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Management of the end-of-life vehicle recycling in the Caribbean

Introduction

The Caribbean faces mounting challenges related to the management of end-of-life vehicles (ELVs). The increasing influx of vehicles, in the face of limited land availability and environmental vulnerabilities, demands a comprehensive and sustainable approach to ELV recycling. The increase in vehicle importation over the past three decades has been made possible, in part, by economic factors such as increased incomes associated with economic growth, as well as social factors such as urbanization and lifestyle preferences which demand greater independence and private mobility (Phillips et al, 2023). Perhaps the most significant impetus however has been the importation and availability of used vehicles, sourced at significantly reduced costs from South-East Asia (Japan, Singapore and South Korea). Today, such imports have resulted in high vehicle population ratios, ranging from between 0.45 to 0.95 for many Caribbean countries. Along with this vehicle intensity has come congestion and other social impacts, which manifest themselves in the form of growing rates of motor-vehicle fatalities and high-risk driving behaviour such as road rage. Additionally, the large number of vehicles within the limited geographic confines of small islands has produced other environmental, health and safety impacts from the disposal of expired oils, lubricants, metals, fuels, tyres, lead-acid batteries, plastics, electronics and other ELV components.[1]

Policy considerations

- **Conduct a comprehensive end-of-life vehicle (ELV) sector assessment including considering economies of scale.**
- **Develop and forward-looking ELV management framework that anticipates and adapts the technological shifts in the automotive industry and the need for circular economy principles.**
- **Invest and foster a skilled workforce through training and education in the management of ELV recycling including keeping abreast of technological advancements.**
- **Incentivize private sector participation and partnerships in ELV recycling.**
- **Leverage trade policies for sustainable ELV management.**

[1] Processing End-of-Life Vehicles: A Guide for Environmental Protection Safety and Profit in the United States-Mexico Border Area, link: https://www.epa.gov/sites/default/files/2020-10/documents/eol_vehicle_guide_final_english.pdf, cited July 10, 2024.

Driven by the global climate change mitigation requirements, the Caribbean small island developing States (SIDS) are targeting the land transportation sectors to curb greenhouse gas emissions and reduce dependence on fossil fuels. For this subregion, the transport sector accounts for 30% of the total fuel consumed.[2] The recently concluded Fourth International Conference on Small Island Developing States[3] has listed sustainable and resilient land transportation as one of the priority areas, recognizing its critical role in decarbonizing the sector while enhancing climate resilience and fostering all arms of sustainable development.

Image 1: Example of informal road-side vehicle scrappage in Caribbean small island developing States

Source: ECLAC 2024.

This transition to non-fossil fuel-powered vehicles further suggests the prospect for increased rates of end-of-life vehicles abandonment,[4] and related environmental and social consequences over the short to medium term. Hsin-Tien et al (2018) point out that such high level of abandonment is a peculiarity to SIDS, given that they typically do not possess the industrial infrastructure for the management of ELV recyclables such as metals, rubber, glass, plastics, vehicles chemicals (used oil, air conditioning refrigerants and lead acid batteries) and other particulates. Image 1 illustrates a typical roadside informal vehicle scrappage site.

Indeed, notwithstanding the lack of formal statistics, there is considerable empirical evidence[5] which attests to this phenomenon in the Caribbean. In this context, a key policy question that arises is whether there are economic opportunities for undertaking ELV recycling in the subregion and what might be the necessary policy adjustments to mitigate the externality impacts of health, environment and safety. Towards addressing this question, this brief is organized into six sections.

2 The Caribbean Centre for Renewable Energy and Energy Efficiency, Sustainable transport, link: https://www.ccreee.org/our-work/sustainable-transport-programme/, cited July 9, 2024.

3 The Antigua and Barbuds Agenda for SIDS (ABAS), a Renewed declaration for Resilient Prosperity; https://sdgs.un.org/sites/default/files/2024-04/SIDS4%20-%20Co-Chairs%20FINAL.pdf, cited July 9, 2024.

4 Especially likely for Internal Combustion Engine (ICE) vehicles.

5 For example see media references: https://www.soualiganewsday.com/index.php?option=com_k2&view=item&id=47880:community-officer-and-personnel-from-vromi-identify-52-abandoned-vehicles&Itemid=451.
https://www.kaieteurnewsonline.com/2017/01/10/abandoned-vehicles-on-road-shoulders-becoming-a-hazard-on-berbice-roads/.
https://jamaica-gleaner.com/article/news/20220125/derelict- vehicles-be-removed-hanovers-streets.
https://trinidadexpress.com/news/local/corporation-aims-to-rid-city-of-derelict-vehicles/article_eac91c62-a13b-54bf-a389-01b0bc07d1cb.html.
https://www.tha.gov.tt/news/owners-to-pay-penalty-for-derelict-vehicles/.
https://islandroads.com/our-highway-service/managing-the-roads/abandoned-vehicles/.

Recycling markets

As the impacts of human consumption become more apparent with time, recycling is seen as an increasingly important strategy for alleviating society's pressure on the natural environment. Apart from the now well-recognized effects of greenhouse gas emissions on climate; the rapid growth of municipal solid wastes; limited land-fill facilities; the proliferation of non-biodegradable plastics and the increased extraction of minerals have all made very strong cases for more judicious use of the natural resource base.

According to Beukering, Kuik and Oosterhuis (2014), the supply of recyclable waste material in an economy grows in direct proportion to population and is less proportional with respect to household income. This rate of growth is however attenuated with an increase in the price for waste collection services. These authors cite Johnstone and Labonne (2004) who describe this dynamic in economic terms to mean that "household demand for waste services has unitary elasticity with respect to population and is inelastic with respect to income and price".

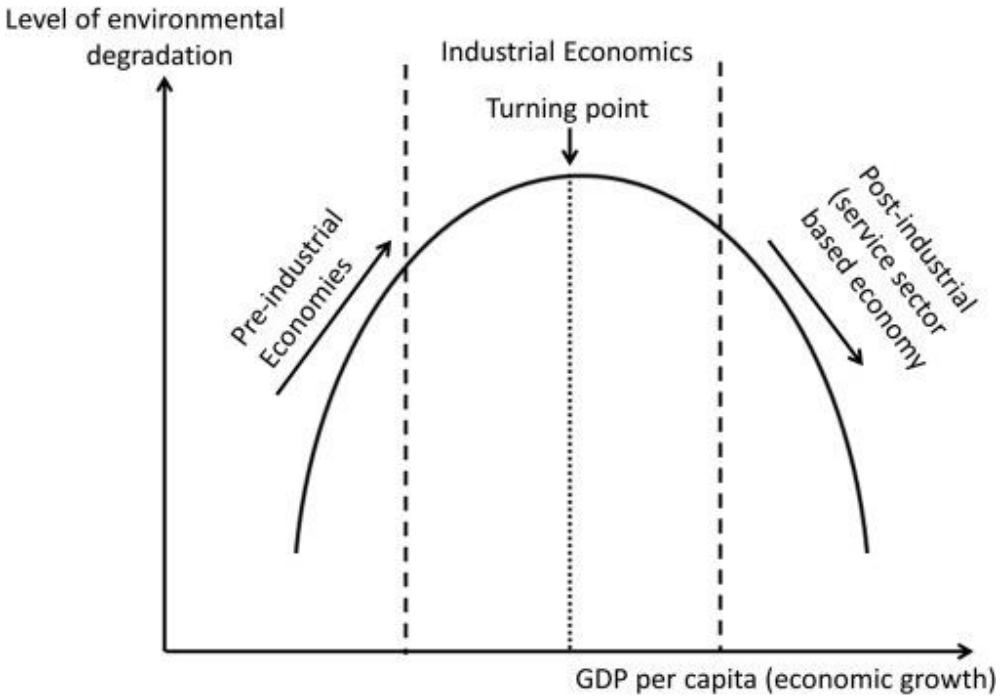
All forms of consumption at the level of the household, and production at the level of firms produce waste. Assuming that the disposal cost of such waste is zero, it is regarded as an economic externality since it does not contribute directly to maximizing consumer utility, or the profit of firms. Disposed materials can, however, become more valuable when their primary materials become scarcer, or as the cost of disposal rises. Primary materials typically include metals, timber, and crude oil which are used for the manufacture of myriad products such as plastics and refined petroleum products. In the case of disposal costs, this might be assessed in terms of the cost of haulage, treatment, and final storage of the waste. Additional indirect disposal costs may also arise over the long term due to deleterious impacts of undisposed or improperly treated wastes, which might in turn cause contamination of air, soil and water, or the creation of other public health hazards and nuisances.

Because of these dynamics, recycling markets are typically highly volatile, particularly in the absence of robust waste management systems and enforcement of regulations. For example, under conditions of high supply of primary materials, the value of recyclables is likely to be low, with high level of disposal. As the price of primary materials increases however, disposed waste materials containing a proportion of primary materials increase in value, thereby incentivizing recyclers to harvest increasing proportions of such waste materials. Ultimately, increased output of recycled materials leads to an oversupply, driving down the price of recyclables once again. However, the implementation of more stringent waste management regulations, while crucial for promoting responsible disposal, can have unintended consequences. If not accompanied by comprehensive compliance enforcement measures, increased disposal costs may incentivize illegal dumping and the improper diversion of waste into recycling streams. This not only undermines environmental goals but also poses risks to public health, ecosystem integrity and the economic viability of legitimate recycling operations. Similarly, where disposal costs[6] or other concomitant costs (health, safety and environmental impacts) to individuals are low, economic agents may dump larger quantities of waste into the environment. At the level of the broader economy, the overall relationship between economic growth and environmental degradation has been characterized by the Environmental Kuznets Curve[7] (EKC) as an inverted U-shaped relationship (diagram 1).

[6] Such as penalties, or indirect consequences such as health impacts or flooding

[7] This relationship is based on the original hypothesis by Kuznets (1955) which posits that there is an inverse U-shaped relationship between economic growth and inequality such that at the early stages, an economy will display high levels of growth alongside high levels of income inequality. This trend is reversed over time as the economy attains a certain level of average income. The EKC mirrors a similar pattern but with respect to the relationship between economic growth and environmental degradation in an economy over time (Kasioumi, 2022).

Diagram 1: The Environmental Kuznets Curve



Source: The Environmental Kuznets Curve provides degradation of the environment in another aspect. Water, Land, and Forest Susceptibility and Sustainability, 2023.

This suggests that as economic growth increases, environmental degradation first increases up to a specific point, after which it declines (Kasioumi, 2022). Applying this concept to end-of-life vehicles reveals two parallel scenarios:

(i) Vehicle consumables: the recycling of vehicle consumables like tires, batteries, and used oil often follows the EKC trajectory. In the early stages of economic growth, informal and often environmentally unsound practices might dominate due to lower costs and less stringent regulations. As economies mature and environmental awareness grows, regulations tighten, and recycling infrastructure improves, leading to more sustainable practices.

(ii) Complete vehicle disposal: managing complete ELVs presents a more complex challenge influenced by a broader range of factors beyond the EKC:

- **Market dynamics:** vehicle depreciation rates, resale values, and the scale of the recycling market significantly impact disposal practices.
- **Regulatory framework:** ELVs categorization as waste is complex due to multi-material composition(s), complexities in the separation and safe management of materials and the many property ownership stages in the life cycle of a typical vehicle.[8] Stringent regulations on vehicle road safety, and disposal, including landfill restrictions and recycling requirements, are crucial drivers of sustainable development practices.
- **Trade and investment policies:** import restrictions on used vehicles and incentives for domestic ELV recycling industries can shape the market.

[8] This includes for example: vendors, owners, users, second-hand domestic and exports markets, collection centres, authorised dismantling facilities, recycling centres, shredders, remanufacturing facilities and industrial/domestic landfill sites, as well as illegal dumping, link: https://www.gefislands.org/HazardousProducts/E-L-V, cited July 9, 2024.

- **Technological capacity:** access to environmentally sound dismantling, handling and recycling technologies is essential for responsible ELV management.
- **Health, safety, and environmental standards:** stringent standards for handling hazardous materials in ELVs are crucial to protect human health and the environment.
- **Labour market considerations:** developing a skilled workforce for ELV dismantling and recycling is essential for a sustainable and socially responsible industry.

In applying the principle of the EKC to ELV recycling markets in the Caribbean, one may surmise that there has been growth in vehicle stocks and use intensity with the economic growth of Caribbean economies over the past five decades. This growth was driven initially by revenue earnings from such sectors as the export of agricultural commodities (sugar and bananas), and subsequently by the extractive industries and expansion of the tourism services sector. Increased vehicle stocks resulted in higher environmental impacts. As these economies mature, greater efforts are being made to mitigate such impacts. The specifics of ELV market evolution are explored in the section which follows.

End-of-life vehicles recycling

ELV recycling has become a worldwide practice as the popularity of the automobile has increased globally. While it has been formally organized and supported by specific legislation in countries and regions such as China, European Union, Japan and South Korea, it is also managed under existing laws in the United States of America (Sakai et al, 2013). In more developed countries, the principal motivation for ELV recycling is to secure secondary raw materials such as metals, plastics and glass for reuse in automobile manufacturing or other industries. This is largely feasible given these countries' scale of economy, and installed industrial complex, with both the technical and human resource capacity for efficiently utilizing such inputs.

For developing countries, however, the inclination towards ELV recycling is mainly to harvest usable spare parts to extend the operational life of vehicles. This is necessary due to incomes levels which constrain the purchase of new vehicles and/or spares, as well as poor public transportation which encourages increased personal vehicle ownership. Such ownership has been made possible through the importation of second-hand vehicles sourced primarily from South-East Asia. Used vehicles are often imported into countries with limited capacity to maintain them and are typically operated on poorly maintained roads which further stimulate the rate of vehicle scrappage in such markets (Numfor et al, 2021). This phenomenon is also evident in the Caribbean, where used vehicle imports have significantly increased over the past three decades (Phillips et al, 2023).

The Caribbean countries have recognized the requirement for the safe management and are participating in a regional project to strengthen the capacity for the environmentally sound management of ELVs.[9] The following national assessments were conducted in 11 participating countries of this project:

- National capacity of environmentally sound management requirements for ELVs.
- Material flow assessment of ELVs including sources and quantities.
- Economic assessment to determine the best approaches for improved financing in ELVs management, considering socioeconomic factors.

Vehicle survivability and scrappage

Across all economies, however, the formulation of any effective ELV recycling strategy would require a determination of the vehicle survival pattern for all

[9] Caribbean Basel Convention Regional Centre of Training and Technology Transfer for the Caribbean, Assessing the management of ELVs in the Caribbean, participating countries are: Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominica, the Dominican Republic, Guyana, Saint Kitts and Nevis, Saint Lucia, Suriname and Trinidad and Tobago: https://www.bcrc-caribbean.org/our-news-events/elvs-assessment-phase-press-release/, cited July 9, 2024.

classes of vehicles. As noted by Hao et al (2011), the vehicle survival pattern describes the change in survival ratio and scrappage rate of a stock of motor vehicles with age. The survival ratio is the number of still operational vehicles in use as a proportion of the stock of vehicles of the same characteristics registered in a specific year. Vehicles scrappage rate is the proportion of vehicles of a specific characteristic that are removed from operations at a particular point in time. Vehicle survival patterns depend on several factors of which, design lifetime, operational conditions (intensity of use, road conditions and level of maintenance) and the existence of compulsory scrappage standards[10] are three of the most important.

Hao et al (2011) describe the vehicle survival pattern characterized by three distinct stages for any stock of vehicles:

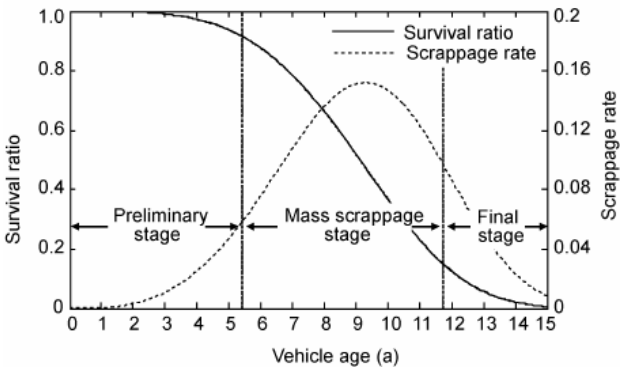
(i)Preliminary stage: during this stage, when vehicles are relatively new, survival ratios exhibit a slow decline from 1 year, as depicted in diagram 2. Scrappage rates are initially low during this phase.

(ii)Mass scrappage stage: as the vehicle stock ages, survival ratios decrease more rapidly, approaching 0 towards the end of this stage. Conversely, scrappage rates rise sharply during this period.

(iii)Final stage: in the final stage, with a dwindling overall vehicle stock, both survival ratios and scrappage rates converge towards 0.

These trends are illustrated in diagram 2.

Diagram 2: Schematic diagram of vehicle survival ratio and scrappage rate functions



Source: Hao et al, 2011.

Research undertaken by the United States National Centre for Statistics and Analysis (2006) indicate that over the past three decades, vehicle survivability ratios have been increasing for this market notwithstanding that vehicles are being driven for higher mileage. Among all classes of light duty passenger vehicles, sport utility vehicles achieved the highest survivability ratios, followed by passenger cars and light trucks. Such measures have not been assessed for Caribbean SIDS but would presumably be lower given the increasing share of used vehicles, differing driving patterns and poorer road conditions when compared to the United States of America.

Although ELV data are not available for many developing countries, table 1 offers some insights on possible scrappage rates based on figures for several economies.

[10] Compulsory scrappage standards and regulatory requirements for vehicles to be removed from the operational stock, based on predefined standards such as age, mileage, or other emissions, safety or performance thresholds.

Table 1 : Global and country/state estimates of automobile ownership and end of life vehicles (2020)

Country/State	Automobile ownership (units)	Deregistered automobiles (units/year)	Number of ELVs (units/year)
European Union	271 319 000	14 077 000	7 823 211
Germany	45 261 188	2 570 137	500 193
Italy	41 649 877	1 835 293	1 610 137
France	37 744 000	2 002 669	1 583 283
England	35 478 652	1 810 571	1 157 438
Spain	27 750 000	996 718	839 637
The Russian Federation	41 224 913	300 000	N/A
Unites States of America	239 811 984	20 419 898	12 000 000
Canada	21 053 994	1 321 658	1 200 000
Brazil	32 100 000	1 058 064	1 000 000
Japan	75 361 876	4 080 000	2 960 000
China	78 020 000	6 000 000	3 506 000
South Korea	17 941 356	849 280	684 000
Australia	15 352 487	600 311	500 000
Subtotal	**792 185 610**	**57 921 599**	**29 673 211**
Global total	**1 016 763 420**	**15 805 275**	**40 176 051**

Source: Sakai et al, 2013.

Policy implications for the Caribbean

a) Assessment of the scale and efficiency of the ELV sector

A key consideration for any successful ELV policy in the Caribbean is the feasibility of achieving a substantial scrappage rate given the relatively small vehicle markets within the subregion. While data from larger and more developed economies suggests that scrappage rates increase for vehicles older than ten years, these markets typically exceed 10 million vehicles.

Given the evidence of increasing vehicle longevity and the limited size of individual Caribbean SIDS vehicle markets, achieving scrappage rates comparable to larger economies and the subsequent scale efficiencies in vehicle salvage operations presents a significant challenge. This challenge is further exacerbated by the fragmented nature of Caribbean vehicle markets. This fragmentation stems from factors such as non-uniform import-export regulations, varying environmental and safety standards, and disparate national policies, all of which contribute to trade, logistical, and transportation hurdles that make it difficult to aggregate scrapped vehicles efficiently and achieve the scale needed for a robust ELV recycling sector.

To foster a sustainable ELV management system in the Caribbean, policymakers should explore opportunities for regional collaboration. This collaborative approach could encompass joint infrastructure development, harmonized regulations and shared resources to achieve economies of scale. At both national and regional levels, policies should prioritize the inherent social benefits of organized ELV management. This includes mitigating environmental hazards and public health risks associated with improper disposal, enhancing roadway safety and aesthetics by removing derelict vehicles, and fostering private sector investment through incentives and streamlined regulations. Furthermore, recognizing the potential for job creation within the ELV recycling sector, particularly in collection, dismantling, and processing, can unlock economic opportunities while advancing environmental sustainability.

b) Establish a comprehensive forward-looking policy and regulatory framework for ELV management that anticipates and adapts to the technological shifts in the automotive industry

To establish a successful ELV recycling program in the Caribbean, a robust forward-looking policy and regulatory framework is paramount, as highlighted by Numfor et al (2021). This framework must encompass stringent quality controls on imported

vehicles, encompassing safety, environmental, and emissions standards, thereby mitigating the potential for market distortions. It also has to consider the rapid global transition of land transportation from internal combustion engines to electric vehicles. This technological transition has implications for the skills and training necessary for the successful development of ELV recycling in the Caribbean SIDS. However, there is the additional consideration that as this transition proceeds apace in the more developed vehicle markets, there could be incentives for increased disposal (dumping) of internal combustion engine vehicles, be it on an interim basis, to developing markets, including those in the Caribbean.

Moreover, as the stock of electric vehicles continues to grow in subregional markets, the profile of vehicle recyclables is also expected to evolve to include a wide range of high-value metals which form part of the battery technology of these vehicles. As documented by Arnold et al (2021), such harvestable metals may include gold, silver, palladium, indium, neodymium, and other rare earth metals. These are deemed to be extremely costly to harvest and are still a relatively small share of the material content of modern electric vehicles. Nevertheless, the domestic vehicle recycling policy would need to be crafted to consider the increased availability and management requirements of these types of materials.

Key policies and regulatory requirements to be considered are:

- Comprehensive vehicle registration and deregistration data management systems: these systems would enable accurate tracking of vehicles throughout their lifecycle thereby facilitating greater efficiencies and enforcement of scrappage policies.
- Compulsory scrappage standards: clearly defined and enforceable standards for vehicle retirement are crucial for diverting end-of-life vehicles from informal markets and improper disposal.
- Compliance including data management and reporting on environmental, health and safety requirements.
- Given the economies of scale required for efficient ELV management, a regional approach should be considered for the Caribbean.

The absence of such a framework, particularly on the requirements of having compulsory scrappage standards, presents a significant impediment to establishing a viable and environmentally sound ELV recycling sector. Such a framework would further serve to limit the prospects for perverse incentives[11] among economic agents seeking to engage in this type of enterprise.

c) Foster a skilled workforce through training and education in the management of ELV recycling including keeping abreast of technological advancements

Developing an efficient and environmentally responsible ELV recycling sector in the Caribbean requires a multifaceted approach, with a key focus on technological advancements and workforce capacity building. The establishment of a robust, technologically advanced, safe and environmentally sound ELV recycling sector in the Caribbean hinges on addressing the institutional, human and other technical complexities inherent in dismantling, processing and materials recovery management (Sakai et al; 2013). This is especially important, given the ongoing evolution of vehicle design technologies, and the extended use of novel materials being used in vehicle production.[12]

Technology access, selection and adoption require careful policy consideration to ensure feasibility, affordability and alignment with local and regional contexts,[13] including the scale of the economy.

[11] By way of example, this could include increased vehicle theft for the purpose of scrappage.

[12] For instance, hybrid vehicles.

[13] This will include for example the economies of scale in the Caribbean subregion.

Integrated technology-related policies to be considered are:

- Safe management of toxic and other hazardous materials. Given the potential for hazardous materials in ELVs, prioritize technologies that facilitate environmentally safe and efficient dismantling (e.g., refrigerant and heavy metals) and components removal.
- Maximizing material recovery and circularity. This will also provide for supporting the local market demands for replacement vehicles parts.
- Technology standards: monitoring and enforcement to ensure safety, environmental and other regulatory requirements. This will also promote continuous improvement in this sector.

d) Establish an investment policy framework promoting public-private sector partnerships in end-of-life vehicles recycling

The development of this subsector is capital intensive, in this regard, an investment policy which incentivizes public and private investment would be critical. Establishing ELV recycling facilities demands significant capital investment for equipment, infrastructure and operations, encompassing shredding, crushing, sorting, packaging, transportation and warehousing of materials. To enhance public welfare through ELV recycling, governments could seek to enter public-private partnerships with local entrepreneurs for the financing and operation of recycling plants. One such immediate partnership is with the scrap metal dealers, who could be encouraged to expand their operations via this arrangement. Additionally, vehicle owners could be encouraged to relinquish near-end-of-life vehicles through an appropriate fiscal arrangement[14] where such vehicles are shunted into recycling instead of the now pervasive practice of vehicle abandonment in public spaces including roadways.

Other public/private policy actions to be considered are as follows:

- Taking into consideration the smaller economies typical of the Caribbean subregion, having accessible, centrally located facilities equipped to required ELV recycling management and regulatory requirements.
- Provide fiscal incentives to attract private sector investments. This can be for example tax breaks, soft-term financing, and environmental levies for the registration of both new and reconditioned imported vehicles.
- Job creation: encourage collaboration between government agencies, educational institutions, technology providers, and private sector companies to develop demand-driven training programs, facilitate technology transfer, and create apprenticeship opportunities that bridge the gap between theoretical knowledge and practical applications.

e) Leverage trade policies to promote environmentally sound management of ELV recycling

While efforts are being made to remove ELVs from the existing national vehicle stock, adjustments to trade policies would also be necessary to achieve the specific social welfare objectives of vehicle recycling. On the one hand, a review of the vehicle import policy would be required subject to market analyses of the optimal level of vehicle rolling stock for sustaining economic and social activities. Deep analysis of the optimal level of both new and used vehicle imports would be required, in addition to a review of regulatory, safety and emission standards, relative to multilateral agreements. Examples of these agreements are for example the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.[15]

[14] As part of a national compulsory vehicle scrappage standard.

[15] Basel Convention, see link at https://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx, cited July 10, 2024.

At the same time, given the industrial limitations for the local reuse of harvested vehicle raw materials in Caribbean SIDS, export promotion and trade facilitation services would also be required to support the private sector in securing access to international markets for vehicle recyclables. Such support should include materials certification tied to vehicle deregistration, streamlining logistics, supporting market access and fostering partnerships with established international ELV recycling industries. Such arrangements could further foster capacity building, and technology transfers, and improve regulatory frameworks and practices necessary for developing the subsector. This can also provide opportunities to consider countertrade[16] arrangements linked to the importation of (especially used) vehicles.

Conclusion

This brief examined the policy implications for the management of ELV in the Caribbean SIDS through recycling. The increasing importance of this issue to the subregion is already evident, as high rates of motorization and urbanization generated significant numbers of ELV vehicles among national vehicle stocks. This is being exacerbated by the ongoing importation of used vehicles into the subregion over decades and inadequate ELV disposals. While the analysis suggests limited scale efficiency for recycling vehicles given the subregion's small automobile markets, the social value of such enterprises is high due to such factors as public health, safety, environmental, road congestion, and loss of aesthetic values associated with ELV accumulations. The convergence of rapid technological advancements in vehicle manufacturing and the global push for sustainable development demands a paradigm shift. Caribbean nations will need to consider embracing a proactive, regulated, and long-term strategic approach to ELV management. This requires a comprehensive assessment of the current situation and future projections to inform the development of innovative solutions that transform this growing challenge into an opportunity for sustainable development, resource recovery and a healthier, more resilient Caribbean.

Bibliography

Arnold Mona, Elina Pohjalainen, Sören Steger, Wolfgang Kaerger and Jan-Henk Welink (2021) "Economic Viability of Extracting High Value Metals from End-of-Life Vehicles", Journal of Sustainability, Vol 13, 1902, MDPI, Switzerland.

Hao Han, Wang HeWu, Ouyang MingGao and Cheng Fei (2011), "Vehicle Survival Patterns in China", Science China - Technological Sciences, Vol 54, No.3, Springer.

Hsin-Tien Lin, Kenichi Nakajima, Eiji Yamasue and Keiichi N. Ishihara (2018) "Recycling of End-of-Life Vehicles in Small Islands: The Case of Kinmen, Taiwan", Graduate School of Energy Science, Kyoto University, Japan.

Kasioumi Myrto (2022), "Economics of Recycling – A Thesis Presented to the University of Guelph, in Patial Fulfillment of Requirements for the Degree of Doctor of Philosophy in Economics", University of Guelph, Guelph, Ontario, Canada.

National Center for Statistics and Analysis (2006), "Vehicle Survivability and Travel Mileage Schedules", United States Department of Transportation, National Highway Traffic Safety Administration, Springfield Virginia, USA.

[16] This is a reciprocal form of international trade in which goods or services are exchanged for other goods or services rather than for hard currency (https://www.investopedia.com/terms/c/countertrade.asp -Accessed May 2, 2024).

Numfor Solange Ayuni, Geoffrey Barongo Omosa, Zhengyang Zhang, and Kazuyo Matsubae (2021), "A Review of Challenges and Opportunities for End-of-Life Vehicle Recycling in Developing Countries and Emerging Economies: A SWOT Analysis", Journal of Sustainability, MDPI, Switzerland.

Phillips Willard, Nicholson George, Alleyne Antonio and Alfonso, Maurys (2023), "Policy considerations for sustainable transportation in three Caribbean small island developing States: options for improving land transportation efficiency. Barbados, the British Virgin Islands and Jamaica", Studies and Perspectives series-ECLAC Subregional Headquarters for the Caribbean, No. 117 (LC/TS.2023/15-LC/CAR/TS.2023/3), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC).

Pieter van Beukering, Onno Kuik and Frans Oosterhuis (2014), "The Economics of Recycling" in "Handbook of Recycling: State of the Art for Practitioners, Analysts and Scientists", Elsevier.

Sakai Shin-ichi, Hideto Yoshida, Jiro Hiratsuka, Carlo Vandecasteele, Regina Kohlmeyer, Vera Susanne Rotter, Fabrizio Passarini, Alessandro Santini, Maria Peeler, Jinhui Li, Gil-Jong Oh, Ngo Kim Chi, Lawin Bastian, Stephen Moore, Natsuko Kajiwara, Hidetaka Takigami, Takaaki Itai, ShinTakahashi, Shinsuke Tanabe, Keijiro Tomada, Takashi Hirakawa, Yasuhiro Hirai, Misuzu Asari, and Junya Yano (2013), "An International Comparative Study of End-of-Life Vehicle (ELV) Recycling Systems", Journal of Material Cycles and Waste Management, Vol. 16, Springer.