# TC Document

## I. Basic Information for TC

| | |
|---|---|
| ▪ Country/Region: | REGIONAL |
| ▪ TC Name: | Circular Lithium: Sustainable Battery Value Chain Solutions |
| ▪ TC Number: | RG-T3787 |
| ▪ Team Leader/Members: | Balza Angulo, Lenin Humberto (INE/INE) Team Leader; Snyder, Virginia Maria (INE/ENE) Alternate Team Leader; Walter, Martin (INE/CCH) Alternate Team Leader; Acevedo Calle, Daniela (LEG/SGO); Ballon Lopez, Sergio Enrique (INE/ENE); Brusatin Cadavid, Nicola (INE/INE); Correa Poseiro, Cecilia (INE/ENE); De Los Rios Rueda, Camilo (INE/INE); De Pierola Del Aguila, Jose Carlos (INE/INE); Dorr, Julian Alexander (INE/INE); Garcia Fernandez, Javier (INE/INE); Juarez Olvera, Mariel (CSD/CCS); Malagon Orjuela, Edwin Antonio (INE/ENE); Planas Marti, Maria Alexandra (INE/ENE); Ramirez Bello, Maria Cecilia (INE/INE); Rihm Silva, Juan Alfredo (INE/WSA); Rodriguez Molina, Raul (INE/TSP); Siroit, Gaston (INE/INE); Sturzenegger, German (INE/WSA); Unzueta Saavedra, Adriana (INE/INE); Urteaga Dufour, Jose Antonio (INE/ENE); Zambrano Polanco, Marcela (INE/WSA); Blanco Iturbe, Maria Alejandra; Pelaez Zambrano, Paula |
| ▪ Taxonomy: | Client Support |
| ▪ Operation Supported by the TC: | . |
| ▪ Date of TC Abstract authorization: | 12/14/2020 |
| ▪ Beneficiary: | Bolivia, Colombia, México, Perú |
| ▪ Executing Agency and contact name: | Inter-American Development Bank |
| ▪ Donors providing funding: | Clean Technology Fund(CTF) |
| ▪ IDB Funding Requested: | US$1,000,000.00 |
| ▪ Local counterpart funding, if any: | US$0 |
| ▪ Disbursement period (which includes Execution period): | 36 months |
| ▪ Required start date: | |
| ▪ Types of consultants: | Individual/Firms |
| ▪ Prepared by Unit: | INE-Infrastructure and Energy Sector |
| ▪ Unit of Disbursement Responsibility: | INE/INE-Infrastructure and Energy Sector |
| ▪ TC included in Country Strategy (y/n): | N/A |
| ▪ TC included in CPD (y/n): | N/A |
| ▪ Alignment to the Update to the Institutional Strategy 2010-2020: | Productivity and innovation; Institutional capacity and rule of law; Environmental sustainability |

## II. Objectives and Justification of the TC

2.1 This Technical Cooperation (TC) aims to accelerate the shift towards circular economies in the region and strengthen policy makers' technical knowledge for the untapped business opportunities of circular systems. Its main objective is to identify and assess sustainable business models for recycling and/or reusing Lithium (or "Li-on") batteries. Efforts will be focused on assessing these opportunities in Bolivia, Colombia, Mexico, and Peru.

2.2 Li-ion batteries are those electrochemical energy storage devices in which energy between the cathode and the anode is transferred based on a lithium-ion flow in an electrolytic solution. The anode is usually made of pure carbon (graphite), while the cathode is a lithium-based alloy. The most common cathodes are now the Lithium Iron Phosphate (LFP) for electric vehicles and power grid applications, and Lithium Cobalt Oxide (LCO) for wireless electronics, although many other are gaining popularity for a wide range of applications (based on alloys of Lithium and Manganese, Nickel, Titanite, etc.).[1]

2.3 Li-ion batteries are becoming a key element of the current technological developments and the efforts to electrify the economy. Their ability to store energy and deliver it in an efficient, fast, and safe manner is making possible the development of the wireless digital industry, the decarbonization of the transport sector, and the integration of intermittent renewable energy technologies into the power grids. Hence, in recent years, lithium has garnered strong global investor interest[2] and its demand has already overtaken the supply. Approximately 59% of the world's lithium resources are found in brines[3], 25% in minerals and the remainder found in clays, geothermal waters, and oil field brines. It is expected that by 2050 the cumulated global demand for lithium will increase by more than 950%[4] compared with current values, driven by a battery-based energy storage increase of thirteen times between 2018 and 2026, reaching a 158TWh market.[5]

2.4 Despite the exponential and continued rise of Li-ion development and the commercialization of batteries, not much attention is being given to the sustainable strategies existing around the lithium value chain, specifically, the battery recycling industry. The life expectancy of a Li-ion battery is approximately 10,000 full cycles, which in many applications translates into approximately 10 years. However, it is important to highlight that batteries used in electromobility in their first life still retain between 60 to 80% of their capacity at the end of their lifecycle.[6] [7] [8] To date, around 95%[9] of Li-ion batteries are disposed upon reaching the end of life instead of being recycled. The environmental impact of Li-ion batteries includes resource depletion, global warming, ecological toxicity, and human health impacts. It is estimated that by 2025, there will be about 11 million tons of spent Li-ion batteries in the market[10]; hence, the question of how to recycle them and ensure circular flows of materials deserves some forethought.

---

[1] Others: NMC: lithium nickel manganese cobalt oxide, LMO: lithium manganese oxide, NCA: lithium nickel cobalt, LFP: lithium iron phosphate, LTO: lithium titanate. https://batteryuniversity.com/learn/article/types_of_lithium_ion

[2] IDB, 2019. Litio en la Argentina, La Cadena de Valor: Oportunidades y desafíos para el desarrollo.

[3] Kavanagh, L, et al. 2018. Global Lithium Sources – Industrial Use and Future in the Electric Vehicle Industry: A Review.

[4] The World Bank. 2017. The Growing Role of Minerals and Metals for a Low Carbon Future. Washington, DC: World Bank.

[5] Wood MacKenzie Power & Renewable Global Outlook, 2019.

[6] ESMAP, Reuse and Recycling of LiBESS, 2020

[7] Bobba, S. et al, 2018. Life Cycle Assessment of repurposed electric vehicle batteries: an adapted method based on modelling energy flows. Journal of Energy Storage.

[8] Battery remaining capacity after its first use may be impacted by weather conditions, among other things.

[9] Heelan J. etf al, 2016. Current and Prospective Li-Ion Battery Recycling and Recovery Processes

[10] Sanderson, H. 2017. Rise of electric cars poses battery recycling challenge. Financial Times

2.5 The United States Environmental Protection Agency (EPA) showed in 2013 that recovery of metals at end of life of Li-ion batteries can significantly reduce their life cycle impacts.[11] Currently, there are three main recycling processes to reuse materials from batteries: hydrothermal recycling, pyrolysis recovery, and direct recycling of their different components. The latter allows for a higher percentage of recovered battery materials and it is the most environmental-friendly methodology but is still in the pilot stage. There are multiple materials than can be recovered from a Li-Ion based battery, depending on its technology, such as cobalt, nickel, manganese, and lithium products. Today the most economically viable material recovery process is for lithium iron phosphate (LFP), which is expected to play a key role in the Electric Vehicles (EVs) and large energy storage industry.[12]

2.6 Also, there are several methodologies being developed to find a second life for used batteries, re-furbish batteries at end of life for use in less-capacity intensive applications, such as transferring from EV to stationary services in electrical networks. According to the Global Battery Alliance (GBA), repurposing or reusing EV batteries to becoming power providers could lower the costs of EV charging infrastructure by 90% by 2030 while supplying 65% of stationary power grids. It should be considered that the performance standards for EV batteries are very high, usually putting a limit at maintaining 80% of usable capacity and achieving a resting self-discharge rate of only 5% over 24h. This allows that these batteries can still perform less demanding application when reaching their end-life cycle, such as stationary energy storage services. In some scenarios, the second life-battery supply for stationary applications could exceed 200 gigawatt-hours per year by 2030.[13]

2.7 Currently, the cost of recycling Li-Ion batteries is still high compared with the cost of new manufacturing, needing concessional resources for the development of its industry.[14] Nevertheless, as more batteries come into disposal and raw material starts to become scarce (particularly cobalt), recycling will become essential, and can lead to enormous benefits, including environmental and social. In 2017, the battery recycling market was valued at around US$10 billion, expecting an annual growth of 11% until 2026.[15] With the projected growth of future Li-ion battery use increasing exponentially, it is critical that the recycling market also react congruently. While some actors, such as the European Union (EU) has already mandated target Li-ion battery collection and recycling rates, regardless of current economic inefficiencies,[16] most countries do not have regulation that would promote recycling. One particular aspect is the lack of standardization and labelling of components, which makes it difficult to differentiate different types of battery packs and, therefore, limiting the efficiency of logistical and recycling processes. Latin America and the Caribbean (LAC) have done so far very little to develop a recycling infrastructure with respect to batteries, which

---

[11] *EPA, 2013, Application of Life Cycle Assessment to Nanoscale Technology: Lithium-ion Batteries for Electric Vehicles*

[12] ESMAP, 2020, Reuse and Recycling: Environmental Sustainability of Lithium-Ion Battery Energy Storage Systems

[13] McKinsey&Co, 2019, Second-life EV batteries: The newest value pool in energy storage

[14] https://batteryuniversity.com/learn/article/battery_recycling_as_a_business

[15] Transparency Market Research (TMR), 2017, 'Battery Recycling Market - Global Industry Analysis, Size, Share, Growth, Trends, and Forecast, 2018-2026.

[16] Hendrickson T. et al. 2015. Life-cycle implications and supply chain logistics of electric vehicle battery recycling in California. Environmental Research Letters

are treated under a broader solid waste management regime. Although some countries have specific regulations for lead battery recycling (Brazil, Chile, Colombia, Costa Rica, Mexico, Paraguay, and Peru), there is still no one with analogous regulatory frameworks for Li-Ion batteries. As of today, most of batteries and e-waste in the region, are exported to the EU or the USA for recycling.[17]

2.8 Policy development, institutional frameworks, and the development of the physical infrastructure for Li-ion batteries recycling would be key for the success in the transition into a green and circular economy. Some key challenges are: (i) lack of harmonized codification for lithium manufacturing and standardized protocols for measuring battery performance, (ii) lack of regulation on the disposal of Li-ion batteries, (iii) lack of standards and regulation governing disassembly, sorting, classification, re-using and recycling batteries methodology, particularly in health and safety matters, (iv) lack of regulations and projects for logistical management of collection and transportation of used batteries, (v) lack of regulation defining clear roles, responsibilities, and liabilities of the initial manufacturer and users in the end-life cycle of batteries, and (vi) lack of inventories for environmental and social impacts of the full life of batteries.

2.9 This TC will support the development of environmentally sustainable solutions for used batteries[18], supporting innovative business models for the LAC region that will find synergies with the already existent extractive and raw material industry in Bolivia, Colombia, Mexico, and Peru. Additionally, the project aims to showcase, through regulation, standards, and capacity building activities, a pathway for the formal recycling sector with improved, risk-controlled labor conditions and local job creation, and promote the regional value chains of new economic activities. Upon growth of the battery market, it may be needed that the region develops its own recycling infrastructure instead of continuing its exporting habit. For countries like Mexico, with large deposits of Lithium, with a growing EV industry and with a common border with the USA, the recycling of batteries will be an opportunity to keep talent in the country. For example, Ganseng, main supplier of lithium to Tesla, is building a battery recycling plant in Bacanora, which will require the regulation of the country to be ready.

2.10 The Circular Lithium project will build from the progress of the IDB's Regional Public Good (RPG) - Development of Lithium: Regional Platform for Sustainable Growth (RG-T3340), which aims to support the development of the lithium industry, placing special emphasis on overcoming the challenges of productivity, sustainability, and the generation of shared value brought about by both the extraction and exploitation of lithium, and the lithium production value chain. This TC will complement activities focusing on the end of the value chain of Li-on batteries and how lithium can be recovered or reused. Bolivia and Peru have been selected as part countries of the IDB's RPG. Bolivia accounts for nearly 26%[19] of global resources of lithium, and it was recently announced that Peru has lithium deposits in rock, such as those in Australia, which have a lithium concentration seven times higher than the salt flats, and reserves of approximately 2.5 million tons are estimated for the 8,000 hectares (of the 92,000 hectares) that have been explored. On the other hand, among Official Development

[17] ESMAP, 2020, Reuse and Recycling: Environmental Sustainability of Lithium-Ion Battery Energy Storage Systems
[18] Solutions will focus mostly from electromobility and renewable energy installations, that can either be recycle or find a second life in applications such as stationary energy storage in power grids
[19] USGS. 2020

Assistance (ODA) beneficiary countries Colombia and Mexico are adopting ambitious electric mobility programs that will drive up batteries demand. In cases such as Mexico, it could also be a beneficiary of the electromobility industry growth in the Unites States, as a receptor of used batteries.

2.11 In Mexico, the *Secretaría de Medio Ambiente y Recursos Naturales (Semarnat)* is leading the design of a national strategy for the development of electromobility, expecting that 5% of sales of new vehicles by 2030 will be electric or hybrid. The regulation in the country classifies lithium-based batteries as "waste for special management"[20], as part of small batteries and together with lead-based batteries, nevertheless there is not specific guidelines for the management, recycling and refurbishing of large Li-ion based batteries. The *Instituto Nacional de Electricidad y Energías Limpias* (INEEL) is now exploring the possibility of second life applications for used batteries in the grid, while in the private sector players such as Ganfeng Lithium is making plans to build a battery recycling plant in Bacanora that could supply both then Latin American and US´s markets. In Colombia, the Ministry of Energy and Mines is also supporting the developing of electromobility and finding innovative energy storage solutions in the power system. In Bolivia, *Yacimientos de Litio Bolivianos* (YLB) has launched, in October 2019, The Lithium Technology Center, in which technical careers will be taught to strengthen Lithium industrialization. In addition, Bolivia signed an inter-institutional cooperation agreement with the national company Quantum Motors that seeks to strengthen the manufacture of 100% Bolivian electric vehicles. In Peru, the Ministry of Energy and Mining is working on the adaptation of a regulatory framework for the exploitation of radioactive minerals to promote the exploration and exploitation of lithium and uranium in the southern part of the country.[21]

2.12 The technical cooperation is aligned with three themes of the Bank's Second Update to the Institutional Strategy (UIS) (AB-3190-2): Environmental Sustainability Productivity and Innovation; and Institutional Capacity and Rule of Law. On the first issue, the TC will support the design of sustainable business models for circular systems to minimize the environmental impact of the sector in the region. On the second issue, the TC will develop activities to strengthen technical knowledge and technology transfer in the sector. Regarding the third theme, the TC supports the strengthening of the policies and institutions that govern the recycling infrastructure in LAC. The TC is aligned with: (i) the Energy Sector Framework (GN 2830-5), by supporting the adaptation and development of new regulation and policies to allow the development of new business models and give a better use of the available technologies to boost the sustainable energy transition; (ii) the Science and Technology Sector Framework (GN-2791-8); (iii) the Climate Change Sector Framework (GN 2835-8); (iv) IDB's Infrastructure Strategy (GN-2710-5), by fostering innovation, promoting the reduction of greenhouse gas emissions and enhancing a more sustainable use of the energy assets through their whole lifecycle.

[20] Guía para el Consumo y Manejo Sustentable de Pilas
[21] Minem. 2019.

2.13 This TC is consistent with the priority areas of each of the four Country Strategies. In the case of Bolivia's Country Strategy, this TC is aligned with the strategic objective of quality public goods and services. More specifically, in the energy sector in Bolivia, the Bank will emphasize its support for renewable power generation, which means that, consequently, there will be an increase in Li-ion batteries, which will need to be managed once they reach their end of life. The TC is also aligned with Colombia's Country Strategic (2018-2022) priority area of sustainability; science, technology, and innovation by spurring innovation and development in business. The project is aligned with the strategic objective of the Bank in Mexico of strengthening the labor market, by creating new economic activities and opportunities in the recycling market, and it is also aligned with the strategic objective in Colombia of spurring innovation and development in businesses. In the case of Peru, this TC is aligned with the aim to improve the environmental management, which is part of the third priority area of the Country Strategy: Environmental sustainability and climate change.

2.14 Finally, this TC is aligned with the objectives of the Clean Technology Fund (CTF), which is one of the two multi-donor trust funds within the wider Climate Investment Funds (CIFs). The CTF aims to provide positive incentives, through public and private sector investments, for the demonstration of low carbon development and mitigation of greenhouse gas emissions. The CTF was established in 2008 to provide emerging economies with scaled-up financing for the demonstration, deployment, and transfer of low-carbon technologies with a significant potential for long-term greenhouse gas (GHG) emission savings. The CTF received 5.5 billion in commitments, to be deployed through six partner multilateral development banks (MDBs). The TC is also aligned with the new CIF's Global Energy Storage Program (GESP) which will help deliver breakthrough energy storage solutions at scale in developing countries, particularly by catalyzing the recycling and second life solutions of batteries (for example by scaling up used EV batteries into large stationary applications).

## III. Description of activities/components and budget

3.1 **Component 1: Regulation and standards support ($200,000).** This component aims to help the beneficiary countries to develop regulatory guidelines regarding recycling infrastructure. It will comprise: (i) the development of battery performance protocols, (ii) the development of a reference labeling system for Li-ion battery components that could guide regulatory developments, and (iii) the development of draft regulation governing the disposal of batteries, including the roles and liabilities of each of the actors involved in the life cycle.

3.2 **Component 2: Capacity building and knowledge dissemination ($400,000).** The objective of this component is to promote the diffusion of knowledge and the adoption of the regulatory standards that support the introduction of innovations in circular systems management. The component will be executed through four activities: (i) a market study for the recycling of batteries and regional value chains' opportunities with the electromobility industry development in the LAC region and the neighboring developed countries, (ii) the development of guidelines for management for logistics

in the collection and transport of used batteries[22] including the participation of small and medium size collectors, (iii) the development of guidelines for the disassembly, classification, and refurbishing of battery components, including health and safety matters, (iv) the organization of workshops and policy dialogues with public and private stakeholders, where key products of this project will be presented and discussed. and (v) a publication that will compile all the knowledge gathered from the different components and that could serve as inputs for future public policy development.

3.3 **Component 3: Support of project development through an innovation competition ($400,000).** This component will finance: the design and the launching of an Open Innovation Challenge that will seek to find the most innovative solutions that substantially recycle and reuse Li-ion batteries in the beneficiary countries, particularly for the establishment of stationary grid services. The solution must: (i) address the challenge that has been established in line with the IDB Group's purpose and mandates, (ii) have the potential to impact lives and drive economic growth in the beneficiary countries, (iii) present a clear path to scale to impact the lives of more people, (iv) present a feasible implementation plan, which is financially and technically sustainable. This component will also finance communication and raising awareness activities related to the competition, as well as advisory services to support scaling up the awarded solutions.

**Indicative Budget (US$)**

| Activity/Component | IDB/Fund Funding (Grant) | IDB/ CTF (Grant) | Total Funding |
|---|---|---|---|
| Component 1: Regulation and standards support | - | 200,000 | 200,000 |
| Component 2: Capacity building and knowledge dissemination | - | 400,000 | 400,000 |
| Component 3: Support of project development through an innovation competition | - | 400,000 | 400,000 |
| TOTAL | - | US$1,000,000 | US$1,000,000 |

## IV. Executing agency and execution structure

4.1 Given the strategic objective of the TC of accelerating the shift towards circular economies in the region, and creating awareness of the untapped business opportunities of circular systems, the Bank, through the Mining, Geothermal Energy, and Hydrocarbon Special Group (INE/MGH) and the Energy Division (INE/ENE) of the Infrastructure and Energy Sector (INE), will act as the executing agency for the administration of the project taking advantage of its expertise and relationship with different stakeholders. In line with OP-1155-2, considering this is a regional TC and in the absence of a regional entity for the execution of the TC, it is appropriate that the

[22] These guidelines may include analysis on behavioral economics that could heal scale up impact.

Bank carries out the contracting of consultants vis a vis the sustainability of the implementation of the project. The IDB's experience and strong collaboration with the participating countries will enable a successful implementation of the preliminary assessments, while also facilitating the articulation among the different countries, stakeholders, and donors in the region. The Bank will contribute to the harmonization of the activities at a regional level, by providing a linkage between existing projects, and guaranteeing that all countries benefit from the experience of the others. Active engagement with and awareness of the work of other organizations operating in the field will also help avoid any potential overlaps with ongoing efforts. Prior to the execution of specific in-country activities in any of the beneficiary countries, the Bank shall obtain the letter of non-objection from the corresponding liaison entity.[23]

4.2 The Bank will be responsible for the selection and hiring of consulting firms and individual consultants which will be in accordance with IDB policies and procedures (GN-2350-9). In addition (i) the individual consultants will be hired in accordance with appendix 10 of GN-2629-1 and guidelines set out in AM-650 and a) will not perform functions similar to those of the staff of the Bank or the Beneficiary and b) will not be hired to act as the Bank´s counterpart on behalf of the Beneficiary; (ii) the procurement process for consulting firms will follow IDB Policy for the Selection and Contracting of Consulting Firms for Bank-executed Operational Work (GN-2765-4) and its related Operational Guidelines (OP-1155-4); and (iii) the procurement of non-consultant services will follow the IDB Corporate Procurement Policy (GN-2303-28). Following IDB Operational Guidelines for Technical Cooperation Products revised version (GN-2629-1), this TC is classified as a product for Client Support.

## V. Major issues

5.1 The main implementation risk of this TC is that key findings and main policy recommendations may not be adopted by policy makers and practitioners in the region. To mitigate the risk, the project team will work closely together with partners, policy makers, and key stakeholders in all the phases of the project. The organization of institutional roundtables and workshops with stakeholders directed to generate debate and promote actions by public officials will be proposed.

5.2 As a lesson learned from the TC RG-T3340, another risk are political uncertainty or changes during the execution period. To mitigate the risk, the project team will make sure that all beneficiary countries assign a focal point with technical background, who might be more likely to surpass political cycles.

---

[23] Two of the beneficiary countries, Colombia and Peru, have presented a written request that the Bank carries out the selection and contracting of consultancy services. According to OP-619-4 Annex II Section 2.1., the activities in Bolivia and Mexico will only begin to be executed and the respective funds disbursed once the letters of request have been obtained from the relevant official liaison entities with the Bank or, a non-objection letter is received from them in cases where the requests come from bodies or entities other than the country's official liaison entity with the Bank.

5.3 The dramatic spread of COVID-19 has disrupted lives and communities and generated important disruptions in economic activities across Latin America and the Caribbean. This means that projects may face implementation challenges, including logistical issues and communication delays. To mitigate these issues, project implementation will firstly focus on desktop research, online communications, and remote interactions with willing partners when feasible.

## VI. Exceptions to Bank policy

6.1 This project will not require any exception to the Bank's policy.

## VII. Environmental and Social Strategy

7.1 According to the Environment and Safeguards Compliance Policy (OP-703), this TC has been classified as a Category "C". No environmental assessment studies or consultations are required for this category (see: Safeguard Policy Filter Report (SPF) and Safeguard Screening Form (SSF)).

**Required Annexes:**

Request from the Client - RG-T3787

Results Matrix - RG-T3787

Terms of Reference - RG-T3787

Procurement Plan - RG-T3787