

Identification of economic incentives for the electrification of river and maritime modes: proposal for the Colombian Case

Identificación de incentivos económicos para la electrificación de los modos fluvial y marítimos: propuesta para el caso colombiano

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Abstract

The transportation sector's significant contribution to greenhouse gas (GHG) emissions, primarily through fossil fuel consumption by motorized vehicles, remains a critical concern. In this industry, maritime transportation independently contributes to 2.89% of total global greenhouse gas emissions, displaying a persistent upward trend even in the face of enhanced efficiency measures implemented in port facilities and vessel operations. In response to this urgent concern, nations and international organizations have been formulating approaches aimed at mitigating greenhouse gas emissions in this transportation sector, encompassing the implementation of economic incentives. This article presents the findings of an exploratory-descriptive research endeavor, which aims to identify incentive policies implemented across various countries to expedite the adoption of electromobility in maritime and river transportation, thereby reducing GHG emissions from vessels. Data was gathered from authorized government websites, various organizations, maritime and river transport companies, and port authorities in each respective nation. Furthermore, this study classifies the incentives according to their methodologies and conducts a comparative analysis with the existing landscape in Colombia regarding the adoption of economic incentives for electrifying river transportation within the country. Through this analysis, some insights and recommendations can be derived to promote sustainable and environmentally-friendly practices in Colombia's river and maritime transportation sectors.

Key words: economic incentives; greenhouse gases; river transportation; maritime transportation; emission reductions.

Resumen

La importante contribución del sector del transporte a las emisiones de gases de efecto invernadero (GEI), principalmente a través del consumo de combustibles fósiles por los vehículos motorizados, sigue siendo una preocupación crítica. En este sector, el transporte marítimo contribuye de forma independiente al 2,89% del total de las emisiones mundiales de gases de efecto invernadero, mostrando una persistente tendencia al alza incluso ante las medidas de mejora de la eficiencia aplicadas en las instalaciones portuarias y las operaciones de los buques. En respuesta a esta urgente preocupación, las naciones y las organizaciones internacionales han venido formulando enfoques destinados a mitigar las emisiones de gases de efecto invernadero en este sector del transporte, que abarcan la aplicación de incentivos económicos. Este artículo presenta los resultados de una investigación exploratoria-descriptiva cuyo objetivo es identificar las políticas de incentivos aplicadas en varios países para acelerar la adopción de la electromovilidad en el transporte marítimo y fluvial, reduciendo así las emisiones de gases de efecto invernadero de los buques. Los datos se recogieron de sitios web gubernamentales autorizados, diversas organizaciones, empresas de transporte marítimo y fluvial y autoridades portuarias de cada nación respectiva. Además, este estudio clasifica los incentivos según sus metodologías y realiza un análisis comparativo con el panorama existente en Colombia en cuanto a la adopción de incentivos económicos para la electrificación del transporte fluvial en el país. A través de este análisis, se pueden derivar valiosas percepciones y recomendaciones para promover prácticas sostenibles y respetuosas con el medio ambiente en los sectores del transporte fluvial y marítimo de Colombia.

Palabras claves: incentivos económicos; gases de efecto invernadero; transporte fluvial; transporte marítimo; reducción de emisiones.

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Introduction

According to a comprehensive report by the International Maritime Organization (IMO, 2020), the transportation of goods and passengers emerges as a prominent source of greenhouse gas emissions worldwide. This crucial sector significantly contributes to approximately 2.89% of the total annual emissions. To address this environmental challenge, sustainable transportation solutions have become a focal point in the quest for mitigating climate change impacts. The Intergovernmental Panel on Climate Change (IPCC) emphasizes the importance of adopting sustainable transport practices to reduce carbon emissions and achieve global climate goals (IPCC, 2021). It is evident that the reduction of emissions in the transportation sector is a critical element in the pursuit of a sustainable and greener future.

Recognizing the urgent need to address these detrimental environmental impacts, multiple initiatives and research sources emphasize the imperative of emission reduction in the transport sector. For instance, the Net Zero Emission by 2050 Scenario proposed by the International Energy Agency underscores the urgency of achieving a 20% reduction in the transport sector's emissions by 2030 and striving for a substantial 50% reduction specifically in maritime transport emissions by 2050 (IEA, 2022). These recommendations align with the global commitment to combat climate change and underline the vital role of the naval sector in achieving sustainable and environmentally friendly transportation solutions.

Due to the increase in fossil fuels, in human industrial activity and the growing energy demands caused by population growth (United Nations, n.d.), this reduction will be possible mainly through the use of technologies aimed at reducing emissions, based on the decarbonization of energy sources, as is the case of the use of alternative energies and electric power in the system (McKinsey & Company, 2021). Although in the fluvial and maritime mode the inclusion of these technologies, such as electric energy is just incipient, due to the low electrification of ships and cargo vessels (Balcombe, 2019; Xuanet al., 2022),

to achieve the proposed environmental goals it is necessary to propose initiatives for the inclusion of this technology to encourage and motivate the transition to these new motor sources.

In search of the above, it is possible to find policies and programs around the world, that seek to encourage the inclusion of electric energy in maritime and river transport modes, which can arouse the interest for different actors and entities involved in transport to opt for including these technologies in their processes, such as incentives that grant financial resources (Kim, 2022; Backer et al., 2020) for the acquisition of these technologies, the reduction of port tariffs (Backer et al., 2020) or obtaining tax subsidies (Port of Stockholm, 2022), among others.

In general terms, subsidies, discounts and project financing programs by governments and private institutions are mechanisms that instead of charging polluters, encourage them to find ways to obtain grants, low-interest loans, discounts or tax exemptions, among others, as a reward for using new methods or technologies to reduce pollutant emissions (Camargo, C. et al., 2022).

To present different alternatives of incentives granted internationally by governments and other private institutions, this paper conducts a search in different countries of such ways to economically encourage the penetration of electric power in maritime and river modes around the world. This work is derived from the research entitled Ferrofluvial 4.0, funded by the Mining and Energy Unit - UPME and the Ministry of Science, Technology and Innovation of Colombia, with the objective of: Formulating a plan for the penetration of electromobility in the rail and river modes for both cargo and passengers, through the evaluation and prioritization of technological alternatives in order to generate a roadmap that strengthens the productive linkages of the country in the medium and long term.

The identification of economic incentives at the global level is fundamental for the Colombian government and other countries to be able to deploy policies and programs aimed at getting

stakeholders to appropriate these technologies and thus achieve the environmental commitments agreed upon at the national and international level.

Methodology

To find different financing mechanisms to encourage the use and development of electromobility in Colombia in the maritime and river modes, an analysis was made of these actions in different countries of the world considered as a reference for Colombia and which are recognized for their performance in this area.

The countries in which information was sought were Colombia, Argentina, Brazil, Ecuador, Chile, Uruguay, Costa Rica, Sweden, Norway, Spain, Germany, Holland, the United States, Canada and Japan.

Through extensive research in official government documents, as well as institutions and organizations within the transportation sector, a meticulous analysis has been conducted. Additionally, a wide range of technical reports and scientific articles related to the topic have been considered. This rigorous approach has enabled the identification of various incentives implemented in different countries. Based on these findings, a comprehensive proposal of short-term, medium-term, and long-term incentives has been developed to stimulate the adoption of electromobility solutions in Colombia. These initiatives aim to drive a transition towards a more sustainable transportation system, providing economic and environmental benefits in the process.

It is crucial to recognize that this proposal is built upon successful international experiences and takes into account the specific characteristics and needs of Colombia. By incentivizing the penetration of electromobility in the country, significant economic advantages can be achieved, such as reducing dependence on fossil fuels. Moreover, it will make a substantial contribution to greenhouse gas emissions reduction and climate change mitigation, aligning with global sustainability commitments.

Incentives for electromobility

As a result of the review of possible incentives applicable in the maritime and river mode in 15 countries analyzed, it was not possible to find economic support alternatives in Colombia, Chile, Ecuador and Uruguay. The incentives found in the rest of the countries are:

In the Latin American context, incentives were found granted in Argentina through Resolution No. 50 of 2017: Bonus for sustainable ships¹- General Ports Administration, which offers discounts between 5% and 10% to vessels that have low gas emissions and are environmentally friendly. In Brazil it was possible to find Discounts for sustainable ships in the Port of Pecém², in which up to 10% can be discounted in the rate for the use of berthing facilities for "sustainable ships". In Costa Rica, the Green Hydrogen Law³, grants tax exemptions, levies, fees or contributions, as well as immigration waivers for foreigners who invest in green h₂ and specific credits with terms, interest rates, guarantees and special procedures, with a duration of 15 years from the law's entry into force.

In the U.S. context, there is the FAST Electricity Act 2021⁴, which establishes a 30% investment tax credit for any electric propulsion vehicle that is not an on-highway passenger car or truck. In addition, there is the EPA's Port Initiative⁵, which provides funding to port authorities and public entities to

¹ Bonuses for ships (May 2, 2017). Retrieved from Official Portal of the Government of Argentina: <https://www.argentina.gob.ar/transporte/administracion-general-puertos-se/puertos/bonificaciones>

² Pecém grants discounts for sustainable ships and becomes the first Brazilian port to be recognized by the Dutch foundation (August 5, 2020). Retrieved from Governo do Estado do Ceará: <https://www.ceara.gov.br/2020/06/05/pecem-se-torna-primeiro-porto-brasileiro-reconhecido-por-fundacao-holandesa-ao-conceder-descontos-para-navios-sustentaveis>

³ Costa Rica: the Green Hydrogen Bill passes a new stage on its way to approval (December 3, 2021). Retrieved from Strategic Energy: <https://www.energiaestrategica.com/costa-rica-el-proyecto-de-ley-de-hidrogeno-verde-supera-una-nueva-instancia-camino-a-su-aprobacion/>

⁴ The Fast Electricity Act (2021). Retrieved from Web Portal Maria Cantwell United States Senator for Washington: <https://www.cantwell.senate.gov/imo/media/doc/FAST%20Electricity%20Act%20Sliddeck%20May%202021.pdf>

⁵ Alternative Fuels Data Center: Ports Initiative (2022). Retrieved from U.S. Department of Energy Web Portal: <https://afdc.energy.gov/laws/325>

help them overcome barriers to the adoption of cleaner diesel technologies and strategies. There is also the Clean Vessel Incentive Program Port of New York / New Jersey⁶, which rewards vessels for using shore power and the cleanest vessels according to the ESI score, values can be found on the Port's Official Port Portal and Public Law 117-58. Port Infrastructure Development Program until 2026⁷ that provides financing for projects that allow the development of port infrastructure of GHG polluting ports.

Canada has the Salish Sea Marine Emission Reductions Fund⁸ which allows financing the purchase and installation of technology to reduce emissions in the operation of ships. This can be directed to fleet modernization, change of fleet or marine vessel to electric, hybrid or zero-emission technology, hull or propeller modifications, etc. Per fiscal year, funding will not exceed \$250,000 per nonprofit recipient and \$200,000 per for-profit recipient. In this country there is also the Clean Technology Initiative⁹ which allows the financing of pilot projects with clean technologies in maritime mode and the EcoAction Program - Port of Vancouver¹⁰, which offers reductions in port duty rates for shipping companies according to the qualification obtained in the following ranges:

Gold: port duty rate reduced by 47%; **Silver:** port duty rate reduced by 35% and **Bronze:** port duty rate reduced by 23%.

In the European context Sweden has the Electricity

tax exemption for onshore power supply¹¹, an incentive that grants an exemption from electricity tax for onshore power supply in ports. The tax rates that would normally be payable are SEK 293 (EUR 33.94) per MWh or SEK 185 (EUR 21.43) per MWh in northern Sweden and the Environmental Discount in the port tariff¹², whereby vessels emitting less pollutant gases pay relatively low navigation fees, while vessels generating more emissions pay relatively higher navigation fees. This changes according to each port's price list. In Norway there is the EPI - Environmental Port Index - Port of Bergen¹³, which applies a discount on quay fees, passenger fares and ISPS charges in the port of Bergen.

In Spain there is Directive 2014/94/EU - OPS Master Plan for Spanish ports¹⁴ in which shipowners who switch off their auxiliary engines in port and connect to the electricity grid will receive a subsidy of €9.6/ton of CO₂. Ships will pay as a supply tax the symbolic amount of 0.05 euro cents per k/Wh for switching off their auxiliary engines and connecting to the general grid. In the United Kingdom there is the Environmental Ship Index Program - Port of London Authority¹⁵, in which ships that are registered in the Environmental Ship Index scheme will receive a discount on their Vessel Conservancy Charges (excluding Estuary Charge) if they comply with the requirement established in the tariff program in force.

The Netherlands has Directive 2003/96/EC¹⁶,

⁶ *Clean Vessel Incentive Program* (2013). Retrieved from Port Authority of New York and New Jersey: <https://www.panynj.gov/port/en/our-port/sustainability/clean-vessel-incentive-program.html>

⁷ *Alternative Fuels Data Center: Port Infrastructure Development Program* (2021). Retrieved from U.S. Department of Energy Portal: <https://afdc.energy.gov/laws/12734>

⁸ *Salish Sea Marine Emission Reductions Fund* (February 1, 2021). Retrieved from Web Portal Government of Canada: <https://www.canada.ca/en/environment-climate-change/services/environmental-funding/salish-sea-marine-emission-reductions-fund.html>

⁹ *Clean Technology Initiative* (2020). Retrieved from Web Portal of the Port of Vancouver: <https://www.portvancouver.com/environmental-protection-at-the-port-of-vancouver/climate-action-at-the-port-of-vancouver/clean-technology-initiative/>

¹⁰ *EcoAction Program* (January 12, 2022). Retrieved from Web Portal of the Port of Vancouver: <https://www.portvancouver.com/environmental-protection-at-the-port-of-vancouver/climate-action-at-the-port-of-vancouver/ecoaction-program/>

¹¹ *Decarbonising Maritime Transport: The Case of Sweden* (March 9, 2018). Retrieved from International Transport Forum: <https://www.itf-oecd.org/decarbonising-maritime-transport-sweden>

¹² Becqué, R., Fung, F., & Zhu, Z. (2018). *Incentive schemes for promoting green shipping*. Retrieved from Natural Resources Defense Council: <https://assets.nrdc.org/sites/default/files/incentive-schemes-promoting-green-shipping-ip.pdf>

¹³ *Environmental Port Index* (2022). Retrieved from Official Portal Port of Bergen: <https://bergenhavn.no/wp-content/uploads/2021/12/Prices-terms-conditions-Port-of-Bergen-2022.pdf>

¹⁴ *Puertos del Estado promotes the exemption of the tax on electricity supply to ships at berth* (2018). Retrieved from Portal Web Portal Ministerio de Transportes, Movilidad y Agenda Urbana del Gobierno de España: <https://www.puertos.es/es-es/Paginas/Noticias/ProyectoOPS2018.aspx>

¹⁵ *ESI Incentives*. Retrieved from the Environmental Port Index Web Portal: <https://www.environmentalshipindex.org/ports>

¹⁶ *Reduced tax rate on electricity supplied directly to ships at berth in port* (September 14, 2020). Retrieved from Official European Commission Portal: <https://eur-lex.europa.eu/legal-content/ES/TXT/HTML/?uri=CELEX:52020PC0497&from=EN>

which is a measure to apply a reduced tax rate of 0.50 EUR/MWh to installations that supply electricity entirely or almost entirely (90% or more) to non-private ships and pleasure craft. There is also the Environmental Ship Index Discount - Port of Rotterdam¹⁷, which gives a 10% discount on the port fee to ships that perform above the legal standard. The discount applies to all ships with an ESI score of 31 or more at the time of arrival (ATA) in Rotterdam. The discount is doubled if the ship also has an individual ESI-NOx score of 31 or more. This discount applies to each call in a quarter, with a maximum of 20 calls per ship per quarter.

The Netherlands also has the Incentive Scheme Climate - Friendly Shipping - Port of Rotterdam¹⁸ which aims to give an incentive contribution and amounts to a maximum of 40% of the costs to support projects that may be difficult to implement without financial assistance. There is also the Port of Rotterdam's Green Award Vessel Discount¹⁹, in which the Port Authority will grant vessels with a Green Award certificate between 15% - 30% discount on port charges when they arrive in Rotterdam and the Port Charge Discounts for electric and low GHG emission vessels in the Port of Amsterdam²⁰, an incentive where inland vessels with Green Award labels can receive up to 20% discount on port charges for inland navigation.

In Germany there is the Environmental Ship Index Program - Port of Rostock²¹ which grants a 5% discount on port fees for ships that score 40 points or more, a 7.5% discount on port fees for ships that score 50 points or more, and a 10% discount on port fees for ships that score 60 points or more.

There is also the Blue Angel - Port of Hamburg²² which grants a 2% discount on the environmental component of the port fee for vessels with Blue Angel certification and the Green Award Program - Port of Hamburg²³ which generates a 3% discount on port fees for oil tankers, chemical tankers and methane tankers of any size that have the Green Award certificate.

In Asia, Japan has the Environmental Ship Index Program - Port of Tokyo²⁴ which grants a 30% discount on port fees for vessels with an ESI score between 20.0 and 29.9, a 40% discount on port fees for vessels with an ESI score between 30.0 and 39.9 and a 50% discount on port fees for vessels with an ESI score over 40.0. They also have the Green Award Program - Nagoya Port Authority²⁵ which offers a 10% discount on port fees for all Green Award certified maritime vessels and the Environmental Ship Index Program - Port of Yokahoma²⁶ which in turn grants a 15% discount on port fees for vessels with ESI scores over 30 points.

Possible incentives acquired from electric charging infrastructure benefits.

The incentives presented in the previous section are those found specifically to enhance electromobility in river and maritime modes. However, it is possible to find a set of incentives associated with the recharging infrastructure in these countries that, although they are mostly aimed at land transport, can serve as a guide to produce incentives in river and maritime modes. Among the initiatives found along these lines, the most common were:

¹⁷ *Environmental Ship Index Discount* (2015). Retrieved from Official Portal Port of Rotterdam: <https://www.portofrotterdam.com/en/sea-shipping/seaport-dues/environmental-ship-index-discount>

¹⁸ *Incentive Scheme Climate-Friendly Shipping* (January 1, 2019). Retrieved from Official Portal Port of Rotterdam: <https://www.portofrotterdam.com/en/port-future/energy-transition/incentive-scheme-climate-friendly-shipping>

¹⁹ *Green Award Discount* (2022). Retrieved from Official Portal Port of Rotterdam: <https://www.portofrotterdam.com/en/sea-shipping/seaport-dues/green-award-discount>

²⁰ *Greenaward* (2021). Retrieved from greenaward: <https://www.greenaward.org/inland-shipping/faq/>

²¹ *ESI Incentives*. Retrieved from the Environmental Port Index Web Portal. <https://www.environmentalshipindex.org/ports>

²² *Special Terms and Conditions applicable to Maritime Shipping* (1 January 2022) Retrieved from the Hamburg Port Authority Web Portal https://www.hamburg-port-authority.de/fileadmin/user_upload/Hafengeld_Seeschiffahrt/Port_of_Hamburg-STC-Maritime-Shipping_as_of_01.01.2022_issued_27.09.2021.pdf

²³ *List of Incentive Providers*. Retrieved from the Green Award Web Portal <https://www.greenaward.org/sea-shipping/incentive-providers/list-of-incentive-providers/>

²⁴ *ESI Incentives*. Retrieved from the Environmental Port Index Web Portal <https://www.environmentalshipindex.org/ports>

²⁵ *List of Incentive Providers*. Retrieved from the Green Award Web Portal <https://www.greenaward.org/sea-shipping/incentive-providers/list-of-incentive-providers/>

²⁶ *ESI Incentives*. Retrieved from the Environmental Port Index Web Portal. <https://www.environmentalshipindex.org/ports>

In Brazil, Resolution 819 of 2018²⁷ was found, which allows those interested in providing the service (distributors, gas stations, shopping centers, ventures, etc.) to charge for the electric car charging service. In Uruguay, the Regulatory Decree 02/12 of Law 16.906²⁸ allows the exemption from Wealth Tax of fixed assets included in paragraphs A) and B) of Article 7, acquired as from the effective date of this law. The referred goods will be considered as taxable assets for the purposes of deduction of liabilities and generates an exoneration of the Value Added and Specific Internal Taxes, corresponding to the import of the goods referred to in the previous paragraph, and refund of the Value Added Tax included in the acquisitions of these goods. Decree 57/022 - UTE Commercial Discount²⁹, which allows the change of the contracted power at no cost, off-peak tariff (0 to 7AM) at 50% in UTE recharge stations, medium consumer and double residential tariffs at 50% in off-peak hours (from 6 to 10 PM).

In Ecuador, the National Finance Corporation³⁰ will cover 70% of the costs of new projects and up to 100% of expansion projects, while the Organic Energy Efficiency Law (LOEE)³¹ offers preferential financing conditions for energy efficiency projects. The regulation will establish preferential rates for public and private electric transportation and incentives for a 10-year period to encourage the use of electric vehicles, such as exempting these vehicles from traffic restrictions due to congestion.

In Costa Rica there is Law 9518 - Law of Incentives

and Promotion for Electric Transportation³² that allows the exemption of the total payment of the selective consumption tax, established in Law No. 4961, Tax Reform Law; Law No. 6826, General Sales Tax Law, and the one percent tax on the customs value established in Law No. 6879, to parts necessary for the installation of recharging centers.^o 6826, General Sales Tax Law, and from the one percent tax on the customs value established in Law No. 6879, to the parts necessary for the installation of the recharging centers, duly defined in the list to be prepared via regulation, by the Ministry of Environment and Energy (Minae). This exemption is valid for five years, as from the publication of this law. In addition, there is Decree N° 41092-IMINAE-H-MOPT³³ in which the parts of the recharge centers may be exempted from Selective Consumption Tax, General Sales Tax, Customs Value Tax (Law N° 6879 modified by Law N° 6946).

In the United States, the Energy Efficiency 2021 program was found³⁴, which is a Zero Emission Airport Vehicle and Infrastructure Pilot that provides financing to airports for up to 50% of the cost to acquire ZEVs and install or modify the supporting infrastructure for the acquired vehicles. It also allows financing of up to 80% of project costs and will be available for both development phase planning activities and the acquisition and installation of alternative fuels or charging infrastructure.

In Canada, the BC Hydro³⁵ could be found which offers incentives in different categories such as:

²⁷ *Regulatory Resolution No. 819*. (June 19, 2018). Retrieved from National Press Portal: https://www.in.gov.br/materia/-/asset_publisher/Kujrw0TZC2Mb/content/id/28737289/do1-2018-07-05-resolucao-normativa-n-819-de-19-de-junho-de-2018-28737273

²⁸ *Regulation of the methodology for the evaluation of investment projects* (February 2, 2012). Retrieved from Official Information Center: <https://www.imo.com.uy/bases/decretos/2-2012>

²⁹ *Decree 57/022: Commercial discount of UTE*. (February 11, 2022). Retrieved from Portal Web Moves Gobernación de Uruguay: <https://moves.gub.uy/wp-content/uploads/2021/04/Promocio%CC%81n-movilidad-ele%CC%81ctrica.pdf>

³⁰ *Ley de régimen Tributario Interno* (August 21, 2018). Retrieved from Portal web Gobierno de Ecuador: <https://www.ces.gob.ec/lotaip/2018/Agosto/Anexos-literal-a2/LEY%20DE%20REGIMEN%20TRIBUTARIO%20INTERNO,%20LRTI.pdf>

³¹ *The Organic Law on Energy Efficiency entered into force* (March 25, 2019). Retrieved from Pérez Bustamante & Ponce Web Portal: <https://www.pbplaw.com/es/la-ley-organica-de-eficiencia-energetica-entro-en-vigencia/>

³² *Costa Rican Legal Information System*. (January 25, 2018). Retrieved from Incentives and promotion for electric transportation: http://www.pgrweb.go.cr/scij/Busqueda/Normativa/Normas/nrm_texto_completo.aspx?param1=NRTC&nValor1=1&nValor2=85810&nValor3=117391¶m2=1&strTipM=TC&lResultado=3&strSim=simp

³³ *Reglamento de incentivos para el transporte eléctrico*. (April 10, 2014). Retrieved from Portal Oficial Sistema Costarricense de Información Jurídica: http://www.pgrweb.go.cr/scij/Busqueda/Normativa/Normas/nrm_texto_completo.aspx?param1=NRTC&nValor1=1&nValor2=86581&nValor3=112394&strTipM=TC

³⁴ *Energy Efficiency* (2021). Retrieved from Electricity Laws and Federal Incentives: <https://afdc.energy.gov/fuels/laws/ELEC?state=US>

³⁵ *Rebates for home EV chargers in Canada* (2021). Retrieved from Chargehub: <https://chargehub.com/en/charging-stations-incentives-in-canada.html>

rebate of up to 50% of the costs to purchase and install an eligible Level 2 EV charger, up to a maximum of \$700 for single-family homes, including duplexes and townhouses with private garages or dedicated parking; rebate of up to \$3,000 for the creation of an EV Ready plan for Apartment Buildings and condominiums; reimbursement of up to \$4,000 per charger, up to a maximum of \$14,000, to purchase and install Level 2 on-grid electric vehicle chargers for workplaces; and reimbursement of up to 75% of eligible EV charger purchase and installation costs for Indigenous communities. Also, in this country

The Fortis BC³⁶ has a rebate of up to 50% of the purchase and installation costs of an eligible Level 2 EV charger, up to a maximum of \$700 and a rebate of up to 50% of the eligible purchase and installation costs*, up to \$4,000 per station, up to a maximum of \$14,000 per application; the Manitoba Hydro³⁷ with a maximum eligible amount for financing is \$3,000 per EV charger, including installation, the Arctic Energy Alliance³⁸ with A rebate of up to \$500 for a Level 2 charger (220 or 240 volt), the Home Energy Loan Program³⁹ in which Toronto homeowners can obtain a low-interest loan of up to \$75,000 to cover the cost of home energy improvements. These include the installation of chargers for their EVs and The Roulez vert Program⁴⁰ with rebates of up to \$600 for the purchase and installation of a Level 2 EV home charging station.

In Sweden there is the Electric Vehicle Charging Incentive under Commission Regulation (EU) No. 1407/2013⁴¹, which covers the cost of up to 50%

³⁶ *Rebates for home EV chargers in Canada* (2021). Retrieved from Chargehub: <https://chargehub.com/en/charging-stations-incentives-in-canada.html>

³⁷ *Rebates for home EV chargers in Canada* (2021). Retrieved from Chargehub: <https://chargehub.com/en/charging-stations-incentives-in-canada.html>

³⁸ *Rebates for home EV chargers in Canada* (2021). Retrieved from Chargehub: <https://chargehub.com/en/charging-stations-incentives-in-canada.html>

³⁹ *Rebates for home EV chargers in Canada* (2021). Retrieved from Chargehub: <https://chargehub.com/en/charging-stations-incentives-in-canada.html>

⁴⁰ *Rebates for home EV chargers in Canada* (2021). Retrieved from Chargehub: <https://chargehub.com/en/charging-stations-incentives-in-canada.html>

⁴¹ *Förordning (EU) nr 1407/2013: Ladda bilen* (18 December

of the equipment for powering electric vehicles, up to a maximum cost per charging point of up to SEK 10,000 (€1,000) for individuals and SEK 15,000 (€1,500) for companies, municipalities, councils, and institutions. In Spain there is Royal Decree 569/2020 - Plan MOVES II⁴² in which citizens with private vehicles and company vehicles can receive subsidies of between 30-40% (up to a total amount of 100,000€) of the cost of purchase and installation of public or private chargers and Royal Decree 266/2021 - Plan MOVES III⁴³ with Subsidies of up to 80% for private vehicles, self-employed and for the administration without economic activity and subsidies of up to 60% for companies and public entities with economic activity. There is also Decree 72/2019⁴⁴ for electric vehicle charging infrastructure, which offers a subsidy of 30% of the eligible cost for private companies and 40% for individuals.

In Norway you can find Free Charging Chips - Fortum⁴⁵ to encourage electric mobility, making it easier for EV owners to experience charging in public parking lots and the Free EV Charging incentive in the municipality of Asker⁴⁶ which offers free charging of electric vehicles in parking lots in the center of Asker municipality. There are also EVSE (Charging Station Installation) Grants for Housing Associations in Oslo⁴⁷ for a maximum of 20% of the EVSE investment and installation costs, up to NOK 5000 (€450) per charging point and NOK 1 000 000 (€91 000) per housing association

2013). Retrieved from Naturvardsverket: <https://www.naturvardsverket.se/bidrag/ladda-bilen/>

⁴² *General Provisions MOVES II Program* (June 17, 2020). Retrieved from Portal Agencia Estatal Boletín Oficial del Estado: <https://www.boe.es/boe/dias/2020/06/17/pdfs/BOE-A-2020-6235.pdf>

⁴³ *MOVES III Program* (April 13, 2021). Retrieved from Portal Oficial Instituto para la Diversificación y Ahorro de la Energía: <https://www.idae.es/ayudas-y-financiacion/para-movilidad-y-vehiculos/programa-moves-iii>

⁴⁴ *Royal Decree 72/2019*. (February 15, 2019). Retrieved from Portal Agencia Estatal Boletín Oficial del Estado: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2019-2148

⁴⁵ *Ladebrikke for elbil*. (2022). Retrieved from Fortum: <https://www.fortum.no/privat/lade-elbil/lade-pa-ladestasjoner/ladebrikke-elbil>

⁴⁶ *Lademuligheter for elbil* (December 22, 2021). Retrieved from Asker kommune: <https://www.asker.kommune.no/vei-trafikk-og-parkering/parkering/lademuligheter-elbil/>

⁴⁷ *Ladeinfrastruktur til borettslag og sameier* (2022). Retrieved from klimatilskudd: <https://klimatilskudd.no/ladeinfrastruktur-til-borettslag-og-sameier>

or co-ownership, where external consultancy and engineering costs can be included in the grant costs; the EVSE (Installation of Charging Stations) Grants for Housing Associations in Skedsmo⁴⁸ for a maximum of 20% of the EVSE investment and installation costs, up to NOK 5000 (€450) per charging point and NOK 250,000 (€23,000) per housing association or co-ownership; and EVSE (Charging Station Installation) Grants for Housing Associations in Asker⁴⁹ for a maximum of 50% of the cost of and installation of EVSE, up to NOK 5000 (€450) per charging point and NOK 50000 (€4500) per housing association.

In the Netherlands there is the Environmental Investment Allowance for Companies (MIA)⁵⁰ which is a subsidy that allows the company to deduct a percentage of its investment costs from taxable profit. This is in addition to regular depreciation. And as a result, the company pays less tax. The percentage of the deduction depends on the company's operating assets and the environmentally friendly investments that qualify on the Environmental List among them. Using the MIA, companies can receive an investment deduction of up to 36% of the amount invested in a charging point.

In Germany you can find the KfW-Bank Incentive for charging stations (private)⁵¹ which grants a subsidy of 900 euros per charging point, the Program: Public charging infrastructure for electric vehicles in Germany (2021 - 2025)⁵²,

which, according to the type of grid connection the financing can vary up to a maximum amount of 10,000 euros. And depending on the type of charging point the installation can be financed up to 60% which is equivalent to 20,000 euros and the NRW-FÖRDERUNG, North Rhine-Westphalia⁵³ which depending on the type of applicant and the characteristics of the system, the financing can be up to 1,500 euros.

In the UK there is the EV charger grant for homes⁵⁴ which offers a subsidy of up to 75% of the total cost of purchasing and installing EV chargers for the home. Company cars and leased cars can also apply for the incentive and the On-Street Residential Charge point Scheme (ORCS)⁵⁵ in which local authorities can receive a grant to partially fund (75%) the capital costs associated with the purchase and installation of on-street EV charging point infrastructure in residential areas⁵⁶.

In Japan there is a subsidy for the purchase and installation of charging points - Tokyo⁵⁷ that allows subsidizing the purchase cost of charging equipment, construction and installation costs, energy conversion equipment, solar energy generation systems and storage batteries, as well as equipment operation costs.

Analysis of possible types of incentives

From the review of incentives, a total of 26 economic incentive programs and initiatives were found to promote electromobility in maritime

⁴⁸ *Tilskudd til ladeinfrastruktur i sameier og borettslag* (July 26, 2021). Retrieved from Viken: <https://viken.no/tjenester/tilskudd-og-stotte/tilskudd-og-stotte-viken/tilskudd-til-ladeinfrastruktur-i-sameier-og-borettslag.20237.aspx>

⁴⁹ *Lading av elbiler i boligselskap i Asker kommune* (May 7, 2021). Retrieved from Asker kommune: <https://www.asker.kommune.no/klima-og-miljo/tilskudd-til-lading-for-elbiler-i-boligselskap/>

⁵⁰ *Wijzigingen in de Milieulijst MIA*. (2022). Retrieved from Rijksdienst voor Ondernemend Nederland: <https://www.rvo.nl/subsidie-en-financieringswijzer/miavamil>

⁵¹ *Ladestationen für Elektroautos*. Retrieved from Bank Aus Verantwortung Web Portal [https://www.kfw.de/inlandsfoerderung/Privatpersonen/Bestehende-Immobilie/F%C3%B6rderprodukte/Ladestationen-f%C3%BCr-Elektroautos-Wohngeb%C3%A4ude-\(440\)/](https://www.kfw.de/inlandsfoerderung/Privatpersonen/Bestehende-Immobilie/F%C3%B6rderprodukte/Ladestationen-f%C3%BCr-Elektroautos-Wohngeb%C3%A4ude-(440)/)

⁵² *Bundesministerium für Verkehr und digitale Infrastruktur*. Retrieved from Bundesanstalt für Verwaltungsdienstleistungen Web Portal https://www.bav.bund.de/DE/4_Foerderprogramme/6_Ladeinfrastruktur_fuer_Elektrofahrzeuge/6_2_Ladeinfrastruktur_oeffentlich/Ladeinfrastruktur_oeffentlich_node.html

⁵³ *NRW-FÖRDERUNG*. Retrieved from the Web Portal of ElektroMobilität NRW <https://www.elektromobilitaet.nrw/foerderprogramme/nicht-oeffentlich-zugaengliche-ladeinfrastruktur/>

⁵⁴ *Electric Vehicle Homecharge Scheme: vehicle applications*. Retrieved from the UK Government's Web Portal <https://www.gov.uk/government/publications/electric-vehicle-homecharge-scheme-vehicle-applications>

⁵⁵ *On-street Residential Chargepoint Scheme*. Retrieved from Energy Saving Trust Web Portal <https://energysavingtrust.org.uk/grants-and-loans/street-residential-chargepoint-scheme/>

⁵⁶ *EV and EV Charging Incentives in the UK*. Retrieved from the Wallbox Web Portal <https://blog.wallbox.com/en/ev-and-ev-charging-incentives-in-the-uk-a-complete-guide/>

⁵⁷ *Subsidies for installation of charging points*. Retrieved from the Web Portal of the Tokyo Metropolitan Center for Climate Change Action <https://www.tokyo-co2down.jp/subsidy/mansion-evcharge>

and river modes in the countries analyzed. The country with the highest number of incentives was the Netherlands with a total of 5 initiatives, followed by the United States with 4 and Canada, Germany and Japan with 3 each. Sweden had 2 incentives and the rest of the countries (Argentina, Brazil, Costa Rica, Norway, Spain and the United Kingdom) had 1 initiative.

In these initiatives it was possible to find different types of incentives, which can be grouped into the following typologies:

- A: Discounts to vessels in ports (port taxes/traffic rights)
- B: Financing equipment or infrastructure for electromobility
- C: Tax exemptions/reductions
- D: Guarantees and special procedures for electromobility projects
- E: Financing to port authorities

Table 2 shows the implementation of these incentives in the countries analyzed (using the above notation), from which the most recurrent type of incentive are discounts to vessels in ports (port fees/circulation rights), followed by the financing of equipment or infrastructure for electromobility and tax exemptions/reductions.

Table 1. Incentive proposals for Colombia.

Country/Incentive	A	B	C	D	E
Argentina	x				
Brazil	x				
Costa Rica		x	x	x	
United States	x	x			x
Canada	x	x			
Sweden	x		x		
Norway	x				
Spain	x				
United Kingdom	x				
Netherlands	x		x		
Germany	x				
Japan	x				

While examining the economic incentives, various certification programs were identified, which serve as evidence of the vessels' ecological contributions. These programs are utilized by authorities to determine eligibility for the aforementioned economic benefits. The identified certification programs include:

Blue Angel

One notable environmental certification is the renowned German label, which serves to assess the ecological performance of services and ensures that transactions are carried out without significant adverse effects on the environment [19]. BlueAngel certification encompasses various activities, including the operational aspects and design considerations of ships (*Blue Angel, n.d.*). This certification allows stakeholders, including authorities and consumers, to identify and support environmentally friendly shipping practices. Additionally, this certification program holds immense value in the realm of sustainability, transportation, and economics.

Clean Shipping Index (CSI)

The Clean Shipping Index (CSI) serves as a valuable tool in assessing ships based on their air and water emissions, waste management practices, and staff training initiatives. This comprehensive evaluation goes beyond regulatory requirements and measures the environmental performance of vessels. Depending on the scores obtained, ships can receive certification ranging from one to five stars, with five being the highest score (*Clean Shipping Index, 2022*). This certification system plays a crucial role in promoting sustainability within the shipping industry. It is essential to highlight the significance of the Clean Shipping Index in driving environmental responsibility in maritime operations. By evaluating various aspects of a ship's performance, including emissions and waste management, the CSI incentivizes companies to go above and beyond regulatory compliance. This promotes the adoption of cleaner technologies, fuels, and practices, ultimately contributing to a greener and more sustainable shipping industry.

The Green Award

Green Award is a renowned certification program that prioritizes safety, security, and environmental considerations within the shipping industry. It acknowledges and incentivizes adherence to rigorous environmental and safety standards. The certification process encompasses a wide range of environmental impacts, including air emissions such as sulfur oxide (SOX), nitrogen oxide (NOX), carbon dioxide (CO2), and particulate matter (PM/BC). Additionally, it addresses issues related to energy efficiency, antifouling paints, oil management, lubrication of mooring ropes, and other deck equipment. Furthermore, Green Award evaluates emissions to waters, such as ballast water, sewage, sludge, bilge, and waste management (*Green Award, 2022*).

Environmental Ship Index (ESI)

The Environmental Ship Index (ESI) is a tool that was established by the World Ports Climate Initiative in 2011 to help reduce emissions of NOX, SOX, particulates, and CO2. The scoring in the ESI system is based on the emissions of these gases as well as the vessel's ability to use shore power supply. To receive a score in the ESI system, the vessel must have emissions that are lower than the legal requirement for NOX and SOX. The ESI score ranges from 0 to 100, with a higher score indicating better environmental performance (*ESI, 2022*).

Proposal for economic incentives for Colombia

Colombia is positioned as one of the Latin American countries with more development of electromobility policies and benefits granted to acquire electric vehicles in the road mode. However, this commitment is null for maritime and river modes, since there are no incentives in the country to promote electromobility in these modes of transport, except for a project initiative in the Amazon River that seeks to implement the use of boats powered by electric motors or solar panels. It is therefore necessary that this good

practice in the road mode be extended to other modes of transportation.

A good way forward is to adopt the initiatives and incentives that other countries are implementing and that can be applicable to some specific regions of the country or in the country in general, considering the orientation and objectives that Colombia has set for itself in terms of greenhouse gas reduction. Among the aspects to be prioritized in these incentives are the development of infrastructure, modernization of passenger transport fleets, recovery of docks, science, and technology projects. Taking as a basis some of the incentives that are in force or that have been implemented in other countries can represent an advantage to design incentives that can bring benefits for the economy, the environment and society.

Based on this analysis of incentives, the following incentives can be proposed for Colombia (See Table 1), which are presented for different time horizons and include the percentage of financing, discount, or exemption for the aspects to be favored in the maritime and river modes.

Table 2. Incentive proposals for Colombia.

Type of incentive	Short term.	Medium term.	Long term.
Insurance premium discounts.	20%	15%	10%
Discounts on mechanical overhauls	15%	10%	5%
Reduction and exemption of import duties.	100%	70%	50%
Income tax reduction on infrastructure investments.	50%	35%	20%
Reduction in port fees for low-emission vessels.	10%	5%	5%
Reduction or exclusion of VAT on the purchase of goods and services for electromobility projects.	0%	5%	19%
Financing of research projects.	100%	100%	100%
Financing of river projects up to 70% of the project by the national government	70%	70%	70%

Conclusions

In the review different initiatives and actions were found in the analyzed countries aimed at generating incentives for electromobility in river and maritime transportation, thus allowing the migration to environmentally friendly modes of transportation. A total of 26 different initiatives were found, most of which were aimed at generating discounts in ports for the use of environmentally friendly vessels, as well as financing projects for the acquisition of equipment and infrastructure and tax reductions.

This article demonstrates the interest of different countries in promoting electric mobility in maritime and river modes, finding more incentives in one country than in another, but in any case, it is an important commitment to generate sustainable transport systems. In the case of the Latin American countries studied, only in Brazil, Argentina and Costa Rica were initiatives of this kind found, which is an opportunity for the other countries to follow suit.

The regulations and policies on electric mobility in Colombia are oriented towards the electrification of road transport and there are no incentives to promote electric mobility in the maritime and river modes. Nor were any incentives identified that could favor the development of maritime or river electric cargo infrastructure. In order to strengthen this aspect, a set of short-, medium- and long-term incentives were proposed to favor investments in this area in the country.

As future work, there is a potential to expand the analysis to encompass additional countries, thereby uncovering alternative forms of initiatives and incentives. Furthermore, it is crucial to conduct further research to identify the financing mechanisms available to governments, which would facilitate the implementation of these initiatives and incentives. Understanding the avenues through which governments can secure funding is essential for effectively materializing such endeavors.

It is imperative to emphasize the importance of broadening the scope of analysis to gain a

comprehensive understanding of the global landscape. Exploring initiatives and incentives implemented in diverse countries can shed light on innovative approaches and best practices that can be adapted to local contexts. Additionally, investigating the financing mechanisms will enable governments to allocate resources effectively and foster the development of sustainable transportation systems.

By expanding the analysis and delving into the financial aspects, researchers and policymakers can foster the creation of a supportive environment that encourages the generation and implementation of impactful initiatives and incentives in the transportation sector.

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