Green Dealings

A just and sustainable lithium battery value chain

Delphi Survey – Executive Report

Martín Obaya
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Buenos Aires, June 2023

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The project has been funded by the Swiss Network for International Studies, under the agreement Nº C21055.

About Green Dealings

The Green Dealings research project aims to examine the rules and dynamics being negotiated and established between Europe and South America concerning the lithium-ion battery value chain. Its primary objective is to facilitate the transition towards a more sustainable and just value chain, particularly from the perspective of lithium-rich countries in South America. The project has received funding from the Swiss Network for International Studies (SNIS) under project code C21055.

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Institutional partners

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A just and sustainable lithium battery value chain

Delphi Survey - Executive report

Foreword

As demand for lithium increases, fueled by the expansion of electromobility, new economic opportunities open up for producing countries. However, this growth also carries risks of negative impacts on the environment and the communities residing in lithium extraction areas. In addition, there is the possibility of wasting opportunities for developing productive, and technological capacities.

Better understanding these dynamics and establishing appropriate governance schemes in the lithium-ion battery value chain are key objectives of the Green Dealings research project, entitled "Green Deals: negotiations around lithium-ion batteries between North America and South and Europe for a just energy transition". To achieve these objectives, it is essential to understand the perspectives of the various actors involved to move towards a more sustainable and equitable value chain, especially from the perspective of countries rich in lithium in brine.

It is with great satisfaction that we present the Delphi study, carried out under the responsibility of Martin Obaya, a researcher at the Universidad San Martín in Argentina. This study benefited from the participation of experts from various fields, who have contributed their knowledge and experience to explore and analyze the multifaceted challenges and opportunities around lithium mining and its impact on environmental, social, and economic sustainability.

The results obtained in this study provide a broad and agreed view on the need to address the sustainability challenges associated with the extraction of lithium in brines, even if it implies the slowdown or suspension of mining activity. We hope that the findings will contribute significantly to the debate and decision-making in the field of policies and strategies related to lithium-ion batteries in search of a just and sustainable energy transition.

With this study, we aspire to lay the foundations for a more responsible and equitable approach in the lithium value chain, which guarantees the well-being of communities, environmental protection, and sustainable development in producing regions.

Marc Hufty

Green Dealings Coordinator,
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Introduction

Climate change is one of the most significant challenges of our time. There is a broad consensus regarding the significance of the energy transition in mitigating greenhouse gas emissions. Lithium-ion batteries are pivotal in driving progress along this trajectory, primarily due to their widespread adoption in electric vehicles. Transportation accounts for about a quarter of global carbon dioxide emissions. The rapid expansion of electromobility in recent years has become a significant source of demand for some minerals. According to estimations from the International Energy Agency, lithium is forecast to witness the steepest growth in demand over the next few decades, even surpassing graphite and cobalt.

Argentina, Bolivia, and Chile form the so-called "lithium triangle." This region concentrates 53% of the world's lithium resources and around 80% of those in salt flat brines[1]. The growing demand for lithium fueled by the expansion of electromobility, creates new economic opportunities for these countries. However, it also entails risks. The extraction of lithium has both environmental impacts and affects the populations residing where lithium mining occurs. Lithium-rich countries also risk missing a valuable opportunity to develop domestic productive and technical capabilities linked to mining activities.

The governments of resource-rich countries are responsible for regulating and monitoring the impacts of mining activities. Together with the operating companies, they must guarantee that sustainability conditions are met. They are also tasked with designing policies and strategies that utilize lithium as a catalyst for socioeconomic, scientific, technological, and economic development at the national and regional levels.

The governance of lithium has gained importance in public opinion debates and captured the attention of various groups, including companies linked to the industry, communities living in proximity to the salt flats, non-governmental organizations, and academic researchers. Over the years, these groups have identified actual or potential imbalances resulting from lithium mining and advanced proposals to address them. More recently, the European Union has also decided to advance in this field. This region, which a few years ago embarked on developing a lithium-ion battery industry, aims to guarantee a steady and stable supply of lithium compounds produced under sustainable conditions.

Within this framework, the Green Dealings network is developing its research project "Green Dealings: negotiating lithium between South America and Europe for batteries that fuel a just energy transition". Commencing in 2022, the project aims to examine the governance schemes currently under negotiation and formation between Europe and South America concerning the value chains of lithium-ion batteries. We seek to understand different actors' perspectives on moving towards a more sustainable and just value chain for countries engaged in brine-based lithium mining. The project is funded by the Swiss Network for International Studies. It will end in October 2023, with a closing conference in Geneva.

1 Source: USGS (2023). Mineral commodity summaries 2023, U.S. Geological Survey. https://doi.org/10.3133/mcs2023

Summary of findings

The survey findings demonstrate a widespread consensus on the substantial sustainability challenges associated with lithium mining in salt flats: 77% of participants agreed that addressing this issue should be a top priority, even if it requires temporarily slowing down or suspending mining activities.

The report addresses different dimensions of sustainability. Table 1 summarizes the main findings. According to the panel, environmental challenges are the priority. The issues demanding utmost attention revolve around the impact of mining on the water balance of the basin (where salt flats are located) and on the biodiversity of the area where the activity is carried out. In the second place, social challenges are among the most significant concerns. In this case, the need to improve conditions for the coexistence of mining activity with regional economic activities is highlighted and the need to respect the social and cultural practices of the communities in proximity to or linked with the salt flats. In the third place, regarding the economic sustainability challenges, participants underlined the need for lithium-rich countries to improve their ability to capture the value generated by mining activities. To address this challenge, two channels were prioritized. Firstly, ensuring greater participation of local communities in the benefits derived from mining activities. Secondly, establishing closer connections between mining operations and actors within the national production and innovation system.

The survey inquired about the public initiatives or policies that could effectively address the sustainability challenges. Specific proposals are available in Table 1. It illustrates that initiatives focused on establishing participatory and multi-stakeholder consultation mechanisms involving the relevant groups in problem-solving and planning are prominently highlighted. The importance of increasing state investment in capacity building in national and sub-national governments in monitoring, oversight, information production, and transparency was also stressed. The selected proposals align with the challenges identified by the panel concerning the governance of lithium mining. Specifically, the need to enhance the capacities of state control institutions and foster increased transparency and accessibility to information was emphasized in this domain.

Regarding which actors should lead the process of designing and implementing the prioritized policies, the results exhibited similarities across all sustainability dimensions. Firstly, the pivotal role of governments at both the national and sub-national levels was underscored. Secondly, the significance of civil society actors, particularly local communities and the national science and technological system, was emphasized. Thirdly, mining companies' involvement operating in the respective territories was acknowledged.

Summary of findings

Sustainability of lithium mining in salt flats. Summary of the challenges, instruments, and actors prioritized by the panel.

Dimensions	Priority challenges	Prioritized public policy instruments
Environmental sustainability	1° Impacts on the water balance of the basin where the salt flats are located. 2° Impact on the biodiversity of the ecosystems where the lithium mining activity is carried out.	1° Increase state investment to create public environmental information and improve its transparency. 2° Promote multi-stakeholder cooperation to address environmental challenges. 3° Increase state investment to strengthen government monitoring capacity.
Economic sustainability	1° Improve the participation of local communities in the economic benefits of lithium mining. 2° Linkage with the national economy and the scientific-technological system.	1° Promote the development of production and technological capabilities en mining countries. 2° Participatory and multi-stakeholder consultation processes to agree on how to improve the participation of local communities in the economic benefits of lithium mining.
Social sustainability	1° Coexistence of lithium mining with other regional economic activities. 2° Mitigate impacts on local communities´ social and cultural practices. 3° Good practices of engagement between the civil society and mining companies.	1° Conduct strategic and land-use planning that favors the coexistence of lithium mining with other regional economic activities. 2° Develop consultation mechanisms that incorporate the perspectives of different stakeholders and are sensitive to cultural diversity. 3° Changes in legislation to ensure that companies incorporate the demands of civil society in the process of defining the terms under which lithium mining is carried out.

Table 1

Source: based on Delphi survey results (Round 2).

Finally, the survey inquired about the issue of justice. The panel was asked about the conditions that should be promoted to guarantee that the lithium battery value chain is just for countries developing lithium mining in salt flats. Findings reveal that for the panel, justice is especially linked to economic sustainability above environmental and social sustainability. According to the panel, prioritizing economic benefits for local communities from lithium mining was considered the primary option. Additionally, they stressed that lithium-demanding countries should promote adherence to social and environmental standards while facilitating the transfer of skills to lithium-producing countries.

Delphi survey: "A just and sustainable lithium battery value chain"

When asked about the primary obstacles to achieving a just battery value chain for countries where lithium mining is carried out, findings align with those reported in in the sustainability section. According to experts, the main obstacle is the institutional weaknesses and limited state capacities

Summary of findings

within lithium-producing countries. Secondly, the panel emphasized the resource asymmetry between countries that demand lithium and those that produce it.

Delphi survey: "A just and sustainable lithium battery value chain"

During the second half of 2022, we conducted a virtual Delphi[2] survey entitled "A just and sustainable lithium battery value chain." The primary aim was to gather insights from experts in the global lithium battery supply chain regarding the key challenges confronting the sustainability of lithium mining in salt flats. In addition, the study inquired about the participants' opinions on initiatives and public policies to address the identified sustainability and justice concerns. In a highly dynamic regional context, where each lithium-rich country has approached sustainability challenges from distinct perspectives and with diverse tools, the survey results offer valuable insights into the priorities identified by the experts and the potential avenues to address them.

The survey consisted of two rounds implemented between August and December 2022. Over 600 experts from across the globe were invited to participate, with anonymity being a critical condition for their involvement. The survey was conducted on a personal capacity basis, meaning that the institutional positions of member organizations were not considered. In the first round, 141 experts participated, while in the second round, there were 83 participants. Across both rounds, the panel predominantly consisted of experts from Argentina, Bolivia, and Chile. Most panel members were academics, followed by participants from the industry, government, international organizations, and non-governmental organizations (see details in Section Panel composition). Due to the virtual nature of the survey, it was not possible to count on the participation of members of indigenous communities. The difficulties of access to digital connectivity of these communities represented an obstacle, given the virtual and anonymous nature of the survey. Undoubtedly, this represents a limitation for the interpretation of the results since these communities are directly affected by the sustainability problems of lithium mining.

In the first round of the survey, a questionnaire was sent out with 16 questions (8 open and 8 closed). Including open-ended questions was intended to ensure comprehensive coverage of all topics. In contrast the closed-ended multiple-choice questions were designed to prioritize challenges and initiatives for addressing them. In Round 2, the results of Round 1 were included in the questionnaire and 13 closed-ended questions were asked. In addition, the survey included 6 statements, and participants were asked to indicate their level of agreement with each statement. In this manner, the objective was to assess whether significant changes occurred in the panel's responses, thereby reaffirming consensus, identifying areas of disagreement, and determining priorities.

This executive report presents a summary of the aggregated results of Round 2. We made this selection to simplify the interpretation of the results. However, it is worth noting that there were no substantial changes in the panel's composition or the priorities chosen by the respondents between the rounds. In October 2023, the full report will be published, presenting the results of both rounds and the disaggregated results (by membership group and by position in the value chain).

Panel composition

2 The Delphi method is an information gathering technique used to obtain the opinion of experts or people with extensive experience in a subject on which the available information is scarce. The survey is anonymous and has an iterative dynamic, developing in rounds, in which the results of the previous round are circulated among the participants. The objective is to identify dissent and achieve some consensus on key issues. For a more detailed explanation about the study, see the Methodological Annex.

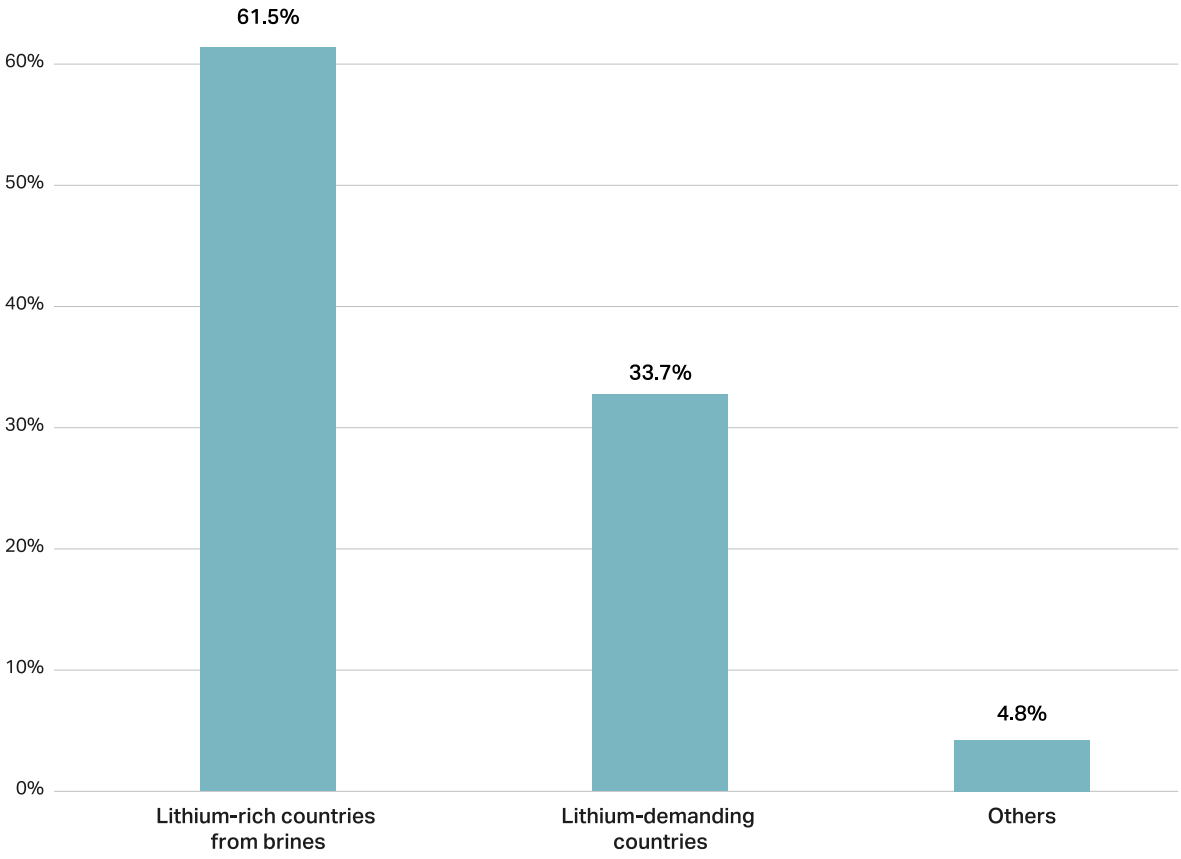
Panel composition

In the first round of the survey, 141 people participated, while in the second round, the number of participants was 83, indicating a retention rate of 58%. This executive report mainly focuses on the data from Round 2. However, we observe no significant variations between both rounds.

The panel mostly comprised participants from countries rich in lithium in brines (61.5%), especially Argentina (37.3%). Bolivia accounted for 14.4%, and Chile for 9.6%. 33.7% of the panel came from lithium-demanding countries, mainly from Europe and North America[3]. The Other category (4.8%) corresponds to participants from Latin American countries that do not have lithium resources in salt flats and Australia[4].

Panelists' position in the value chain (Round 2)

Figure 1



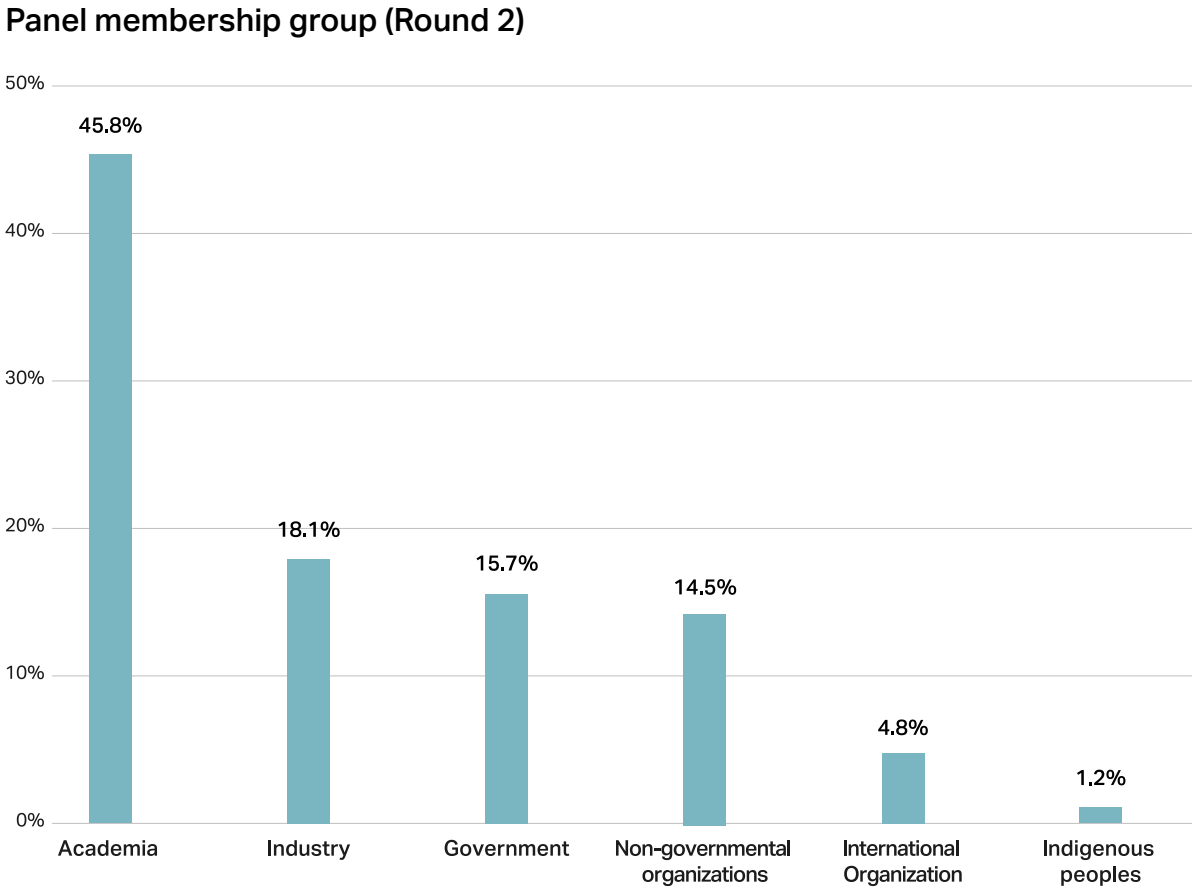
Regarding the sector of activity, the panel primarily comprises researchers from the scientific and university system, accounting for nearly 46% of the total. They are followed by representatives from government and international organizations at 20.4%, industry at 18.1%, and non-governmental organizations (NGOs) at 14.5%.

3 The category of "lithium demanding" countries indicates the dominant position that these countries (or the region to which they belong) currently hold in the battery value chain. 27.7% of the survey participants came from Europe, with 4.8% from Switzerland, 3.6% each from Germany, Belgium, Portugal and the UK, 2.4% from Spain, and 1.2% each from Austria, France, Norway, the Netherlands and San Marino. Six percent of the participants came from North America, with 3.6% from Canada and 2.4% from the United States.

4 Mexico accounted for 2.4% and Peru and Australia 1.2% each.

Panel composition

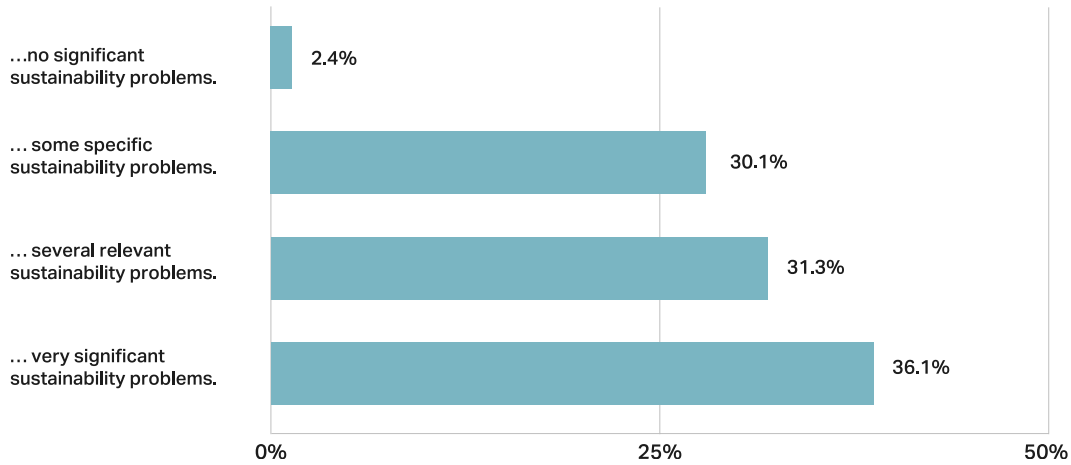
Figure 2



Sustainability of lithium mining in salt flats

The first section of the survey asks general questions regarding the sustainability of lithium mining in salt flats and its governance. The survey results deliver two clear messages. Firstly, most of the panel acknowledges the significant sustainability issues associated with lithium mining in salt flats. 36.1% of respondents consider these problems very significant, while 31.3% perceive them as relevant (Figure 3). Secondly, 77% of the panel advocates for measures to tackle this problem, even if it involves slowing down the pace of expansion (56.6%) or completely suspending the activity (20.5%) (Figure 4).

Figure 3



Sustainability of lithium mining in salt flats

What do you think is the most appropriate course of action from the point of view of sustainability of lithium mining in salt flats?

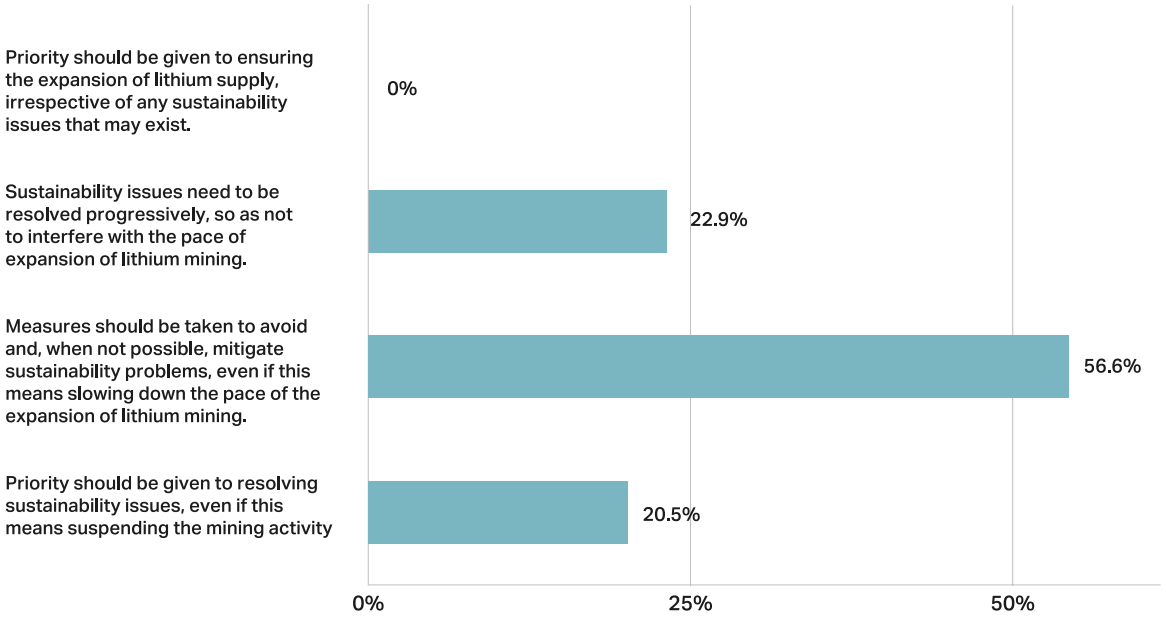


Figure 4

In Round 1, participants were asked the following open-ended question: "Which are the main sustainability challenges of lithium mining in salt flats? The answers to this question were coded, and the results are shown in Figure 5. According to the panel, the main challenges correspond to environmental sustainability issues, followed by those of social and economic nature and questions related to the sustainable governance of lithium mining.

Among the environmental challenges, the impact on the water balance and water availability in the basin (where salt flats are located) stands out according to 67.3% of the participants. Furthermore, 29.7% of the panel emphasized the loss of biodiversity and the impact on the ecosystems where the salt flats are situated.

Sustainability of lithium mining in salt flats

Main challenges for the sustainability of lithium mining in salt flats (Round 1)

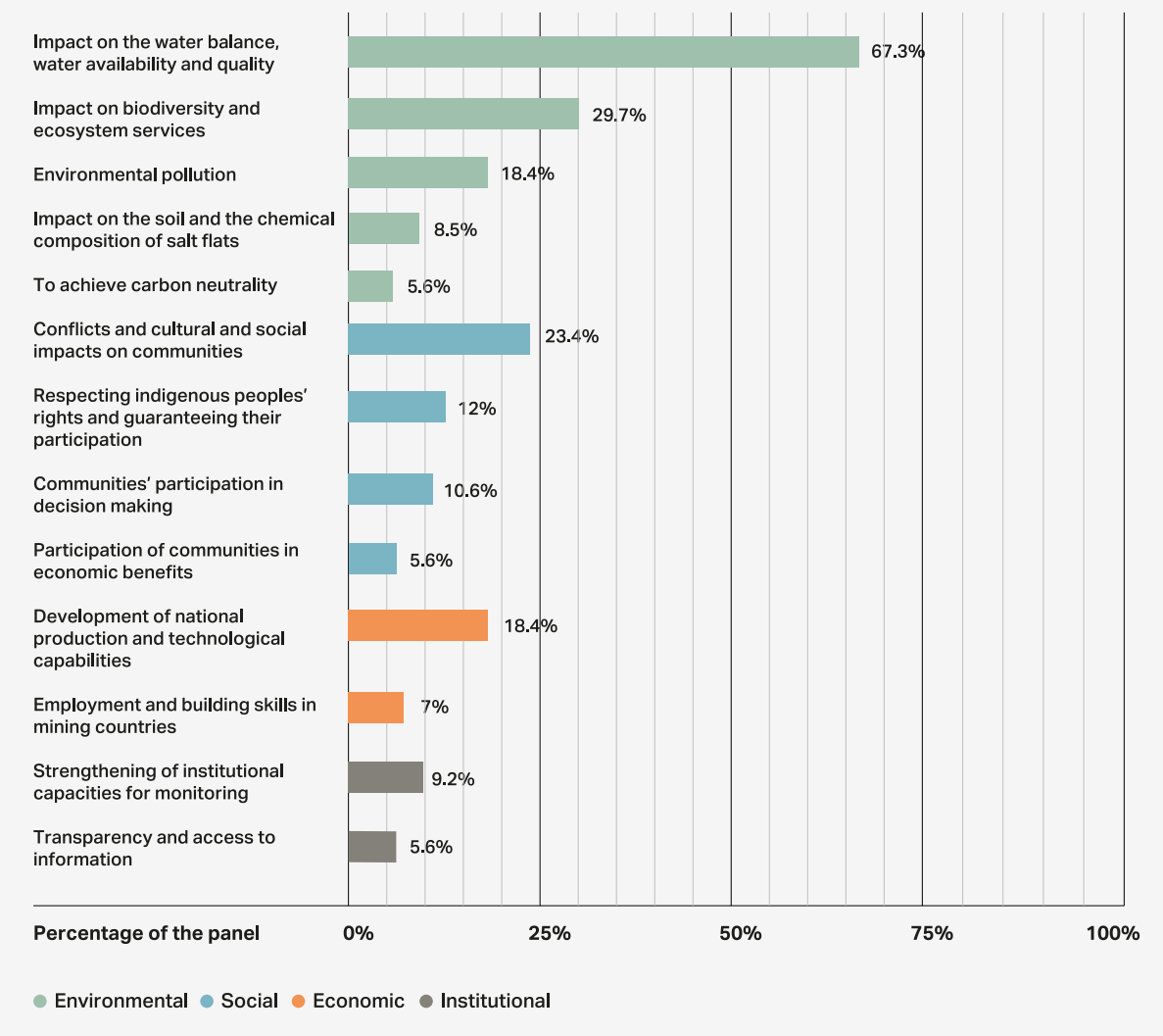


Figure 5

Methodological note: On the left side of the graph, you can observe the categories derived from the coding process. The numbers at the end of each bar represent the percentage of the panel that included the respective category in their responses. Environmental challenges are represented by the green bars, while social, economic, and institutional challenges are represented by the blue, orange, and gray bars. It is important to note that the total percentage for each category exceeds 100% because participants were allowed to provide multiple answers. Categories with a participation rate of less than 5% in the aggregate responses of the panel are not reported.

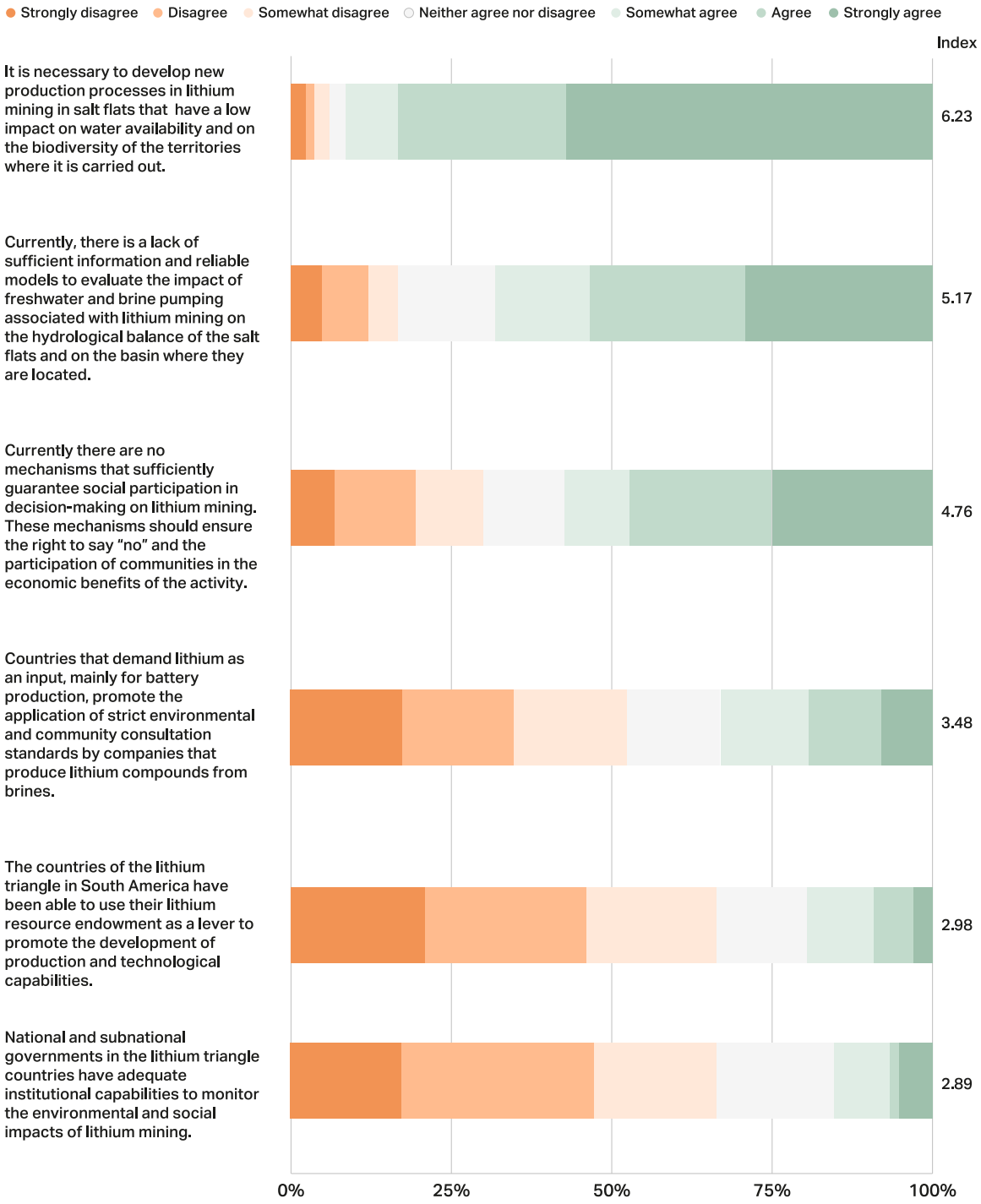
The priority given to environmental challenges was ratified in Round 2. The panel was presented with a series of statements based on responses to the open-ended question from Round 1.

Participants were requested to indicate their level of agreement with each statement. 91.5% of the panel agreed with the statement: "It is necessary to develop new production processes in lithium mining in salt flats that have a low impact on water availability and on the biodiversity of the territories where it is carried out," among which 61.4% expressed "strongly agree". Likewise, a significant majority of the panel, comprising 68%, expressed varying levels of agreement with the statement, "Currently, there is a lack of sufficient information and reliable models to evaluate the impact of freshwater and brine pumping associated with lithium mining on the hydrological balance of the salt flats and on the basin where they are located" (Figure 6). These findings demonstrate a notable consensus within the panel regarding the current deficient state of knowledge concerning the environmental impacts of lithium mining, particularly on water basins. Moreover, the results highlight the shared belief in the necessity of developing process innovations that minimize or mitigate these impacts to the greatest extent possible.

Sustainability of lithium mining in salt flats

Statements presented to the panel to express their agreement or disagreement (Round 1)(*)

Figure 6



(*) Methodological note: responses are expressed on a scale of 1 to 7, being 1 "strongly disagree" and 7 "strongly agree". The index corresponds to the simple average of the responses.

In the open consultation with the panel, environmental issues are followed in importance by challenges to social sustainability (Figure 5). According to the experts consulted, the most relevant of these are the impacts of lithium mining on the cultural and social practices of local communities (23.4%) and ensuring respect for their rights, including participation and free, prior, and informed consultation with indigenous peoples (12%) (Figure 5).

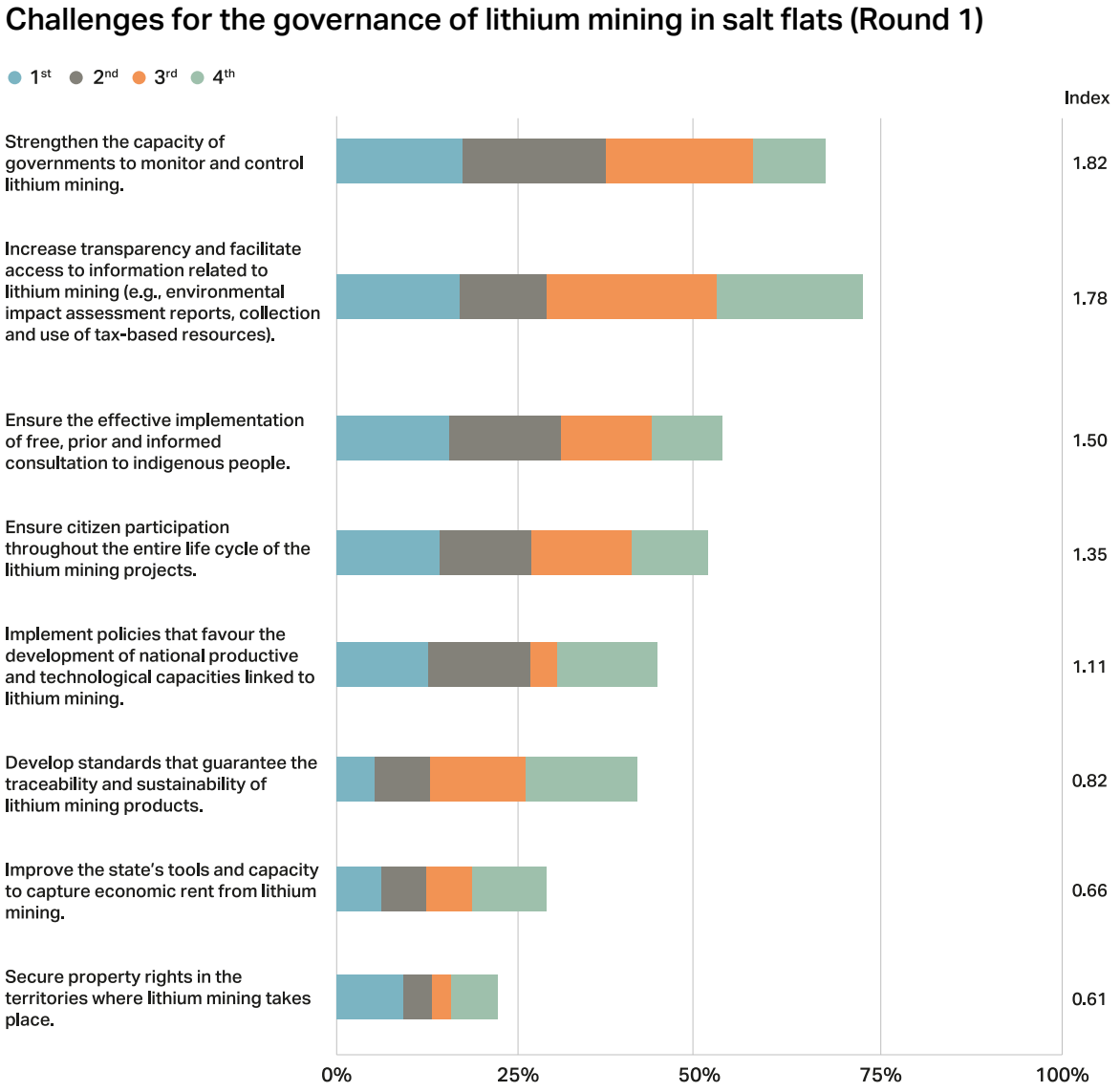
In the third order of importance were the challenges linked to economic sustainability. In particular, the objective of fostering the development of national productive and technological capabilities was emphasized (Figure 5). The perception of a deficit in this field was ratified in Round 2, as 67% of the panel disagreed, to varying degrees, with the statement that "The countries of the lithium triangle in South America have been able to use their lithium resource endowment as a lever to promote the development of production and technological capabilities" (Figure 6).

Finally, in the open question, the panel placed the challenges related to the governance of lithium mining at the fourth level of importance. The responses point to the need to strengthen government monitoring and control capabilities and increase transparency, and facilitate access to information (Figure 5). The importance of the first point was ratified by the panel in Round 2. A significant majority of the panel, comprising over two-thirds (68.6%), expressed varying degrees of disagreement with the following statement: "National and subnational governments in the lithium triangle countries have adequate institutional capabilities to monitor the environmental and social impacts of lithium mining."

These responses align with the findings from a closed question in Round 1 that inquired about the primary challenges concerning the governance of lithium mining (Figure 7). In addition to those already mentioned, two issues emerge as priorities that allude to the participation of civil society in defining the terms under which the activity is carried out: prior, free, and informed consultation with indigenous peoples and the implementation of mechanisms that encourage citizen participation throughout the life cycle of mining projects (Figure 7).

Sustainability of lithium mining in salt flats

Figure 7



(*) Methodological note: the spread of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc.). The reported index in the right column summarizes the information obtained and ranks the challenges: it was calculated by assigning to the answer a value of 4 when the option was chosen first, 3 if it was second-elected, 2 if third-elected, 1 if fourth-elected, and 0 if unelected. Then a simple average of these values was calculated.

Environmental Sustainability

To evaluate the dimensions of environmental, social, and economic sustainability, by means of closed-ended questions, the panel was requested to prioritize a set of challenges based on their level of significance. Regarding environmental sustainability, the panel assigned priority to the water issue, with a significant majority selecting the option of avoiding or mitigating the impact of mining on the water balance in the basin where the salt flats are situated. The second prioritized option was to avoid or mitigate the impact of mining on the biodiversity of the ecosystems where the activity occurs, which aligns with the previously reported results (Figure 8).

It is worth noting two results with relatively low percentages, despite their significant role in the strategy of countries with a high demand for lithium resources, particularly in Europe, where the approval of the European Battery Regulation is anticipated.

The first concerns the strategy of increasing battery recycling to promote the circular economy and, at the same time, reduce the dependence on external sources of raw material supply. The option to "Decrease the demand for lithium, for example, through initiatives that promote battery recycling" maintained its position as the fourth priority, with a relatively low score. The objective of "achieving carbon neutrality of lithium mining", another important chapter of the EU strategy, was relegated to the last position.

Main challenges for the environmental sustainability of lithium mining in salt flats(*)

Which of the following environmental sustainability challenges should be addressed as a priority?

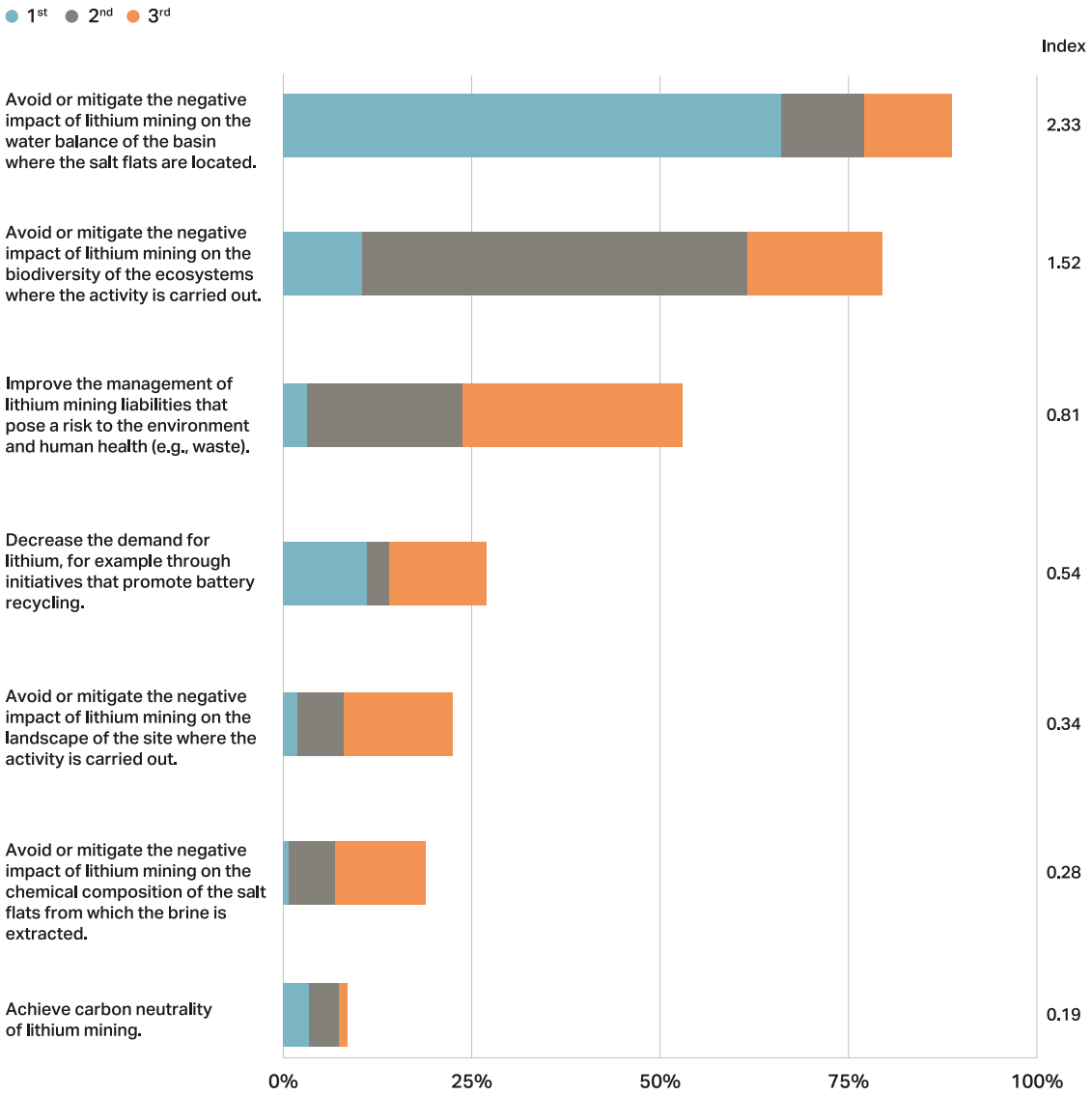


Figure 8

(*) Methodological note: The length of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc). The index reported in the right column summarizes the information obtained and ranks the challenges. It was calculated assigning each response a value of 3 when the option was chosen first, 2 if it was chosen second, 1 if it was chosen third, and 0 if it was not selected. A simple average of these values was then calculated.

Environmental Sustainability

Regarding the initiatives or policy instruments that should be implemented to tackle the priority challenges, the panel emphasized the need to increase state investment to generate environmental information and enhance oversight capacities in critical areas, particularly biodiversity and water balance. This option is congruent with the deficit identified in relation to the state's capacity to monitor and control mining activity. Furthermore, the experts emphasized the importance of promoting multi-stakeholder cooperation schemes as a valuable tool to address the identified challenges. It is worth noting that regulatory changes, both in mining countries and in countries that import lithium, appear last among the priorities to address environmental challenges (Figure 9).

When asked about the actors that should lead the selected initiatives, the panel prioritized the governments of lithium-producing countries (both national and sub-national levels). Following closely, civil society actors, including local communities and actors within the university and science and technology system, were identified. After those, lithium mining companies were acknowledged as having a relevant role in this regard (Figure 10).

Environmental Sustainability

Public policies or tools that should be implemented as a priority to address the environmental sustainability challenges(*)

Which of the following public policy initiatives or tools should be implemented as a priority to address these challenges to environmental sustainability?

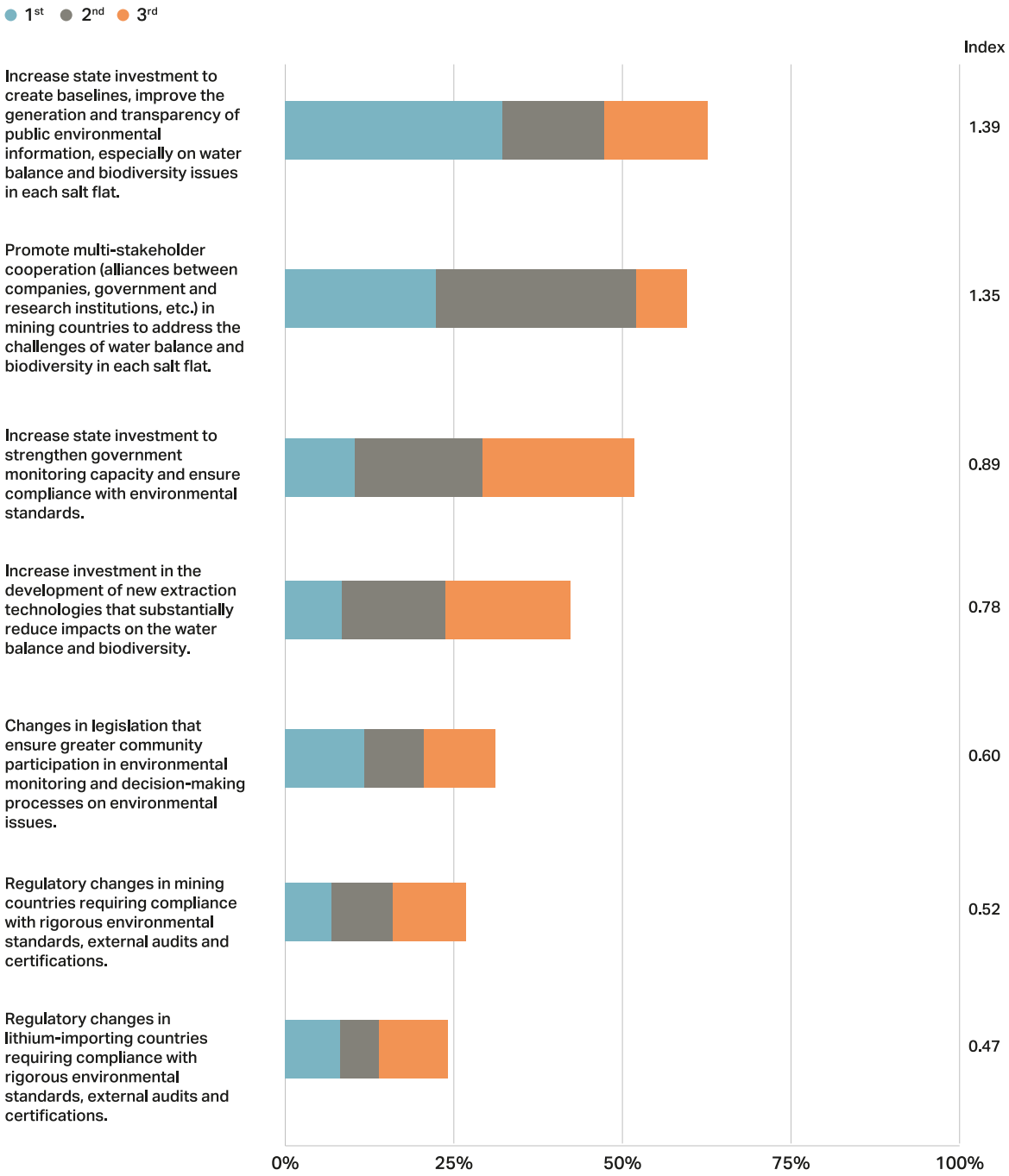


Figure 9

(*) Methodological note: The length of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc). The index reported in the right column summarizes the information obtained and ranks the challenges. It was calculated assigning each response a value of 3 when the option was chosen first, 2 if it was chosen second, 1 if it was chosen third, and 0 if it was not selected. A simple average of these values was then calculated.

Environmental Sustainability

Actors that should play a key role in promoting the prioritized initiatives(*)

Considering the initiative you selected as most important, select the three actors that should play a key role in promoting it.

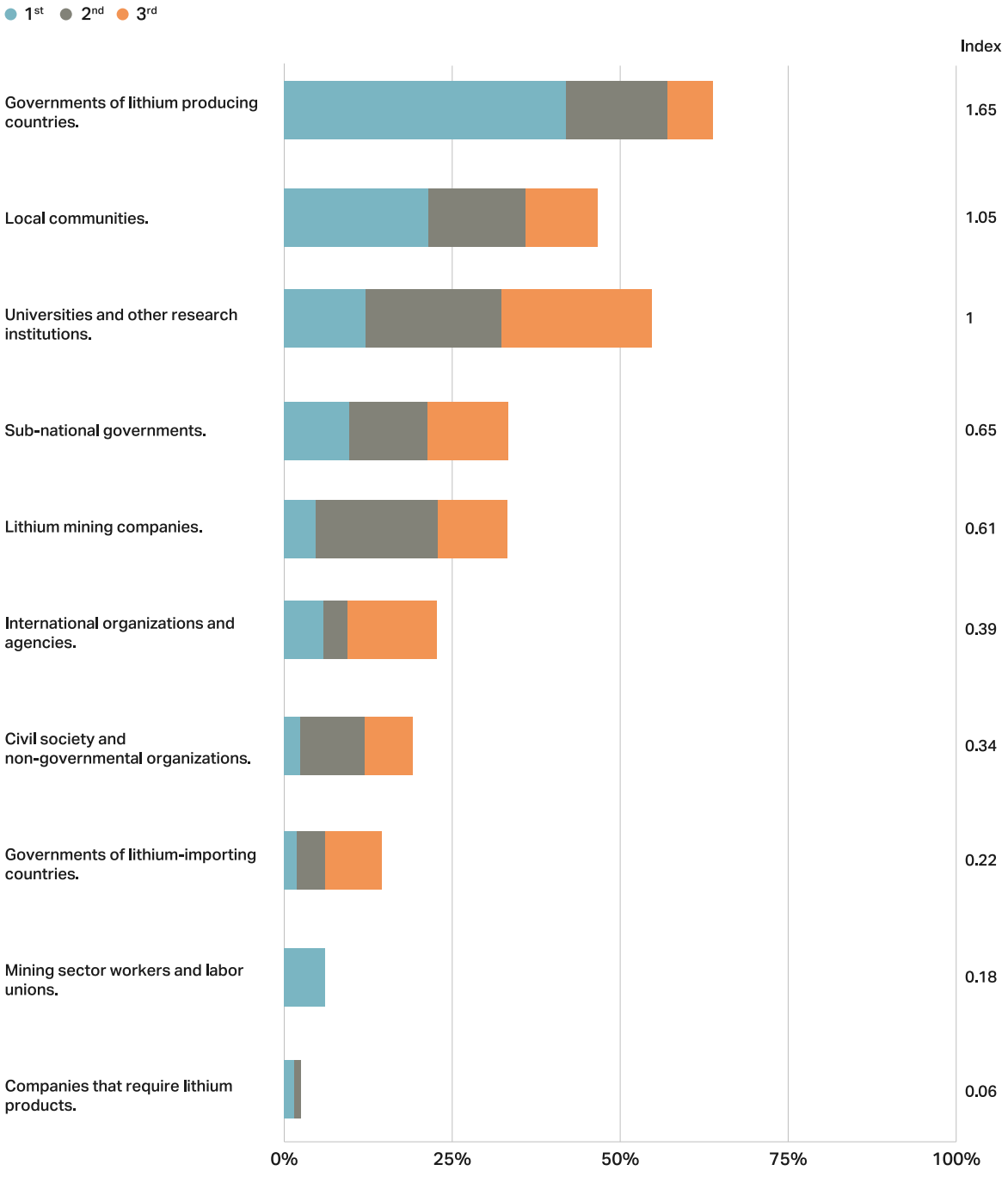


Figure 10

(*) Methodological note: The length of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc). The index reported in the right column summarizes the information obtained and ranks the challenges. It was calculated assigning each response a value of 3 when the option was chosen first, 2 if it was chosen second, 1 if it was chosen third, and 0 if it was not selected. A simple average of these values was then calculated.

Economic Sustainability

Economic Sustainability

In terms of economic sustainability, the panel identified two priority challenges. Firstly, enhancing the participation of local communities in the economic benefits derived from lithium mining. Secondly, strengthening the linkages between lithium mining and the productive apparatus as well as the scientific-technological system to foster the development of productive and technological capabilities.

Main challenges for the economic sustainability of lithium mining in salt flats(*)

Which of the following economic sustainability challenges should be addressed as a priority?

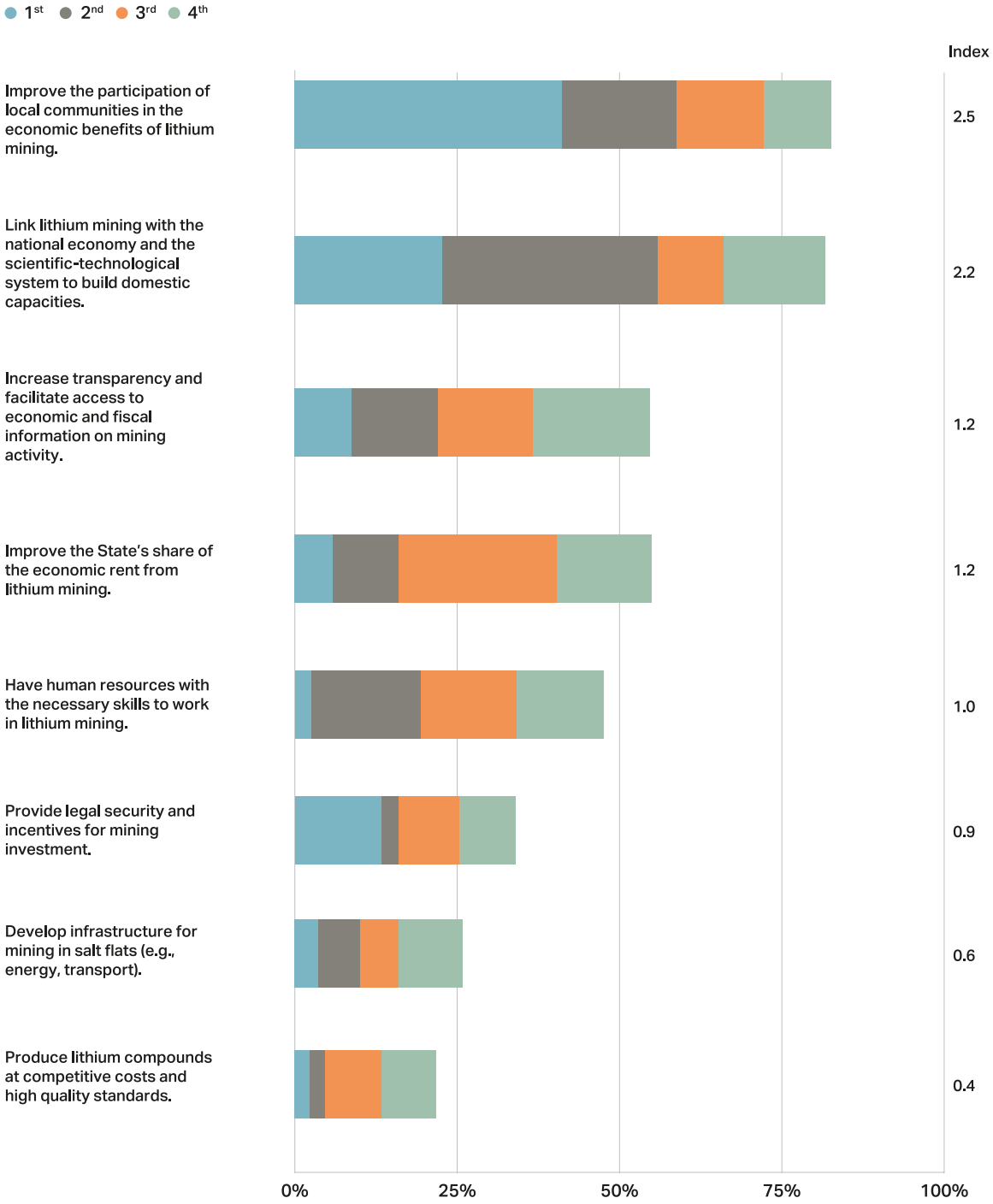


Figure 11

Economic Sustainability

(*) Methodological note: The length of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc). The index reported in the right column summarizes the information obtained and ranks the challenges. It was calculated assigning each response a value of 4 when the option was chosen first, 3 if it was chosen second, 2 if it was chosen third, 1 if it was chosen fourth, and 0 if it was not selected. A simple average of these values was then calculated.

In general, the policy initiatives prioritized by the panel align with the identified challenges. To address the first challenge, the options most voted as priority actions were the implementation of participatory processes and multi-stakeholder consultation (to agree on how to improve community participation in economic benefits) and the adoption of regulatory reforms ("Changes in the regulatory and institutional framework to ensure...") (Figure 12). Regarding the second challenge, the panel highlighted the need to implement public policies that promote the development of productive and technological capacities in mining countries, for example, agreements for technology transfer or ensuring access to raw materials. As a third priority, the panel identified the challenge of increasing transparency and facilitating access to economic and fiscal information on mining activities. According to the panel, increasing state technological and coordination capacities of public agencies would be a priority measure to address this problem (Figure 12).

Similar to the area of environmental sustainability, the panel emphasized the prominent role of the governments of lithium-producing countries and civil society actors, including local communities and academia (Figure 13), in addressing the economic sustainability challenges. Lithium-demanding companies, international organizations and agencies, and the governments of lithium-demanding countries were perceived as having a relatively minor role in this process, according to the panel's perspective. This last case is particularly noteworthy since these countries and agencies possess resources that could contribute to the development of capabilities in lithium producing countries. This collaboration could help overcome the resource asymmetry between lithium mining and demanding countries, which was identified as a significant obstacle in achieving a just value chain (Figure 18).

Economic Sustainability

Public policies or tools that should be implemented as a priority to address the economic sustainability challenges(*)

Which of the following public policy initiatives or tools should be implemented as a priority to address these economic sustainability challenges?

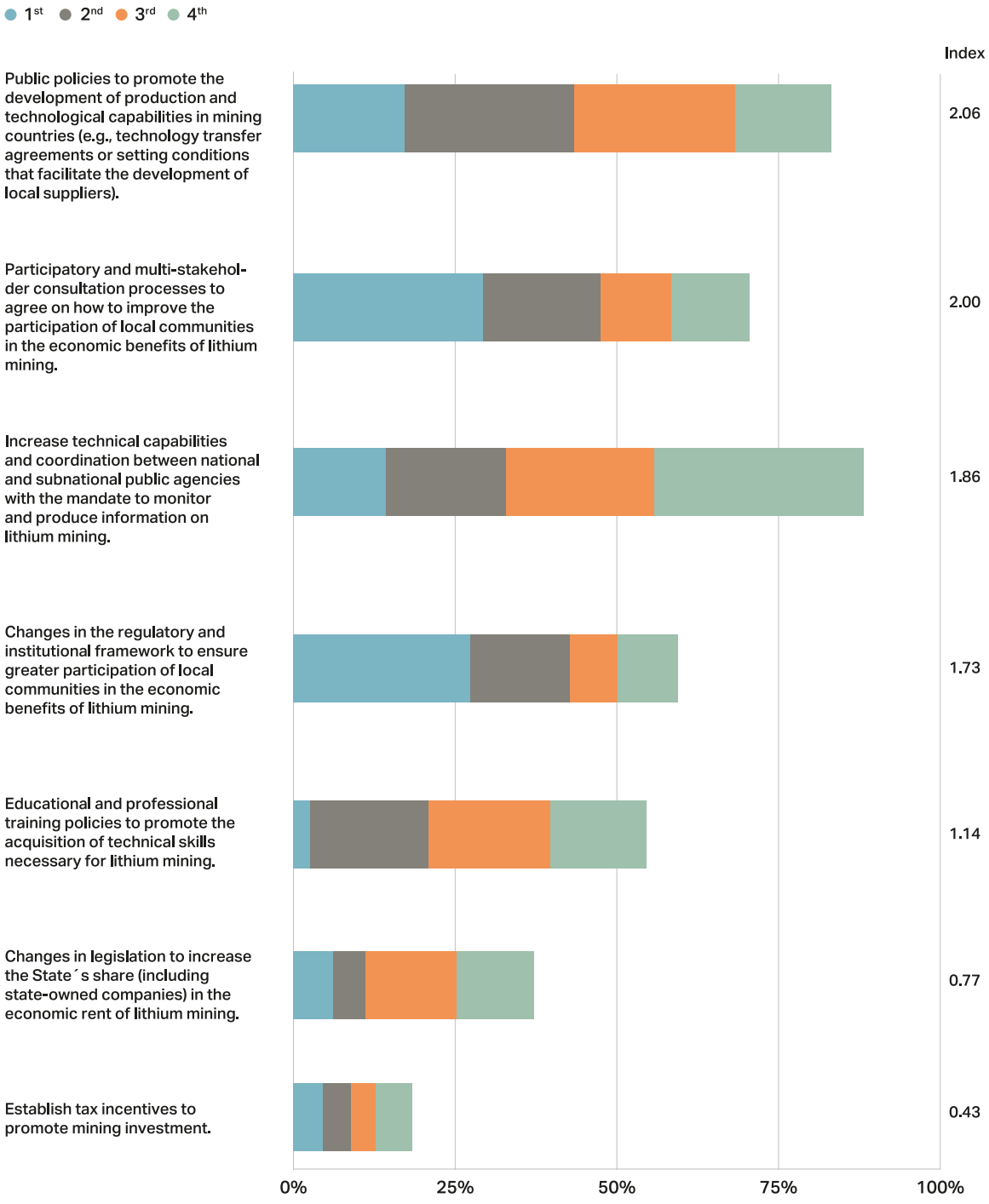


Figure 12

(*) Methodological note: The length of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc). The index reported in the right column summarizes the information obtained and ranks the challenges. It was calculated assigning each response a value of 4 when the option was chosen first, 3 if it was chosen second, 2 if it was chosen third, 1 if it was chosen fourth, and 0 if it was not selected. A simple average of these values was then calculated.

Economic Sustainability

Actors that should play a key role in promoting the prioritized initiatives(*)

Considering the initiative you selected as most important, select the three actors that should play a key role in promoting it.

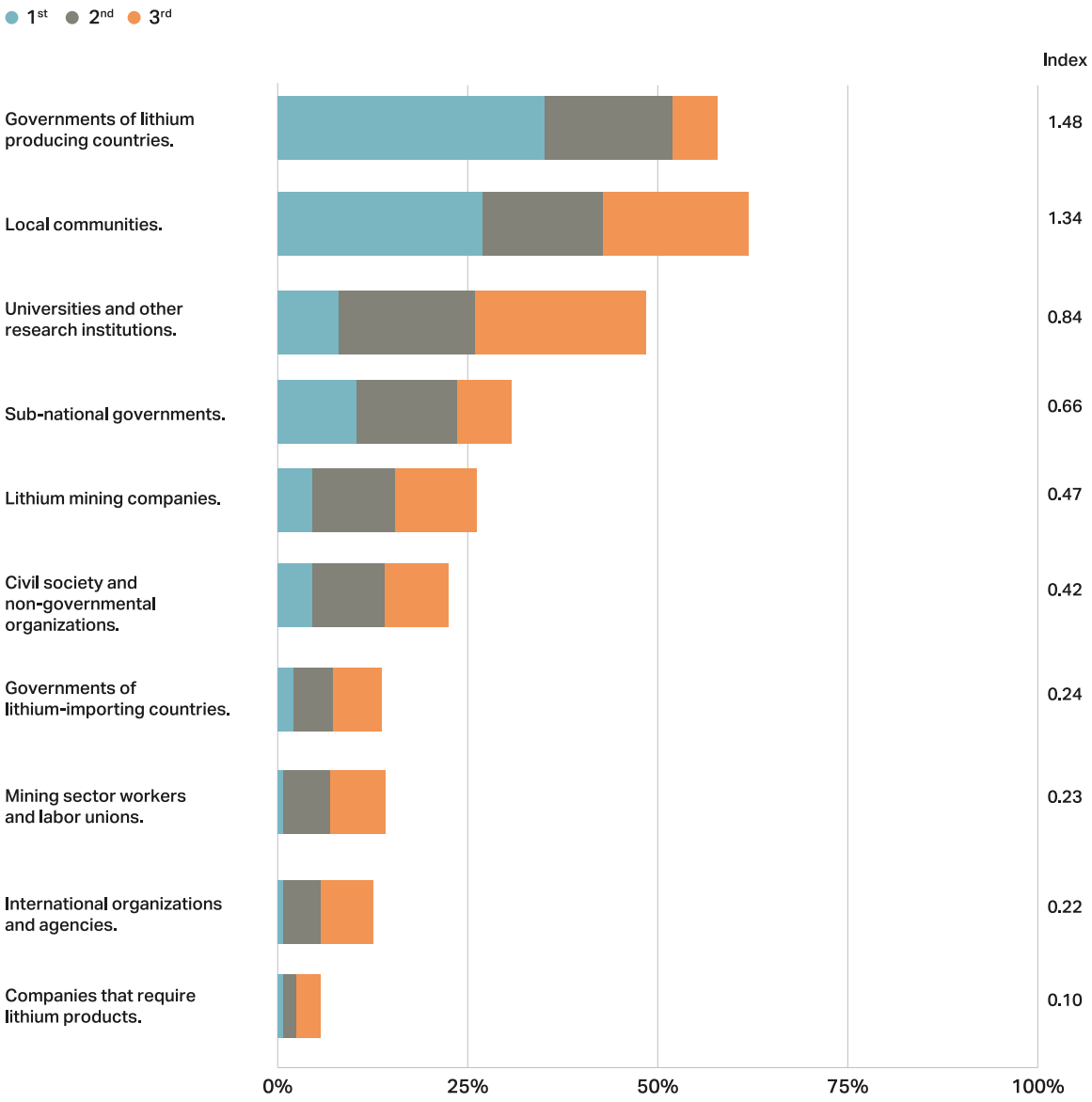


Figure 13

(*) Methodological note: The length of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc). The index reported in the right column summarizes the information obtained and ranks the challenges. It was calculated assigning each response a value of 3 when the option was chosen first, 2 if it was chosen second, 1 if it was chosen third, and 0 if it was not selected. A simple average of these values was then calculated.

Social Sustainability

In terms of social sustainability, the panel prioritized the need to develop a strategy that favors the coexistence of lithium mining with other regional economic activities such as tourism or agriculture. Then, the panel emphasized the importance of mitigating the adverse impacts of mining activity on the social and cultural practices of local communities. This entails respecting their rights and ensuring the effective implementation of free, prior and informed consultation. In third place, the respondents prioritized the challenge of implementing good practices of engagement and building shared views between civil society and lithium mining companies.

Main challenges for the social sustainability of lithium mining in salt flats(*)

Which of the following social sustainability challenges should be addressed as a priority?

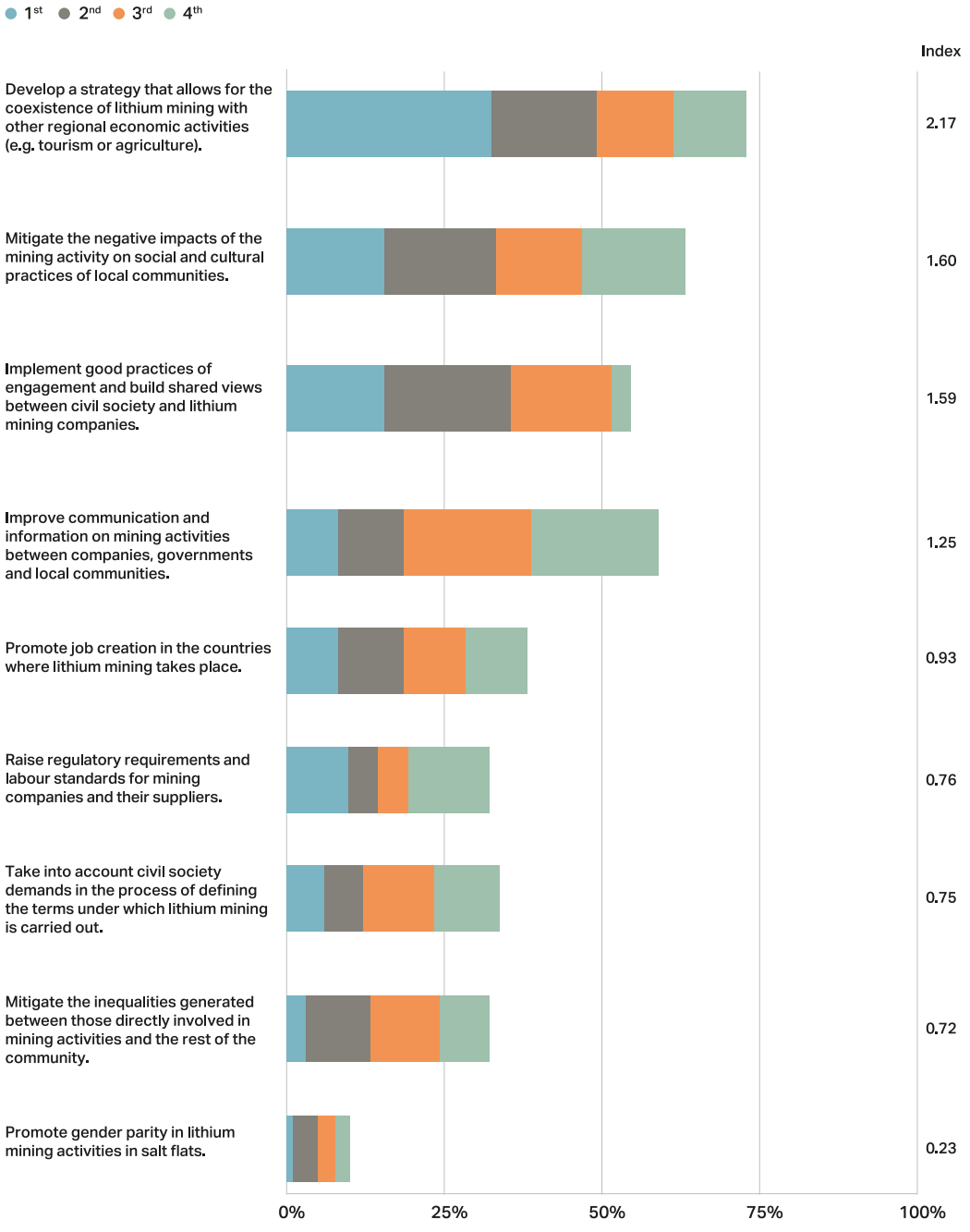


Figure 14

(*) Methodological note: The length of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc). The index reported in the right column summarizes the information obtained and ranks the challenges. It was calculated assigning each response a value of 4 when the option was chosen first, 3 if it was chosen second, 2 if it was chosen third, 1 if it was chosen fourth, and 0 if it was not selected. A simple average of these values was then calculated.

To address these challenges, the panel favored the implementation of variously compatible and interrelated participatory tools. These include developing a planning strategy to ensure the coexistence of lithium mining with other economic activities, implementing consultation mechanisms that incorporate the perspectives of different stakeholders, and conducting multi-stakeholder consultation processes to mitigate the negative impacts on the social and cultural practices of local communities (Figure 15). Likewise, part of the panel favored the legal route, highlighting the need to prioritize changes in legislation to ensure that companies incorporate the demands of civil society and to make sure they mitigate and compensate for the negative impacts on the social and cultural practices of local communities (Figure 15).

As with environmental and economic sustainability, the panel considered that the governments of lithium-producing countries and civil society actors (local communities and academia) should lead the implementation of these policies. In line with the other two dimensions of sustainability, according to the panel, companies, the governments of lithium-demanding countries and international organizations and agencies play a secondary role in this area (Figure 16).

Social Sustainability

Public policies or tools that should be implemented as a priority to address the social sustainability challenges

Which of the following public policy initiatives or tools should be implemented as a priority to address these social sustainability challenges?

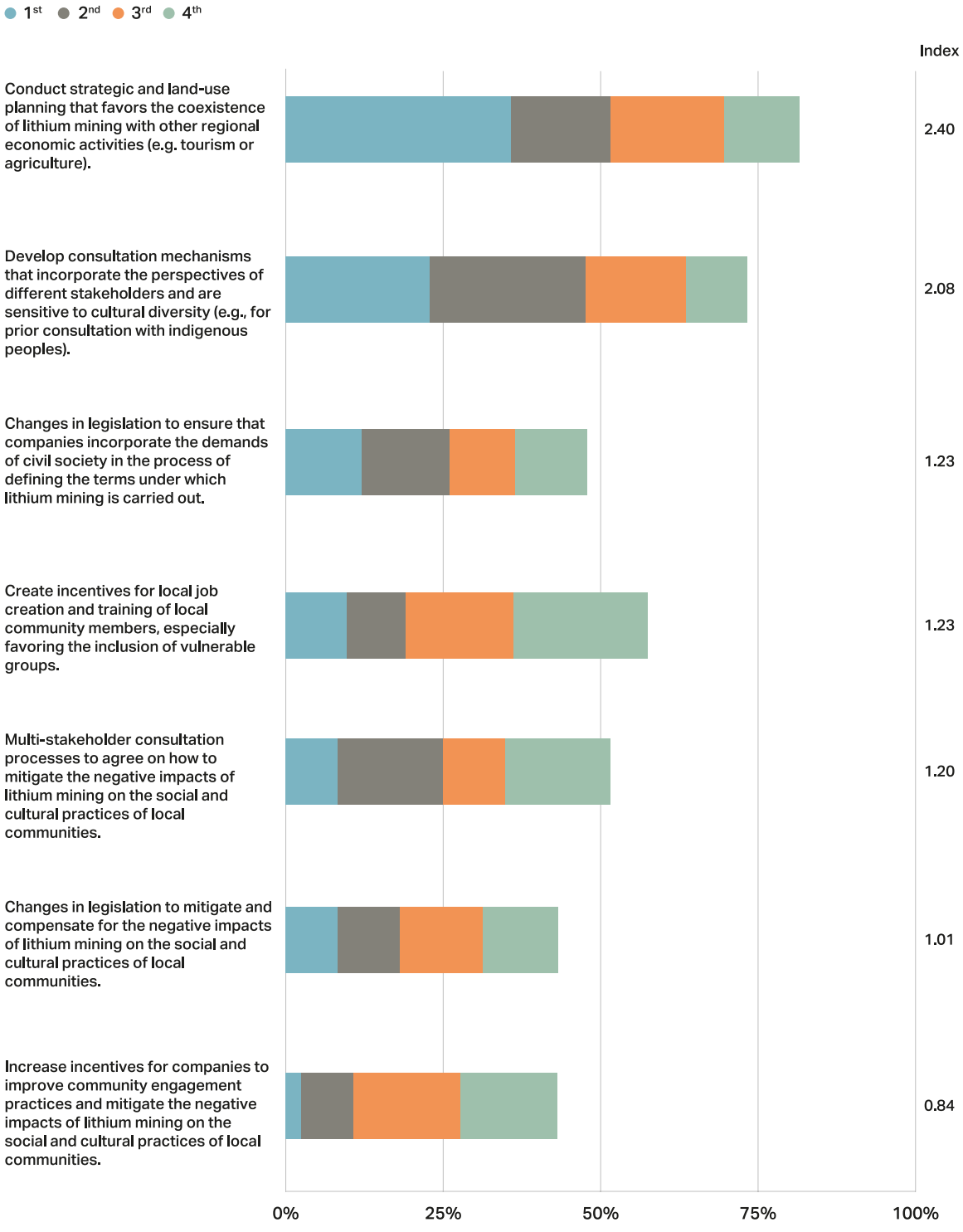


Figure 15

(*) Methodological note: The length of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc). The index reported in the right column summarizes the information obtained and ranks the challenges. It was calculated assigning each response a value of 4 when the option was chosen first, 3 if it was chosen second, 2 if it was chosen third, 1 if it was chosen fourth, and 0 if it was not selected. A simple average of these values was then calculated.

Actors that should play a key role in promoting the prioritized initiatives

Considering the initiative you selected as most important, select the three actors that should play a key role in promoting it.

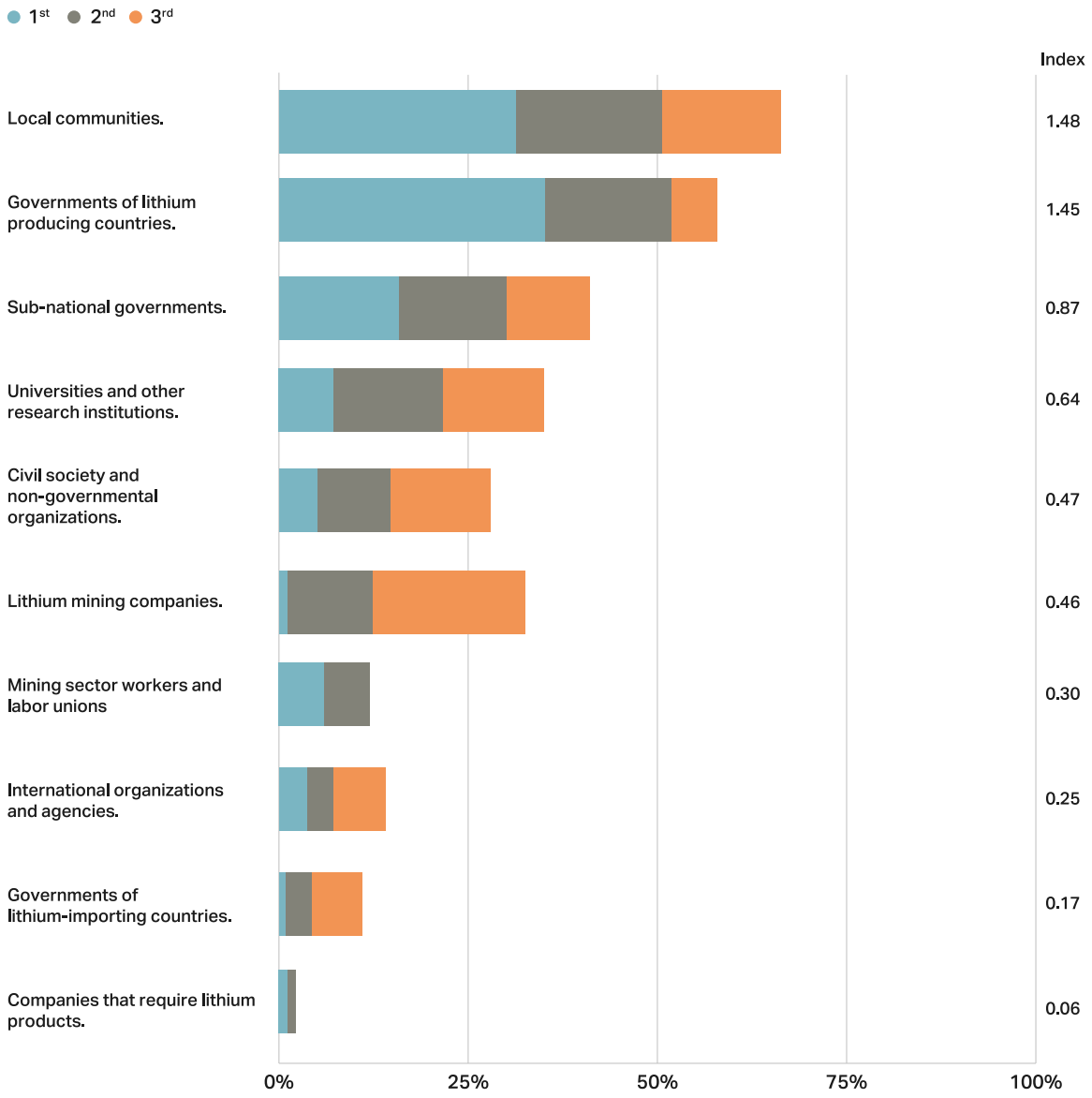


Figure 16

(*) Methodological note: The length of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc). The index reported in the right column summarizes the information obtained and ranks the challenges. It was calculated assigning each response a value of 3 when the option was chosen first, 2 if it was chosen second, 1 if it was chosen third, and 0 if it was not selected. A simple average of these values was then calculated.

A just value chain for brine-based lithium-rich countries

In Round 1, the panel was presented with an open-ended question (not included in this executive report) along with a set of predefined options. They were asked to rank the conditions that should be prioritized to ensure a just lithium battery value chain. The questionnaire explicitly emphasized that the question centered on ensuring a just value chain specifically within the countries engaged in lithium mining.

The top priority identified by the respondents was ensuring that local communities receive economic benefits from lithium mining (Figure 17). As mentioned earlier, the priority of ensuring economic benefits for local communities was also highly ranked in the context of economic sustainability. Additionally, the panel emphasized the importance of lithium-demanding countries promoting compliance with social and environmental standards and transferring capacities to lithium-producing countries. This finding suggests that the panel's understanding of justice is closely tied to economic sustainability, above the environmental and social sustainability dimensions.

A just value chain for brine-based lithium-rich countries

Conditions for a just lithium battery value chain (*)

What conditions should be promoted so that the lithium battery value chain becomes just?

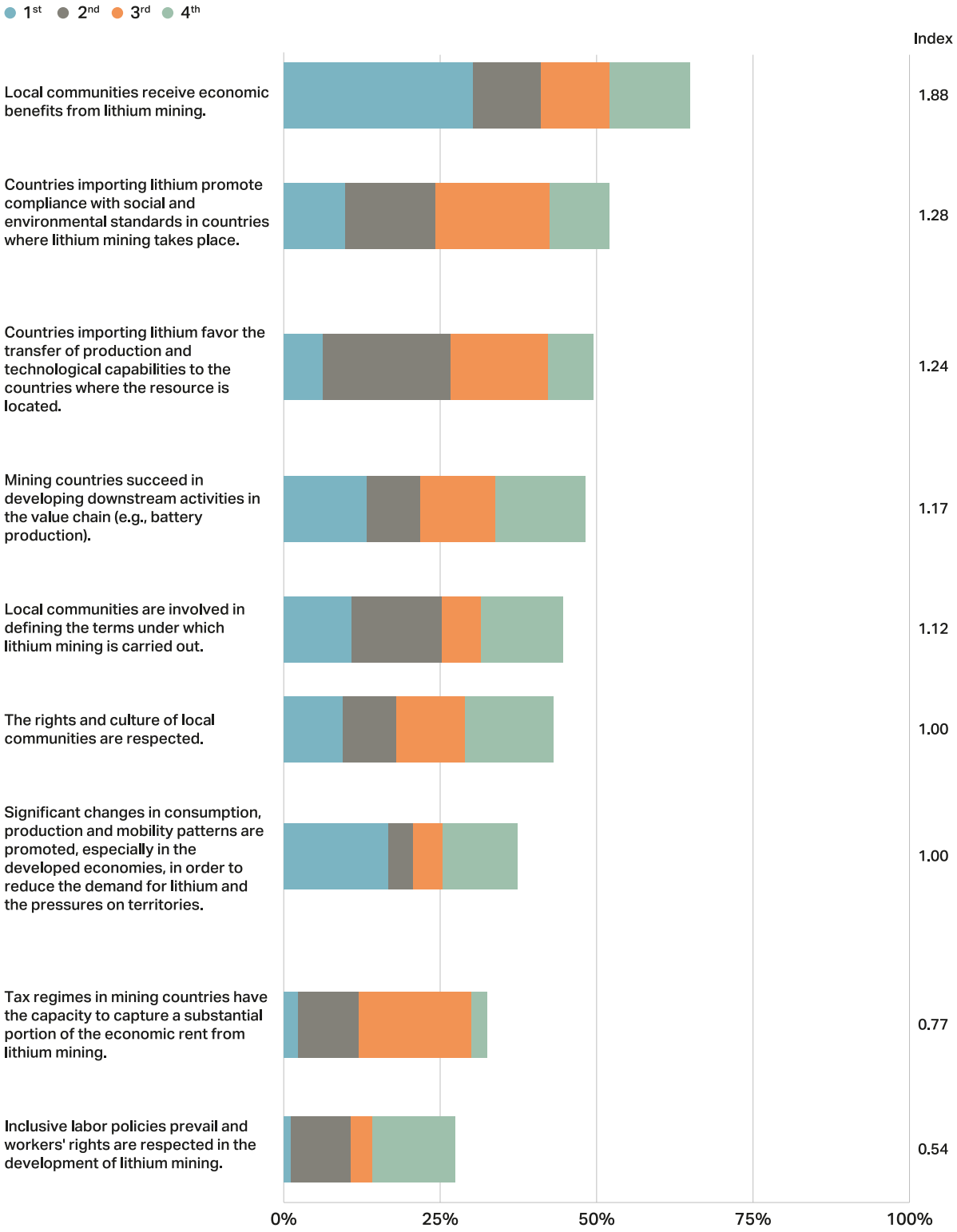


Figure 17

(*) Methodological note: The length of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc). The index reported in the right column summarizes the information obtained and ranks the challenges. It was calculated assigning each response a value of 4 when the option was chosen first, 3 if it was chosen second, 2 if it was chosen third, 1 if it was chosen fourth, and 0 if it was not selected. A simple average of these values was then calculated.

A just value chain for brine-based lithium-rich countries

When asked about the primary obstacles to achieving a just battery value chain for countries involved in lithium mining, the panel identified two key factors. Firstly, respondents emphasized the institutional weaknesses and limited state capacities in lithium-producing countries (Figure 18), which aligns with the sustainability challenges previously mentioned. Secondly, the panel highlighted the significant resource asymmetry between lithium-demanding and lithium-producing countries. They also highlighted that the high global demand for lithium creates disincentives for value addition in the mining countries themselves.

Obstacles hindering the development of a just lithium battery value chain(*)

Which of these obstacles do you think are the most relevant for the construction of a lithium battery value chain that is just for the countries where mining takes place?

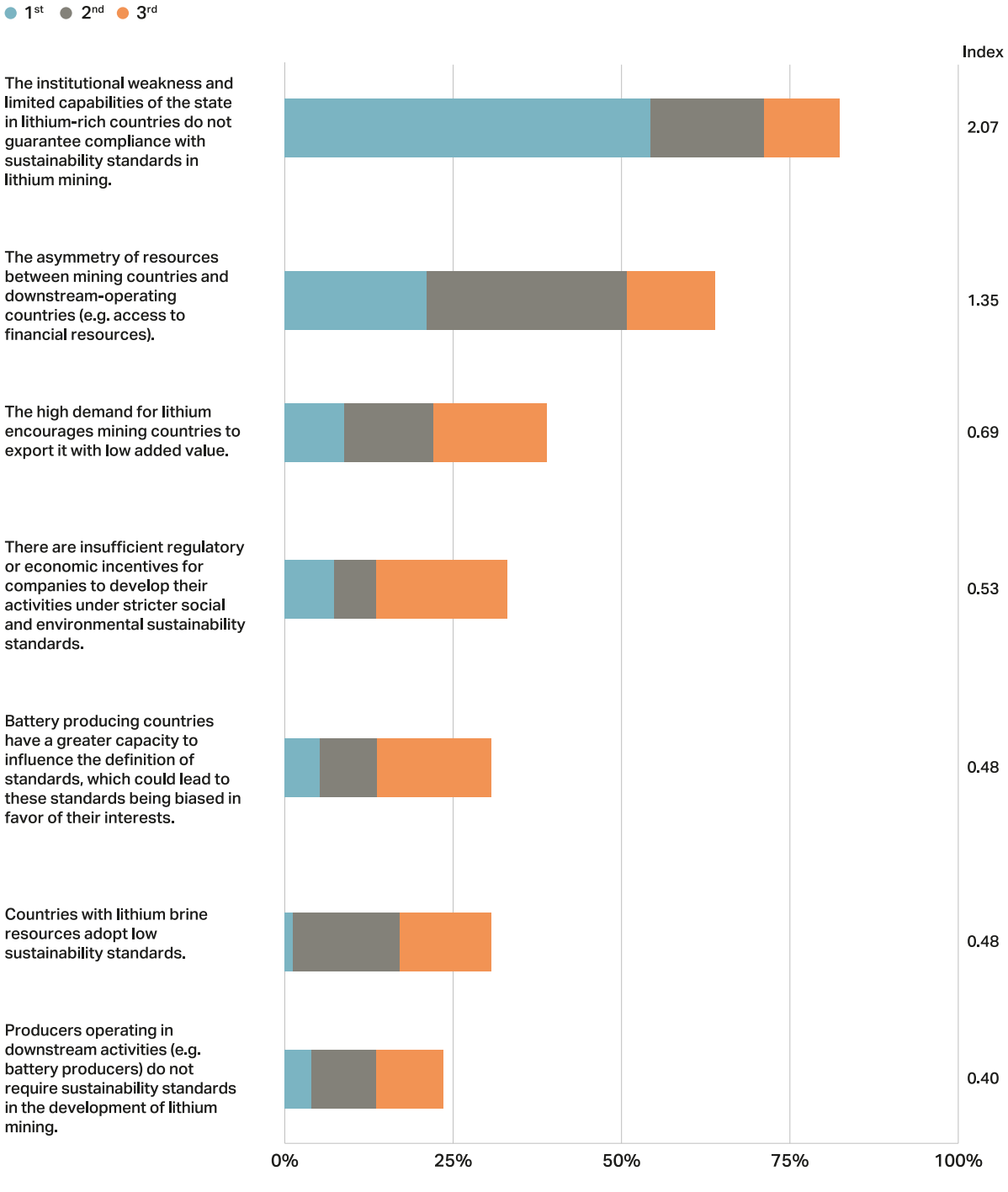


Figure 18

(*) Methodological note: The length of the bar indicates what percentage of the panel mentioned that challenge. The color code reports the order in which it was mentioned (first, second, etc). The index reported in the right column summarizes the information obtained and ranks the challenges. It was calculated assigning each response a value of 3 when the option was chosen first, 2 if it was chosen second, 1 if it was chosen third, and 0 if it was not selected. A simple average of these values was then calculated.

Methodological Notes

Objectives, methodology, and scope

The objective of our Delphi survey was to delve into the primary concerns of stakeholders within the lithium-ion battery value chain regarding sustainability and justice in lithium mining in salt flats. Additionally, it aimed to identify priority actions that should be undertaken to foster the development of a more just and sustainable value chain, as well as determine which actors should lead this process.

The survey follows the Delphi methodology. This type of survey is anonymous and has an iterative dynamic. The survey is developed in several rounds of consultation with a panel of experts on the topic addressed. From the second round onwards, the aggregated results of the previous round are presented, together with individual responses chosen to represent diverse perspectives on the matter. This process invites the panelists to reflect on their responses while enabling organizers to analyze the key challenges, areas of disagreement, and points of consensus surrounding the topic at hand. By incorporating the opinions of other experts, it is expected that a consensus will be reached within the panel, leading to a reduction in the overall uncertainty surrounding the results. While some degree of variance in responses is expected in practice, this variability can provide valuable information regarding areas of agreement or disagreement among the experts (Calatayud et al., 2020).

This type of survey is used to obtain the opinion of experts or people with extensive experience in complex and controversial issues when the information available is limited (Beiderbeck et al., 2021; Slocum, 2003). This approach is justified due to the inherent uncertainty and complexity involved in the diagnostic processes being pursued: "The technical knowledge of a group of experts intentionally selected for the purposes of the study allows more valid conclusions to be reached than those that could be reached from a random sample that would allow generalization to a broader population" (Calatayud et al., 2020:11, own translation).

The survey convened experts involved in the entire lithium battery value chain. However, it focuses on sustainability and just conditions in the segment corresponding to lithium mining in salt flats.

Implementation team

The survey design and implementation were under the responsibility of researchers from the Argentinean institutions CENIT-EEyN-UNSAM, IIEP-FCE-UBA, and Fundar. They were supported by the network of researchers of the Green Dealings project, with special incidence in identifying key issues, reviewing options in closed questions, and translating the questionnaires into English.

The CENIT-EEyN-UNSAM and IIEP-FCE-UBA teams were the main ones responsible for the conceptual design and formulation of the questionnaires and the recruitment of experts. They also participated in the analysis stage and led the writing process of the reports. The Fundar team participated in the conceptual discussion of the study and the questionnaire design process. It was also responsible for the implementation of the survey, including designing questionnaires in the digital platform, running preliminary tests, sending invitations and follow-ups to the panelists, among other activities. Fundar was also responsible for the data processing and the designing of this report. All the aforementioned institutions collaborated in the process of writing and reviewing the reports.

Recruitment and composition of the panel of experts (March to August 2022)

In line with the recommendations from existing literature, an effort was made to form an expert panel that covers different areas of practice and expertise. The primary objective was to gather diverse viewpoints regarding the outcome of interest (Okoli and Pawlowski, 2004). Including a larger number of panelists results in a broader range of perspectives being incorporated into the study. This facilitates enhanced feedback among panel members in subsequent rounds. Thus, a base of more than 600 experts from more than 20 countries was built, characterized according to their country of residence (and their position within the lithium battery value chain), their membership group, their specific involvement within the battery value chain, and the particular segment of the chain to which they were connected. In recruiting the panel of experts, the aim was to achieve diversity in the panel, considering the criteria listed below. Diversity in the profiles of potential respondents would minimize the biases associated with the prevalence of a particular type of profile in the panel (Calatayud A. et al., 2020).

1. Expertise: relevant knowledge and/or experience on the topics covered by this study.

2. Position in the value chain: residents in countries with different types of participation in the value chain (countries rich in lithium in salt flats and countries demanding lithium).

3. Membership group: government, academia, industry, non-governmental organizations, international organizations, and indigenous peoples.

4. Activity in the value chain: production, formulation of public policies and legislation, research, and development, representation of interests, and defense of rights.

5. Chain segment: exploration, extraction, and production of lithium compounds; production of lithium batteries and their components; production of goods that use lithium batteries; recycling of lithium batteries.

The construction of the database with potential survey participants was carried out through the network of contacts of the implementing team. To this initial set, we added contacts provided by experts and institutional partners of the Green Dealings project. Of the identified stakeholders, 622 were contacted to participate in the survey through a formal recruitment email, obtaining a response rate (for Round 1) of 22.7% (141 participants). The "Panel composition" section of this report describes the panel's composition by membership group and position in the value chain.

It should be clarified that, with one exception, it was not possible to count on the participation of members of indigenous communities. Difficulties of access to connectivity for these communities represented an obstacle, given the virtual and anonymous nature of the survey. Undoubtedly, this represents a limitation for the interpretation of the results since these communities are among the main ones affected by the sustainability problems of lithium mining.

Conceptual design of the survey and development of questionnaires (March to August 2022)

The survey was conducted in two rounds, encompassing both Spanish and English languages. This approach was adopted to ensure a comprehensive panel encompassing diverse geographic regions. For Round 1, a questionnaire comprising 22 questions was developed, incorporating a balanced

mix of open and closed-question formats. It included 8 open-ended questions, 8 closed multiple-choice questions, and 6 closed questions focused on participant identification data, such as gender, age, country of residence, group affiliation, and involvement in specific value chain segments and productive activities (Table 1).

The open-ended questions inquired about the key challenges, conditions, and obstacles related to sustainability, justice, and governance in the context of lithium mining. Additionally, sought to identify regarding relevant actors and public policy initiatives to address these challenges. The purpose of these open questions was to gather a comprehensive understanding of the panel's viewpoints, essentially creating an "inventory" of issue deemed relevant by participants. This approach was valuable in identifying response options that may not have been covered in the closed-ended questions of the same thematic axis. Consequently, it allowed for the inclusion of new options in the second round of the survey, ensuring a more comprehensive exploration of the subject matter.

Number of questions per survey section.

Table 1

Question type	Round 1 (n = 22)					Round 2 (n =14)	
	Sustainability	Justice	Governance	Initiatives, instruments, and actors	Id. data	Sustainability	Justice
Open-ended	1	2	1	4	0	0	0
Close-ended	5	2	1	0	6	11	2
Statement	0	0	0	0	0	1	0
Total	**6**	**4**	**2**	**4**	**6**	**12**	**2**

Source: questionnaires of Round 1 and 2.

After each open-ended question, a corresponding closed multiple-choice question was presented. The closed question provided a set of statements related to sustainability, and panelists were requested to rank their preferences among 3 or 4 options. The formulation of the multiple-choice questions is the result of an iterative process. The implementation team initiated the process by conducting a brainstorming session to identify the primary sustainability and justice challenges associated with lithium mining in salt flats and potential strategies or instruments to tackle these issues. Subsequently, an extensive review of academic and non-academic literature was undertaken to further refine the initial formulation. This encompassed analyzing company reports, international organizations' publications, and other relevant sources to gather valuable insights and ensure a comprehensive understanding of the subject matter. Then, at least six formulation sessions were held in which the implementation team synthesized the questions and statements. As a next step, the terminology used was revised, and the length of the statements was shortened.

Round 2 of the survey was structured into three sections. The first section focused on sustainability and consisted of 13 closed multiple-choice questions. Participants were provided with the Round 1 results and were asked three related questions: the first one reiterated the priority challenges, the second one sought information on initiatives or instruments to address those challenges, and the third one inquired about the key actors responsible for implementing such initiatives. In each case, the option "Other (specify)" was included among the response options, allowing participants to provide additional inputs.

The second section centered around the topic of justice. The Round 1 results were presented, and two closed multiple-choice questions were posed to gauge any changes in the panel's opinions regarding conditions and obstacles to achieving a more equitable approach to lithium mining in salt flats.

The third section featured a single question consisting of six statements. Participants were asked to express their level of agreement or disagreement with these statements using a 7-level Likert scale (Table 1). The statements were formulated based on the findings of Round 1. The purpose of employing a Likert scale was to assess the degree of consensus that could be reached among the entire panel in relation to these statements.

Survey implementation (August to December 2022)

The survey was conducted virtually, with participants providing their responses confidentiality conditions. It was emphasized that the survey was answered in a personal capacity, and the institutional positions of member organizations were not consulted or considered. This approach aimed to ensure unbiased and independent perspectives from participants. The Survey Monkey platform was used to make the survey available in virtual format. The decision was made after testing alternative platforms that presented some limitations to formulating the type of questions we intended to ask.

After sending a formal invitation to participate in the survey by email, a systematic follow-up was carried out to involve as many people as possible. To encourage participation, periodic reminders were sent to individuals who had either not yet begun or had partially completed the survey, notifying them of the opportunity to participate and reminding them of the survey deadline. In the initial email of invitation as well as in the successive reminders and in the introductory part of the Round 1 questionnaire, the respondents were urged to invite other colleagues who, by virtue of their experience and knowledge, could also participate/take part in the survey.

Round 1 of the survey was open from August 29th, 2022 (the day the invitation mailing was sent) up to and including September 25th. Responses were processed at the aggregate level three weeks after the deadline. In the case of the open-ended questions, this involved coding the respondents' answers. These questions referred to the challenges to sustainability; the conditions and obstacles to building a just value chain for lithium-rich countries in salt flats; the governance challenges; and the initiatives and instruments to address the challenges identified and promote a just chain, as well as the actors that should lead these initiatives.

The coding process was based on the response options of the closed-ended questions. When the response could not be classified in any of the options offered by the questionnaire, categories were created to capture the panel's answers adequately. The coding process was carried out by two research assistants whose work was divided in half: four open-ended questions were coded by one of the assistants, while the remaining four were by the other assistant.

At the end of the work, a cross-coding exercise was carried out to validate the coding criteria: 10% of the responses to each question were randomly selected, and the roles of the coding assistants were reversed. After coding this sample, the codes chosen in this revision instance were contrasted with those chosen in the first instance.

After six weeks of processing, the survey results were interpreted, and the Round 2 questionnaire was designed. In addition, new questions were asked about initiatives to address the challenges to sustainability and justice in the chain and the actors who should promote these initiatives. The responses gathered from the open-ended questions served as valuable input for formulating the response options provided to respondents in this particular instance.

The questionnaire design for Round 2 involved an iterative process in defining the final formulation of the 14 closed multiple-choice questions. The questions in Round 2 aimed to validate the priority challenges identified by the panel in Round 1 and identify the initiatives required to address them and the key actors who should be involved. Furthermore, the survey included six statements based on the open-ended questions from Round 1. Participants were asked to express their level of agreement or disagreement with these statements, allowing for a deeper understanding of the panel's perspectives and the consensus reached on these issues.

The deadline to participate in the second round began on November 17th. 2022, with a formal invitation email and ended on December 20th. The survey was sent exclusively to those participating in the first round. On this occasion, 83 people participated out of 141 invitees, representing 58% of the original panel.

At the end of December 2022, we decided to close the survey after round 2. The decision was mainly based on the fact that a certain degree of consensus had been achieved on the key issues investigated, as evidenced by the low variability in the responses provided in each round.

Results processing and preparation of the executive report (January to June 2023)

Following the completion of the second round, the survey results were analyzed in both aggregate and disaggregated forms. In the subsequent weeks, a comprehensive comparison was conducted between the results of the second round and those of the initial round. Furthermore, a detailed analysis was performed by cross-referencing the responses based on the participant's country of residence and their respective expert groups. While these specific findings are not included in this report, they will be published in the final report, offering a more comprehensive and nuanced understanding of the data.

In general, the panel's composition remained consistent in terms of the respondent's place of residence, group affiliation, and professional activities, with only minor observed variations. The relative participation of respondents from lithium-rich countries from salt flats decreased by 6.6 percentage points (from 66.7% to 60.2%). There was also an increase of 8.9 percentage points in the relative participation of the academic sector (from 36.9% to 45.8%) and a decrease of 6.7 percentage points in the relative participation of industry (from 24.8% to 18.1%). Likewise, there was a fall of 6 percentage points in the relative participation of respondents linked to production activities. For this comparative analysis, the responses of the 141 Round 1 respondents were taken into account, and the aggregate results were compared with the responses of the 83 Round 2 respondents. The objective was to evaluate possible variations in the responses between the two rounds and thus identify emerging consensus or whether there were ongoing disagreements on any of the issues addressed in the study. Generally speaking, there was little variation between rounds. The challenges identified as priorities in Round 1 of the survey retained their position in the second consultation.

As there was a 42% decrease in participation between rounds, it was important to account for the potential impact on the relative composition of the panel in terms of participants' characteristics. A cross-checking exercise was conducted to ensure the robustness of the findings in Round 2. This exercise aimed to verify that the results obtained in Round 2 remained consistent and were

not significantly influenced by the changes in the panel's composition. To address this concern, the Round 1 results were re-analyzed, focusing solely on the respondents who had also participated in Round 2. Through this process, it was determined that there were no significant modifications in the results. Consequently, it can be concluded that the study's findings remain unaffected by the changes in the composition of the panel between the two rounds.

In contrast to Round 1, the multiple-choice questions in the second round included an "Other" option below the predefined response options. This allowed respondents to provide spontaneous responses and indicate options that were not included in the provided list. The "Other" option allowed respondents to provide additional input beyond the predefined response options. However, the requirement to select options from the list remained unchanged. The responses under the "Other" option were carefully processed to identify new challenges, initiatives, or actors. A threshold of 5% of the panel was established to determine the significance of these responses. The analysis revealed that no new category exceeded the threshold, indicating that the predefined options adequately covered the relevant aspects.

During the first semester of 2023, the compilation of data and the selection of graphs and results were undertaken, forming the basis of this executive report.

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