy at the provincial level, and the interest in harmonising policies for the promotion of bioenergy at the regional level, in Mercosur.

Representatives of Brazil's energy agri-business⁷ highlighted the importance of balanced and predictable public policies on bioenergy, stressing **the need to raise awareness in global society and among public decision makers about the real impacts and benefits of bioenergy**, particularly biofuels, as well as their effective contribution to the energy transition and decarbonisation of the environment. They recommended reporting on the positive differences that can be consistently assessed through life-cycle analysis, and the advantages and sustainability provided by process integration and the circular economy in bioenergy processes.

Observations by private sector representatives from Colombia emphasised the vast potential for expanding biofuel production. They stated that 1.5 million hectares highly suitable for sugar cane production for energy purposes are available in Colombia. They also highlighted the opportunities offered by innovative bioenergy technologies, such as biogas, electricity and hydrogen production, in integrated contexts.⁸ Adoption of biofuels began in Colombia in 2004, undergoing significant diversification of products since 2014. Since 2020, it has been pursuing innovation and competitiveness at a global level, with the expansion of electricity production and the evaluation of new biofuels, such as 2G ethanol, SAF and HVO. Given these possibilities, the importance of the predictability and scope of public bioenergy policies was reiterated, noting that while regulated markets manage uncertainties, open markets suffer from legal uncertainty. This was summarised as: "only markets that receive the right regulatory (and public policy) signals develop".⁹

To a lesser but also important extent, the discussions noted that there is a lack of a local culture and political will in some countries that is conducive to the adoption of biofuels, and that there are limitations in the adoption of innovative technologies in existing plants.

How could GHG emissions reduction commitments contribute to promoting bioenergy investment in Latin American countries?

Mechanisms for financial valuation of decarbonisation from bioenergy (such as carbon taxes or similar), associated with meeting national commitments under global agreements to tackle climate change, could improve the results of projects significantly and encourage or make feasible their implementation.

For example, in 2022 the RenovaBio programme in Brazil certified the mitigation of 36 MtCO₂, compensating biofuel producers with around USD 590 million, at a rate of USD 19 per tonne of CO₂ avoided. Other countries can consider similar programmes to RenovaBio.

⁶ "Contributions for a more sustainable Argentina", presented by Patrick Adam and Jorge Feijóo, Cámara de Bioetanol de Maíz y Centro Azucarero Argentino [Corn Bioethanol Chamber, Argentine Sugar Centre] at the workshop.

⁷ "Ethanol: Solution for global challenges", presented by Evandro Gussi, União da Indústria de Cana-de-Açúcar e Bioenergia [Sugarcane Industry and Bioenergy Association] (UNICA), at the workshop; oral contribution by André Nassar, Associação Brasileira das Indústrias de Óleos Vegetais [Association of Vegetable Oil Industries] (ABIOVE), at the workshop.

⁸ "Outlook for bioenergy in Colombia", presented by Johan Martinez, Azocaña, at the workshop.

⁹ "Biofuels: A sector, a legacy for Colombia", presented by Carlos Mateus, Fedebiocombustibles, at the workshop.

TOPIC 3. BIOENERGY RESOURCES AND TECHNOLOGY PATHWAYS: ROLE IN INVESTMENT

What are the limitations and constraints in the natural resource base hindering the development of the potential for bioenergy in Latin America? Land? Water? Competition with other activities?

Various studies have demonstrated that Latin America has, in general, particularly favourable conditions for promoting and developing sustainable bioenergy production systems, considering modern biofuels and bioelectricity. There are significant available areas with appropriate soil and climate conditions for high productivity cultures, which would have limited impact on other productive activities and natural resources.

However, **systematisation of information is still limited, e.g. through agro-ecological zoning that enables consideration of environmental restrictions, protected or susceptible areas, and priority uses, together with significant factors for production, such as soil, climate, water availability and logistical infrastructure.**

Brazil has had a positive experience with agro-ecological zoning of sugar cane and oil palm plantations by Embrapa. This can be used as a benchmark.

Bioenergy production requires ongoing attention to desirable diversity and renewal of the biological resource base of production (plant germ plasm), requiring the promotion of selection programmes for varieties, seeking the regular renewal of cultivars. This activity is naturally very specific to each climate and soil type, and to other conditions, and the same is true of exchange programmes between variety selection and breeding programmes. This should be promoted at the national level.

How could sustainability, productivity and efficiency be increased in conventional bioenergy technologies?

It was widely recognised by the economic agents involved in bioenergy in Latin America at the workshop that there are some interesting and promising prospects for innovative technologies within the range of possibilities offered by bioenergy, such as cellulosic ethanol (second generation) and biodigestion of sugar cane vinasse. However, there is also substantial room for adoption of incremental improvements and refinements in the processes of converting biomass into energy vectors. This is low risk and offers good short-term results, and should be promoted. In other words, there is room and opportunity for incremental innovation and the spread of techniques that are already well known and mastered, as they are more accessible and less risky, before embarking on disruptive innovation (Nogueira *et al.*, 2020).

Examples of this include measures related to biomass production – such as biological pest control, irrigation using sugar cane vinasse (nutrient recycling), direct planting, optimisation of harvesting and transport – and its conversion into bioenergy – such as more efficient extraction systems, boiler control and steam systems, and increased co-generation. These are all well-known and freely available possibilities to improve bioenergy production chains, in a broad sense, that have not yet been adopted in more conservative production units or those with limited access to finance.

What are the main barriers and challenges in terms of developing biofuels markets?

While vehicle technology does not present any restrictions on the use of low-percentage biofuel/petroleum-derived blends, such as E10 and B10 – as exhaustively proven by millions of engines operating in dozens of countries, with the most diverse climate conditions and vehicle ages – prejudices and misinformation persist in some countries, as reported by the workshop participants. If these could be overcome, by setting out the advantages of biofuels, these countries could, in a very short time, be using the fuels they produce, reducing imports, improving air quality and generating employment and income locally. It is a paradox that some Latin American countries regularly export well-specified biofuels to very demanding markets but do not use even a tiny fraction of these in their domestic markets.

A key point raised by the participants to consider in promoting the use of biofuels in these countries is that it requires government action to educate the population and consumers and counter misinformation. The actions of oil companies and service stations are also crucial here. Examples from the region show that it makes a decisive difference whether they take a pro or anti stance to these fuels, as they are usually the owners of the logistical infrastructure, such as the terminals where biofuel blends need to be prepared. The participants pointed out that there are no technical restrictions related to durability, maintenance or the lifetime of equipment that would justify not adopting low-percentage biofuel blends (Cortez *et al.*, 2018).

Once these cultural barriers are overcome, blending mandates can be implemented in a flexible manner and can open up space for successively more advanced technologies that are commercially available. These include flex-fuel vehicles, capable of using any biofuel (including pure biofuels) and hybrid vehicles, which combine the use of electric engines with combustion engines in an energy-optimised way, offering the lowest GHG emissions of all currently existing technologies, at around 20 grammes of CO₂ per kilometre travelled.

TOPIC 4. PUBLIC POLICIES, REGULATORY FRAMEWORKS AND FINANCIAL MECHANISMS TO PROMOTE BIOENERGY

What are the needs for implementation, improvement and monitoring of public policies and regulation at the various levels of bioenergy production and use?

These needs vary from country to country, depending on the scale of the market and the maturity of energy market regulation. However, public policies are always the decisive factor, and no biofuels programmes can be implemented without them. There are no known cases of biofuels succeeding in being introduced to the market, even if produced and used in sustainable and economically competitive ways, without government policies and measures, often related to the promotion of use. These usually take the form of mandates for biofuel use (in terms of volume, oxygen content or, preferably, GHG emissions mitigation potential), creating demand that, in turn, stimulates production.

Thus, at a minimum, it is necessary to define fuel specifications and establish blending mandates, which could initially be for captive fleets (specific consumers) or regionalised. According to the participants, a balanced tax framework is also essential for determining the competitiveness of biofuels, including through tax structures that consider the positive externalities of bioenergy.

It is always desirable for any programme for developing the market for biofuels to plan and implement a communication programme for users, retailers, garages, *etc.* on the implications and justifications for using biofuels. It could be useful to publish indicators of progress on the energy, socio-economic and environmental results achieved and to be achieved.

Could the external biofuels market help strengthen the bioenergy agri-business?

The export of biofuels can undoubtedly represent relatively flexible additional demand for surplus production. In some cases, such as in Guatemala, it may be the only demand where no domestic market has been implemented. Due to its potential and favourable conditions for sustainable and competitive production, Latin America will be able to generate significant volumes of exportable surpluses to reduce GHG emissions in other countries.

Unfortunately, protectionist trade barriers have, in many cases, prevented the export of biofuels by countries capable of producing them sustainably on a competitive basis.

What characteristics of bioenergy projects make them bankable and attractive?

Well-designed bioenergy projects that pay sufficient attention to sustainability are currently inherently attractive to banks, including multilateral development institutions. These requirements can easily be met under the natural conditions in Latin America with the conventional technologies available.

However, this is necessary but not sufficient. An adequate and stable legal and regulatory framework that defines the prospects for demand for biofuels and/or bioelectricity with sufficient certainty, allowing its marketing under sufficiently remunerative conditions, is essential, as highlighted at the workshop.

What are the most interesting and suitable business and financing models for bioenergy projects?

Bioenergy projects can be very diverse in technology (raw material/product) and scale, and so can business models and financing schemes. The formation of consortia and groups involving agents with complementary characteristics, sharing and reducing the financial risk and results, offers interesting options that make the projects more robust. These agents include: a) biomass producers already established in the country or in countries in the region; b) manufacturers/developers of production systems (this is particularly relevant and common in electricity generation and anaerobic biodigestion systems); c) financial agents (in "project finance" schemes); and d) purchasers of the biofuels ("offtakers") or electricity produced, such as fuel distribution companies and electricity distribution concessionaires.

An interesting innovation adopted by international banks in recent years and incorporated into the financing facilities of Brazilian investment banks is to link interest rates to the fulfilment of environmental goals, such as reductions in GHG emissions or increased efficiency in the use of natural resources. For example, the interest rates on a BRA 100 million (Brazilian real) loan from a private bank for a biodiesel production plant in southern Brazil will be automatically reduced by 0.15% per year based on the fulfilment of sustainability objectives (UDOP, 2023). These objectives include the purchase of raw materials from family farms and the adoption of reverse logistics to reduce fuel consumption.

Box 1 Experience of the Brazilian Development Bank in promoting bioenergy

The Brazilian Development Bank (BNDES) is playing a significant role in promoting the economic development of productive infrastructure in Brazil. This bank has played a leading role in financing new projects and the expansion of existing ones, and in the promotion and introduction of new technologies for bioenergy systems. The role of BNDES was enhanced in 2007 with the creation of its Biofuels Department, which has five main objectives: a) expansion of production capacity; b) incentivising innovation and technological development; c) enhancing positive externalities; d) promoting sustainability; and e) contributing to the creation of a global bioethanol market (Milanez and Nyko, 2012).

In the last 20 years, BNDES has disbursed around BRA 70 billion to finance investment throughout the productive chain, from the optimisation of idle industrial and agricultural (with regeneration of sugar cane fields) capacity. This has involved improvements in both sugar cane production (including genetic improvements, soil use efficiency, improved planting efficiency, cultural practices and harvesting) and in the industrial sector (process efficiency, reduction of waste and increased co-generation).

The bank's actions to promote research and development include its Support Programme for Industrial and Technological Innovation in the Sugar-Energy and Sugar-Chemical Sectors (BNDES, n.d.a), a joint initiative between BNDES and FINEP, the federal innovation agency, between 2011 and 2014. This sought to improve productivity and promote the production of cellulosic ethanol and new products in this industry. As a result of this technological development, the ethanol sector has benefited from

Box 1 Continued

productivity gains through the introduction of innovations that are unprecedented globally, such as second-generation ethanol and genetically modified sugar cane varieties.

More recently, BNDES has adopted environmental and climate change mitigation indicators in the various forms of financing in its projects. In 2021, BNDES launched the RenovaBio credit facility (BNDES, n.d.b), offering BRA 2 billion to biofuel producers to stimulate the reduction of emissions through better productive and environmental practices. Each loan will be for up to BRA 100 million per production unit, with a limit of BRA 200 million per economic group. The repayment period is up to 96 months, with a grace period of up to 24 months. Interest comprises preferential long-term rate or market cost benchmarks plus 1.5% per year and a credit risk premium. The interest rates can be reduced by up to 0.4% if the company demonstrates the carbon emission reductions stipulated by the bank, in line with RenovaBio.

PLANNED INVESTMENTS IN BIOENERGY PROGRAMMES

Considering the potential identified for bioenergy and the favourable context in Latin America – and the need to promote sustainable bioenergy as quickly as possible, compatible with the demands of human society – the investment required is significant. Some values are presented below.

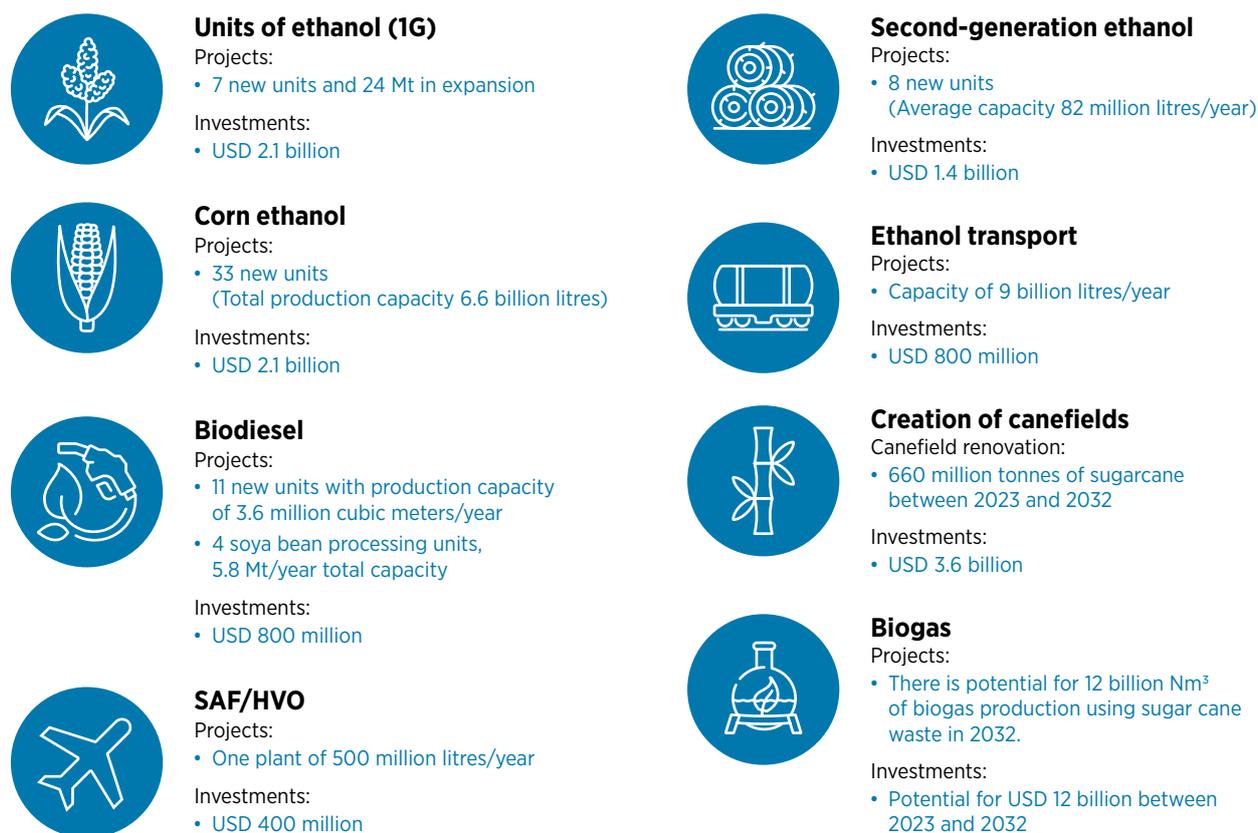
An estimate by the Inter-American Development Bank (IDB) took the pattern of development adopted in Brazil as a reference for projecting the expansion of energy systems in the Latin American region, envisaging GHG emissions neutrality by 2050, with bioenergy meeting 37.5% of the countries' energy consumption by 2050. This study points to significant expansion of biofuel production, increasing by 47% between 2020 and 2030 to 1.7 EJ of ethanol and biodiesel production. Diversification of the production profile is expected from 2030, with investment in advanced biofuels (such as HVO and SAF) achieving total production of 4.5 EJ in 2050, representing 375% growth compared with 2020. Implementing the full scenario (all of the sources) would require estimated annualised investment of USD 45.3 billion, generating 4.7-5.8 million jobs in the region.¹⁰

A more detailed study by the EPE¹¹ for Brazilian conditions estimates investment in biofuels of USD 24.4 billion to 2032, of which half relates to investment in anaerobic biodigesters. This is summarised in Figure 2.

¹⁰ "Scenarios for bioenergy in Latin America", presented by Carlos José Echevarría, IDB, at the workshop.

¹¹ "Situation and outlook for bioenergy in Brazil", presented by Solange O. da Costa, EPE, at the workshop.

Figure 2 Expected investment in biofuel production in Brazil to 2032



Source: "Situation and outlook for bioenergy in Brazil", presented by Solange O. da Costa, EPE, at the workshop.

Notes: Mt = million tonnes; Nm³ - A standard cubic meter, *i.e.* the amount of a gas contained in a volume of 1 m³ at 1.01325 bar and 0 °C.

CONCLUSIONS

The presentations and discussions at the workshop enabled a review of the current situation and outlook for bioenergy in Latin America. This highlighted significant points for fostering the effective implementation of sustainable bioenergy production and use systems in the region, considering its natural resources and socio-economic development needs.

1. AN ADEQUATE LEGAL AND REGULATORY FRAMEWORK IS ESSENTIAL

Natural and economic development conditions are already particularly attractive in the Latin American region. Bioenergy production activity should primarily be driven by private companies, while promoted and regulated at the government level. The existence of an adequate and stable legal and regulatory framework that defines and promotes the development of demand for biofuels and/or bioelectricity with sufficient certainty, thus enabling their marketing under sufficiently remunerative conditions, is considered essential. While significant investment opportunities in biofuels have been identified in the region, financial risk imposes high costs and

thus sufficient investment is unlikely without the necessary legal certainty. Bioelectricity continues to advance in Latin America, especially in regions with appropriate regulatory conditions for electricity markets, taking advantage of the potential of co-generation systems based on industrial co-products, such as sugar cane bagasse and cellulosic leachate.

2. FINANCIAL VALUATION OF GHG EMISSIONS REDUCTIONS FROM BIOFUELS HAS PROVEN TO BE A SUCCESSFUL APPROACH

The significant and motivating results achieved by the RenovaBio programme in Brazil over recent years clearly demonstrate the importance of accounting and financial valuation for GHG emissions reduction. The transparent and consistent methodology and modelling adopted in RenovaBio can be implemented relatively quickly, achieving significant economic and environmental results and enabling national decarbonisation targets for the transport sector.

3. CO-OPERATION AMONG COUNTRIES IS IMPORTANT

Almost paradoxically, two very different contexts co-exist in the Latin American region despite having similar natural and historical conditions. Some countries possess significant bioenergy systems in their economies and a clear range of advantages. Some countries are still struggling to promote bioenergy, hindered by prejudices that harm both their people and their environment, persisting in patterns of energy use that countries with more challenging conditions have overcome. The presence of a favourable legal framework, resulting from political convergence, is the most salient distinction between the two groups of countries. Dialogue between government bodies can improve the knowledge base and provide references for countries interested in promoting bioenergy.

Dialogue between public sector energy leaders and executives in the region is promoted by OLADE and by multilateral institutions, such as IRENA, the Food and Agriculture Organization of the United Nations/Global Bioenergy Partnership and the IDB, which have sought to foster such exchanges. This should be enhanced. The workshop showed that there is already good dialogue with effective exchanges of experiences between entrepreneurs and stakeholders in the biofuels sector in the region.

On a broader scale, the Biofuture Platform is also aggregating and fostering dialogue among countries with similar interests, sharing experiences and learning on bioenergy in real conditions. This is a government-led initiative launched in 2016 that currently involves 22 countries. Its objectives are:¹² a) promoting technology co-operation; b) forging consensus on sustainability, availability and governance of biomass; c) developing financing mechanisms; and d) fostering policy guidance and convergence.

¹² "Biofuture Platform", presented by Lais de Souza Garcia, Foreign Affairs Ministry, at the workshop.

NEXT STEPS

Considering these conclusions and the main barriers, the following actions are suggested for the implementation of sustainable national biofuels markets, especially where such markets do not exist. Some countries are already further ahead and naturally better placed to attract projects.

1. IMPLEMENTING AN ADEQUATE LEGAL AND REGULATORY FRAMEWORK

As a first step, an institutional basis should be established, considering the challenges and opportunities of the current energy transition and the implications of the global climate issue, within the framework of a sustainable bioenergy law. This institutional basis should have sufficient scope and autonomy to define and detail strategies and policies to promote bioenergy, being capable of guaranteeing its sustainability and overcoming the barriers to the investment needed. This must include a balanced tax framework, as set out below.

2. CONSOLIDATING THE BIOENERGY MARKET

An appropriate institutional structure must be developed within the framework of this sustainable bioenergy law. This must define the 'who' and 'how' of responsibility for implementing consistent goals and clear long-term strategies. It should include financial incentives, such as adequate subsidies and discount rates, and tax incentives, which must include a fair tax framework (considering the externalities of biofuels and their energy contents), mandates and obligations. Measures to support research and technological development, marketing and infrastructure, training and capacity building of human resources, and, last but not least, develop reliable services for information, improving public awareness and enhancing the governance of sustainability should also be considered, as discussed in Topic 4. But this can be initiated and pursued only within an adequate legal framework, as the discussions at this workshop confirmed.

3. PROGRESSIVE DEVELOPMENT AND DIVERSIFICATION OF PRODUCTS AND MARKETS

Given the wide range of bioenergy technologies and biofuels, it is important to consider gradual implementation of bioenergy production and use systems, e.g. starting in limited markets, with low levels of blending. Use of ethanol/petrol and biodiesel/diesel blends at up to 10% biofuel when properly specified (E10 and B10) is quite safe and well proven in fuel logistics systems (terminals and service stations) and millions of vehicles in many countries. This can be adopted quickly. However, higher blending levels require prior assessments of markets, and the use of pure biofuels could require changes to engines. The biofuels market is expanding and consolidating, with countries that are not yet using biofuels gaining confidence based on the many successful examples.

Sustainable biofuels are advancing in other fields and modes of transport, such as biomethane from biogas of various origins, which is being used in heavy-goods vehicles, SAF and production of cellulosic ethanol (or second-generation ethanol – 2G ethanol), using low-cost raw materials. Adoption of these biofuels requires more detailed planning due to their more complex production and use chains. The application of support mechanisms and support for demand formation can be considered minimum requirements for promoting the development of these new biofuels.

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APPENDIX I: WORKSHOP PROGRAMME

SUSTAINABLE BIOENERGY PATHWAYS IN LATIN AMERICA

Promoting bioenergy investment and sustainability São Paulo - Brazil

🕒	17 MARCH 2023
<p>9:00-9:30</p> <p>OPENING</p> <p>(ON-SITE AND VIRTUAL SESSION BEGINS)</p>	<p>1. Opening and welcoming remarks</p> <p>Opening:</p> <p>Ricardo Gorini – Head of REmap, International Renewable Energy Agency (IRENA)</p> <p>Welcome:</p> <p>Angela Oliveira da Costa – Empresa de Pesquisa Energética (EPE), Government of Brazil</p> <p>Representative of bioenergy producers – Evandro Gussi, Brazilian Sugar Cane Industry Association (UNICA)</p> <p>Representative of the R&D community – Prof. Jose R. Cardoso, São Paulo University</p> <p>Presentation of the agenda and objectives – Prof. Luiz Horta Nogueira</p>
<p>9:30-11:00</p> <p>ENCOURAGING INVESTMENT AND THE SUSTAINABILITY OF BIOENERGY PRODUCTION FROM LATIN AMERICAN GOVERNMENTS</p>	<p>2. Government perspectives on the importance of bioenergy investment in Latin America: Prospects, priorities, lessons learned and future outlook</p> <p>Argentina (5-10 minutes), Juan Ignacio Paracca, Bioenergy Specialist from the government of Argentina</p> <p>Colombia (5-10 minutes), Juan Camilo Acevedo Páez, adviser to the Minister's Office</p> <p>Brazil (15-20 minutes), Marcelo B. Morandi, Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA); Angela Oliveira da Costa, EPE, Ministry of Energy and Mining</p> <p>Panel discussion (45 minutes), representatives of governments, OLADE, Medardo Cadena</p>
<p>11:00-12:30</p> <p>INVESTING IN THE BIOENERGY SECTOR: PRIVATE SECTOR PERSPECTIVES ON BIOFUELS AND BIOELECTRICITY</p>	<p>3. Private sector perspectives on the importance of bioenergy investment in Latin America: Outlook, priorities, lessons learned and prospects</p> <p>Representatives of the Colombian industry (15 minutes), Johan Martinez of ASOCANA and Dr. Carlos Mateus, Legal Director and Secretary General of Fedebiocombustibles</p> <p>Representatives of the Argentinian industry (15 minutes), Jorge Feijóo, President of the Argentinian Sugar Centre, and Patrick Adams, President of the Argentinian Corn Bioethanol Chamber</p> <p>Representatives of the Brazilian industry (15 minutes), Evandro Gussi from UNICA and Andre Nassar from ABIOVE</p> <p>Panel discussion (45 minutes), industry representatives (Brazil, Colombia and Argentina), Jose Echeverria Barbero from the Inter-American Development Bank (IDB) (virtual) and Artur Milanez (Brazilian Development Bank [BNDES]), Aida Lorenzo from ACR Guatemala (virtual)</p>

12:30-12:45 THE ROLE OF BIOENERGY IN LATIN AMERICA	Biofuture Platform/Ethanol Initiative - Lais de Souza Garcia , Foreign Affairs Ministry of Brazil International Energy Agency perspective, IEA, Ana Alcalde (virtual)
12:45	(End of morning on-site and virtual session)
ON SITE SESSION	
12:45-14:00	Lunch
	Start of the working session with delegates attending in person
14:00-14:30	Working session – introduction of the methodology, objectives and milestones for a roadmap for bioenergy investment in Latin America (20 min). Questions and answers from the audience – technical co-ordination: Prof. Luiz Horta Nogueira and Walter J. Sanchez
	Session 1: Bioenergy resources and technology pathways
14:30-15:30	First approach: From the availability and scope of resources to the identification of the sustainable potential of bioenergy resources (30 min) Second approach: From the exploitation of sustainable bioenergy resources to the scope for implementation of appropriate technologies (30 min)
15:30-15:45	Refreshments
	Session 2: Public policies, regulatory frameworks and financial mechanisms
15:45-16:45	Third approach: From exploitation and sustainable use of bioenergy resources to public policies and regulatory frameworks to encourage investment (30 min) Fourth approach: From sustainable exploitation and use of bioenergy resources to increased investment and development of financial mechanisms (30 min)
16:45-17:00	Final points, conclusions and next steps - Prof. Luiz Horta (15 min)
17:00-17:15	Closing remarks – Brazilian government and Ricardo Gorini
19:00	Dinner

APPENDIX II: LIST OF PARTICIPANTS

NAME	ORGANISATION	COUNTRY
Marcelo Ruiz	Obispo Colombres experimental station	Argentina
Carlos Jose Echeverria	IDB/Brazil	Brazil
Lais Garcia	Biofuture Platform/Itamaraty	Brazil
Christian Matamala	EcoVirtual Centre	Brazil
José Henrique Penido	Comlurb	Brazil
Andrea	USP/IEE	Brazil
Margareth de C Oliveira Pavan	USP	Brazil
Ubiratan Francisco Castellano	Joule Energy Ltd	Brazil
Rachel Henriques	EPE	Brazil
Edmilson Moutinho dos Santos	USP	Brazil
Anna Leticia M. Turtelli Pighinelli	Embrapa Meio Ambiente	Brazil
Rafael Araujo	EPE	Brazil
Glaucia Souza	FAPESP BIOEN & USP	Brazil
Rafael Capaz	UNIFEI	Brazil
Paulo Jardim	Consultant	Brazil
Camila Vásquez	Ministry of Energy	Chile
Jairo Alberto Valencia Ilanos	Ipse	Colombia
Yineth Piñeros Castro	Jorge Tadeo Lozano University	Colombia
Omar Arango	Consultant	Colombia
Lina Mariana Rodríguez Jiménez	Universidad del Valle	Colombia
Mónica Aragón	Veolia	Colombia
MonicaS	Redomass	Colombia
Pedro Guevara	Tecsol Ltda	Colombia
Carmen S Duarte Gonzalez	Gaia Ingeniería LTDA	Colombia
Iván Barragán	Biotermica Innovacion S.A.S.	Colombia
Tatiana Rodriguez	universidad militar	Colombia
Diana Jiménez	GGGI	Colombia
Eduardo Moretti	Embassy of Brazil in Bogota	Colombia
Oscar Iván Galvis Mora	ECDBCAR	Colombia
María Lourdes Hernández Rojas	RIJE SAS Imports	Colombia
María Lourdes Mateus	N/A	Colombia
Laura Vanegas	Umng	Colombia
Juan Diego Rojas Vargas	Costa Rican Electricity Institute	Costa Rica
Ana Maria Majano	LEDS LAC Regional Platform	Costa Rica
Carolina Hernandez	Ice	Costa Rica
Gabriela Jarrin	OLADE	Ecuador
Ana Alcalde	IEA	France
Anabely Escobar	Ministry of Environment and Natural Resources	Guatemala
Aida Lorenzo	Renewable Fuels Association	Guatemala
Victoria Cortés	Zamorano	Honduras
Cristian Irias	Energy Secretariat	Honduras
Diana Solis	Consultant	Honduras
José Manuel Medina	ICF	Honduras
Walter Angel	Ministry of Energy	Mexico
Gabriel Acosta	Agrosilvicultores de Hidalgo Soc. Cooperative	Mexico
Gabriel Acosta	Agrosilvicultores de Hidalgo Soc. Cooperative	Mexico
Harold Madriz	Ministry of Energy and Mines	Nicaragua
Rosa Martinez	Ministry of Energy and Mines	Nicaragua
Felipe Mitjans	Vice-Ministry of Mines and Energy	Paraguay
Silvia Barrenechea	ITP CITES network	Peru
Antonio Bernal	Sustainable Future	Peru
Julio Reyes	Technological Institute of Production	Peru
Maite Rubira	Ministry of Industry, Energy and Mining	Uruguay
Ignacio Figoli	Government	Uruguay
Nikolai Guchin	ANCAP	Uruguay
Luis Borges	Faculty of Engineering - Universidad de la República	Uruguay
Gabriela Malvasio	OLADE	Uruguay
Verónica Perna	MIEM DNE	Uruguay



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