

DOCUMENT OF THE INTER-AMERICAN DEVELOPMENT BANK

COLOMBIA

**PREPARATION OF THE GEF “DEMONSTRATION AND ASSESSMENT
OF BATTERY-ELECTRIC BUSES”**

(CO-T1349)

TECHNICAL COOPERATION DOCUMENT

This document was prepared by a team comprised by: Roberto Esmeral (INE/CCS) team leader; Andrés Baquero (CCS/CCO) co-team leader; Carlos Mojica (INE/TSP), Ana Maria Pinto (TSP/CCO), Jose Luis Alba (CAN/CCO), Diego Valenzuela (LEG/SGO), Maria F. Alva (INE/CCS) and Juan Carlos Gómez (INE/CCS).

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TC Document
Preparation of the GEF “Demonstration and Assessment of Battery-electric Buses”
CO-T1349

I. Basic Information

▪ Country/Region:	Colombia
▪ TC Name:	Preparation of the GEF “Demonstration and assessment of battery-electric buses”
▪ TC Number:	CO-T1349
▪ Associated Loan/Guarantee Number:	CO-G1004
▪ Taxonomy	Operational Support
▪ Team Leader/Members:	Roberto Esmeral (CCS/CCO), team leader; Andres Baquero (CCS/CCO) alternate team-leader, Carlos Mojica (INE/TSP) Ana María Pinto (TSP/CCO), José Luis Alba (CAN/CCO), Diego Valenzuela (LEG/SGO), Juan C. Gómez (INE/CCS), Maria Fernanda Alva (INE/CCS),
▪ Date of TC Abstract authorization:	N.A.
▪ Beneficiary:	Republic of Colombia – Ministry of Transport (MT) and Ministry of Environment and Sustainable Development (MESD)
▪ Executing Agency and contact name	IDB through CCS/CCO. Contact: Roberto Esmeral
▪ Donors providing funding:	Global Environmental Facility (GEF)
▪ IDB Funding Requested:	USD\$60,000
▪ Local counterpart funding, if any:	N.A.
▪ Disbursement period (which includes Execution period):	12 months
▪ Required start date:	December 2013
▪ Types of consultants:	Firms and/or Individual consultant
▪ Prepared by Unit:	INE/CCS
▪ Unit of Disbursement Responsibility:	INE
▪ TC Included in Country Strategy (y/n):	No
▪ TC included in CPD (y/n):	Yes
▪ GCI-9 Sector Priority:	Protect the environment, respond to climate change, promote renewable energy and food security

II. Description of the Associated Loan/Guarantee

- 2.1 The Global Environmental Facility (GEF) ID 5199 project is expected to reduce the technology, regulatory, financial and awareness barriers that prevent development and widespread adoption of battery-electric buses in urban transit solutions. The proposed project will finance incremental costs associated to: (i) testing the battery-electric bus under operational conditions; (ii) the development of policies, regulations and standards

for battery-electric buses adoption; (iii) building the technical capacities of relevant stakeholders; and (iv) raising awareness and disseminating information on battery-electric vehicle technologies. Firms and individual consultants are expected to carry out the bulk of the work associated to outcomes (ii) and (iv) above. Actions related to bus development and testing and capacity building will fall upon BYD Company Limited (BYD), a world leader in battery technologies and battery-electric vehicles, who will develop a prototype battery-electric articulated bus, that fulfills current and specifications required by the Ministry of Transport of Colombia and TRANSMILENIO S.A, the entity in charge of the mass public transportation in Bogota. BYD will also carry out the trainings required to properly operate and maintain the buses.

- 2.2 The cost of the development and testing of the battery-electric articulated bus prototype has been valued at US\$20 million as stated in the Project Identification Form (PIF). This prototype will be subject to several tests in order to determine its operational, environmental and financial performance. The cost of these tests was initially valued at US\$1.7 million, although this value may be revised during the execution of this TC.
- 2.3 The test of articulated, battery-electric buses should provide evidence on the performance and operational costs of this technology, as well as information that leads to the homologation of these vehicles. The results of this project will be available to the public so they can serve as inputs for decision makers of relevant transport and environmental authorities, private bus operators and the financial sector, among others. The purpose is to facilitate the transition from technology demonstration and development, to its deployment.
- 2.4 There are two likely outcomes of the GEF Project, both of which are expected to contribute towards the adoption of battery-electric buses into full transit operation. The first one considers the tests as a demonstration that the buses are both operationally and financially viable, which may lead to a quick introduction into service if the window of opportunity opened by PAT is taken¹. In the second one, the battery-electric articulated bus fails to fulfill either operational or financial targets, but still produces a wealth of information regarding the areas on which development work should focus to obtain a suitable vehicle in the short to medium term.
- 2.5 Additional funding has been considered for the project in order to support the eventual introduction of battery-electric articulated buses into operation. The source of such additional funding would be the Bank's Sustainable Energy and Climate Change Initiative (SECCI) Multi-Donor Fund, which was established to expand investments in renewable energy and energy efficient technologies, amongst others goals. In particular, an Investment Grant (IG) of up to US\$1.5 million has been considered, of which US\$200,000 will be aimed at capacity-building in relevant institutions. The remaining funds will be used to cover any relevant incremental costs of the technology in order to dispel any doubts about the operational capabilities of these buses.

¹ In fact, Express del Futuro S.A. (a TransMilenio operator) and its sister company Consorcio Express S.A.S. (operator of 2 of the 13 zones into which SITP is divided) are already testing out battery-electric buses from BYD. The expected outcome is to incorporate them into full operation.

III. Justification and Objectives

A. General justification

- 3.1 The transport sector is one of the fastest growing sources of greenhouse gases (GHG) emissions in Latin-America and the Caribbean (LAC). In Colombia, in 2004, the transport sector contributed with 12% of the total GHG emissions of the country, and with 33% of the emissions from energy conversion². There are two factors that may allow battery-electric buses to significantly slow down the growth of GHG emissions from this sector. First, there is the prevalence of hydropower in Colombia, which accounts for most of the electricity generation in the country. Secondly, the government's interest to promote the use of public transportation as the preferred mobility solution, a goal that is supported by the adoption of Bus Rapid Transit (BRT) systems in larger cities (e.g. Bogota, Bucaramanga, Cali, etc.), and Strategic Public Transit Systems (SETP –Sistemas Estratégicos de Transporte Público) in small to medium sized cities. These transit policies are seen as an interesting context in which to pursue the use of battery-electric buses instead of diesel-powered ones, as a means to reduce GHG emissions related to transport. In addition to the global environmental benefits derived from the reduction of GHG emissions, electric-powered vehicles could also have a significant impact reducing criteria pollutants (e.g. particulate matter, carbon monoxide and nitrogen oxides,) which are responsible for serious public health hazards in urban areas. Furthermore, the substitution of diesel with electricity could have a positive effect on the country's energy security and balance of payments.
- 3.2 On October 21, 2013, the Government of the city of Bogota adopted the Technological Advancement Plan (PAT –*Plan de Ascenso Tecnológico*).³ The purpose of the PAT is to promote a complete changeover of Bogota's transit fleet towards buses that rely on 'cleaner' powertrains from an emissions standpoint. The PAT states that it is up to TransMilenio and Bogota's current Integrated Public Transport System (SITP) operators (for phases 1 and 2) to: (i) identify potential technologies for implementation; (ii) work together with new bus technologies providers to establish the testing and demonstration program for Bogotá; and (iii) develop and propose a business plan for the selected technology, which constitutes the basis of TransMilenio's choice to allow the introduction of that specific technology. Another key fact of the PAT is that it considers that remuneration schemes of the new technology may be subject to review in the medium and long term, in order to transfer any unforeseen economic benefits of these technologies to the users or the local government.
- 3.3 According to a letter dated April 12, 2013, the GEF approved, among others, the PIF for the Project "Demonstration and Assessment of Battery-electric Vehicles for Mass Transit in Colombia", item no. 13 in such letter, which refers to a grant of up to US\$2,200,000.
- 3.4 The World Bank, acting as a the Trustee for the GEF, confirmed in a letter dated March 12, 2013 that the fund's Chief Executive Officer/Chairperson had committed resources for up to US\$1,258,254 for activities carried out by the Inter-American Development

² Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM), Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), 2010.

³ Plan de Ascenso Tecnológico – Technology Advancement Plan.

Bank (IDB) in connection with GEF Projects, Project Preparation Grants and IDB fees. Among those commitments are US\$60,000 to be used as a Project Preparation Grant for the project “Demonstration and Assessment of Battery-electric Vehicles for Mass Transit in Colombia”.

B. Objective

- 3.5 The objective of this TC is to prepare the Project Document to be submitted for CEO Endorsement by the GEF. In order to achieve this, the consultants will (i) carry out an extended literature review regarding the project; (ii) determine the current conditions under which the GEF project will be executed; (iii) recommend those activities that should provide the highest impact upon the introduction of battery-electric articulated buses and of other low or zero-carbon vehicle powertrains; (iv) prepare the documents under IDB and GEF standards to be submitted for approval; and (v) provide support to the IDB during the approval process by the GEF. This includes carrying out additional studies, such as one that will provide an overview on technologies and standards for vehicle charging.

C. Technical Issues and Sector Knowledge

- 3.6 The IDB supports technological improvements in Colombia’s public transport systems. This TC will complement the results achieved with IDB’s technical cooperation No. ATN/MC-12152-RG –“Hybrid Bus Test Program in Brazil and Colombia”, with specific insights on electric-vehicle technologies.
- 3.7 The “Hybrid Bus Test Program in Brazil and Colombia” operation became the “Hybrid and Electric Bus Test Program (HEBTP) in Latin America” with the subsequent addition of a battery-electric 12m bus, and the inclusion of Santiago de Chile as one of the trial cities. The conclusions of the expanded testing program were very encouraging, as the alternative drivetrain buses showed, in all the cities, their operational capabilities as well as financial and environmental benefits over the traditional diesel buses.
- 3.8 The specifics of the field-test of battery-electric buses were prepared with resources from IDB’s TC No. ATN/OC-13086-CO –“Market Entry of Electric Buses for Mass Transit in Colombia”. The IDB has also hired other consultancies to support the work being carried out towards the adoption of battery-electric buses in Colombia, through other work and TC operations such as the study “Feasibility of charging stations for battery-electric buses in Bogota’s TransMilenio system”, and project No. 3003/TC-CO, which work has been carried out as an “Economic appraisal for the financing of hybrid and electric buses within the framework of the Integrated Transit System in the city of Bogotá” as well as a “Cost-Benefit Analysis of the Funding Program for the Technological Transformation of the SITP and Potential GHG Emissions Reduction”.
- 3.9 As stated in the Project Preparation Grant Request, other complementary studies have been carried out in preparation of the GEF project. The first of these is the testing protocol mentioned in paragraph 3.8 above. The second study is an overview of current technologies for battery-electric vehicles with an emphasis on applications for mass transit, which was carried out, as the testing protocols mentioned above, by the National Renewable Energy Laboratory (NREL), concluding that advances in motor

and battery technologies are reducing the performance gap between electric and the traditional diesel powered buses. With respect to the cost benefit analysis of Battery-electric buses, the analysis was carried out by the Universidad de los Andes of Bogotá Colombia considering the impact of using both Hybrid (Diesel-electric) and/or electric buses only. This cost-benefit analysis concluded that, in spite of their higher capital costs, the introduction of alternative drivetrain buses still yields a Cost-Benefit Ratio of 1.4 if they replace the entire diesel fleet, although the analysis does not consider an electric-only fleet scenario. The final study to be mentioned was carried out by an electric-bus expert in Colombia and concludes that the existing electrical infrastructure surrounding the tow bus depots expected to be used as bases for the demonstration and trials are able to handle the increased energy demands from the charging process. This study also concludes that the existing spaces within the depots could be used to recharge the buses, although further analysis needs to be paid to the way in which the chargers are to be physically located, in order to avoid impose any operational restrictions on these infrastructures.

- 3.10 All of the studies mentioned above have been commissioned directly by IDB or have been produced with monies provided by it. This active participation in all the complementary studies to this TC, provides the Bank with all the technical knowledge required to carry out this PPG.

IV. Description of Activities/Components and Budget

- 4.1 **Preparation of the definitive operational and financial schedule of the project, preparation of the document to be submitted to the GEF and resolution of any issues that might arise from their consideration.** This work, to be carried out by a firm or by a few specialized consultants, depending on the results of a review of the project's context carried out by the Bank's Climate Change and Sustainability Division (INE/CCS) collaborators, will develop the full project proposal according to GEF guidelines (see Appendix for the guidelines), including the terms of reference to be used when hiring consultants and firms whom will carry out the different activities of the GEF project. The outputs of the consultancy will also include:
- a. Literature and context review
 - b. Preparation of the project procurement plan.
 - c. Preparation and validation of the Monitoring and Evaluation Plan.
 - d. Preparation of financial plan including project budget and co-financing.
 - e. Profile of the main experts group required for the project management and implementation, including list of responsibilities for the main project officers.
 - f. Assessment of the project's potential for GHG emissions reductions and other environmental benefits.
 - g. Assessment of the project socio-economic benefits.

Table 1. Indicative Results Matrix

Indicator	Unit	Baseline	End of Project	Data Source
Operational and financial schedules developed for the project	Unit	0	1	IADB
Full project proposal for submission to CEO Endorsement	Documents	0	1	IADB

Table 2. Indicative Budget (US\$)

Activity/Component	Description	IDB/Fund Funding	Counterpart Funding	Total Funding
Component 1	Firms and/or individual consultants	60,000		60,000
Total		60,000		60,000

- 4.2 Monitoring of the execution of this TC will be carried out by the Roberto Esmeral, Climate Change and Sustainability Division Specialist at the Bank’s Country Office in Colombia (CCS/CCO), with the support of other personnel at the Colombia office. Additional technical support will be provided by personnel in the transport division of the Bank in Colombia or from the Bank’s Headquarters.

V. Executing agency and Execution Structure

- 5.1 Following a Request from the GEF OFP in Colombia, the Ministry of Environment and Sustainable Development, the IDB will execute this TC. Contracting will be carried following the Bank’s procurement policies.
- 5.2 The execution structure considers a close collaboration with C40-CCI in their role as the Execution Agency for the GEF Project. They will be asked to participate in any meetings that take part within the TC and will be asked to provide feedback on any products that may be submitted by the consultants.

VI. Major Issues

- 6.1 The execution of the TC has no apparent issues that may prevent it from carrying out its purpose of preparing the GEF Project “Demonstration and Assessment of Battery-electric Vehicles for Mass Transit in Colombia”.
- 6.2 However it is important for the outputs and outcomes of the GEF Project to acknowledge that between the time in which the GEF project was being formulated and today, there have been relevant changes to the context within which the project would be executed. Key among these are: (i) the advances that the Government of Bogotá has made with respect to policies that promote the inclusion of “cleaner” powertrain vehicles in the operations of TransMilenio and SITP, including increased remuneration for the operators who incorporate them and the possibility of using the city as testing grounds for these technologies; (ii) the Hybrid-Electric Bus Testing Program in Latin America, that saw hybrid and electric buses tested in Bogota, Santiago, Sao Paulo and Rio⁴, having developed their own testing protocols; and (iii) the recent introduction of a line of credit by Bancoldex –Colombia’s Bank for Entrepreneurship and International

⁴ It is important to note, though, that this test was limited to 12m buses only, and the GEF Project is aimed at testing an 18m articulated bus.

Trade, targeted specifically at alternative drivetrain buses, an initiative supported by the IDB through one of its loan operations.

- 6.3 In order to maximize the relevance and impact of the GEF project, INE/CCS hired four consultants to review how these changes may impact the original components of the GEF project, as well as its objectives and scope. Based on their analysis, the consultants will propose, and justify, changes or amendments that the GEF Project, as originally formulated, may require to be as relevant as possible.
- 6.4 The consultants to be hired through this TC, will complement the ones hired by INE-CCS on the identification and mitigation of any risks associated to the execution of the GEF Project and any additional operations developed to support it.

VII. Exceptions to Bank policy

- 7.1 No exceptions are considered to the Bank Policy.

VIII. Environmental and Social Strategy

- 8.1 The execution of this TC does not pose any significant risk on the environment or any social group. On the contrary, it is expected that the products associated to this TC will help to improve the analytical foundations that will underpin the design and formulation of the “Demonstration and Assessment of Battery-electric Vehicles for Mass Transit in Colombia” GEF Project. According to the [Safeguard Policy Filter Report](#) and the [Safeguard Screening Form](#) obtained from the Bank’s environmental and social safeguards system, this TC has received the "C" Category.

IX. Annexes

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| Annex I: | Terms of Reference |
| Annex II: | Procurement Plan |
| Annex III: | Project Identification Form (PIF) of the project with GEFID 5199 “Demonstration and Assessment of Battery-electric Vehicles for Mass Transit in Colombia”. |
| Annex IV: | GEF’s letter to confirm Council’s Approval of the “Demonstration and Assessment of Battery-electric Vehicles for Mass Transit in Colombia” project. |
| Annex V: | World Bank Letter to confirm commitment of US\$60,000 as Project Preparation Grant for the project (Page 3 –Annex 1, item 5). |
| Annex VI: | Decree 477 of 2013 from Bogota –which guides the adoption of the PAT. Other dispositions are also established. |
| Annex VII: | Document “Methodological Guide to perform tests in buses with zero or low emission technologies”. |
| Annex VIII: | Non-objection from the Ministry of Environment to request IDB to act as the Executing Agency for this TC. |