Vehicle Scrapping or Recycling?
Indian Perspective

By Prabhat Khare

Background:

In India, the automobile explosion took place when this market was opening up in the 1990s. Before 1990 an automobile was like a lifetime investment for an Indian family. The family vehicle was meant for a generation, and they never had a defined shelf life. However, as the cars became old, not suitable for family use, these vehicles were sold to people who went on to use them as means of local commercial application or as trainer cars in India but never went off the road. When computerization of Govt. functions started in the late 1980s, RTOs were left to themselves. Hence, accurate quantification of road-worthy automobiles always remained a challenge in India. Also, during the old manual system of RTOs never took cognizance of vehicles going out of service because of various factors (accidents, technical issues, etc.); the available database could not be relied upon. When the new Vehicle Scrappage Policy[1] was being drafted, the number of vehicles going off the road based on the defined time validity had become a concern. Many studies were conducted to arrive at a figure by many agencies. One such study was done in 2016, jointly by Central Pollution Control Board (CPCB) and GIZ. Based on their study, more than 8.70 million vehicles reached end-of-life (ELV) status by 2015. By 2025 the ELV numbers may go up to be nearly 21.80 million (two-wheelers account for about 80 percent of the total ELVs). In India, on average, two billion new vehicles are added every year that spew noxious pollutants and heat-trapping gases throughout their life cycle. At the same time, as the number of automobiles is also becoming old and obsolete, they emit more such pollutants.

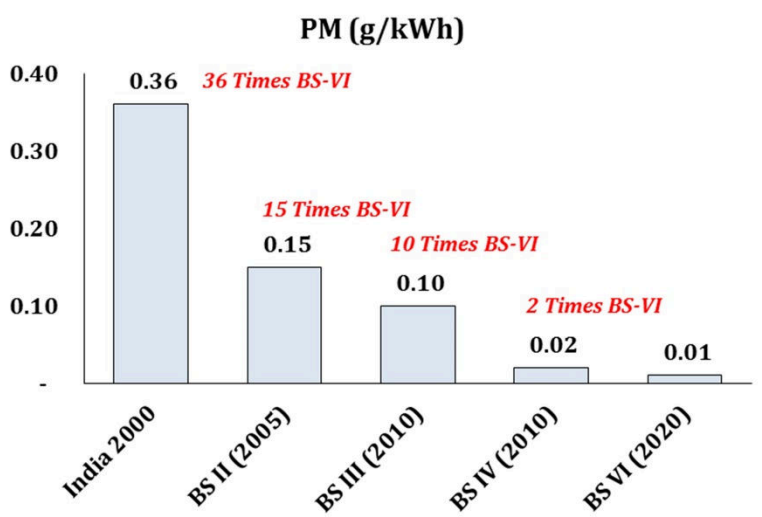
India has been able to withstand the pressure of global trade in old used vehicles mainly because of its domestic policy. That policy does not permit registrations of vehicles that are below the applicable national emissions standards. India also has a strong manufacturing base. However, vehicles change several hands within the domestic market. Growing obsolescence is making smaller cities and towns the dumping ground of these old vehicles in India. There are several complex dimensions associated with old vehicles that require immediate policy attention in India.

There are a quarter of a billion registered vehicles on Indian roads, which are the source of pollution. The results are serious damage to the environment. The damage is not only in terms of Air Pollution, but there are also other environmental degradations all through the complete life cycle of vehicles. So, it is necessary to monitor and regulate the life cycle of Automobiles, and then at the end of their useful life, they need to be properly disposed of. The other environmental damages (land & soil degradation, groundwater contamination, etc.) are equally important and are as problematic as air pollution. Many harmful gases (HC, NOx, Sox with PM) are formed as a by-product of IC engine

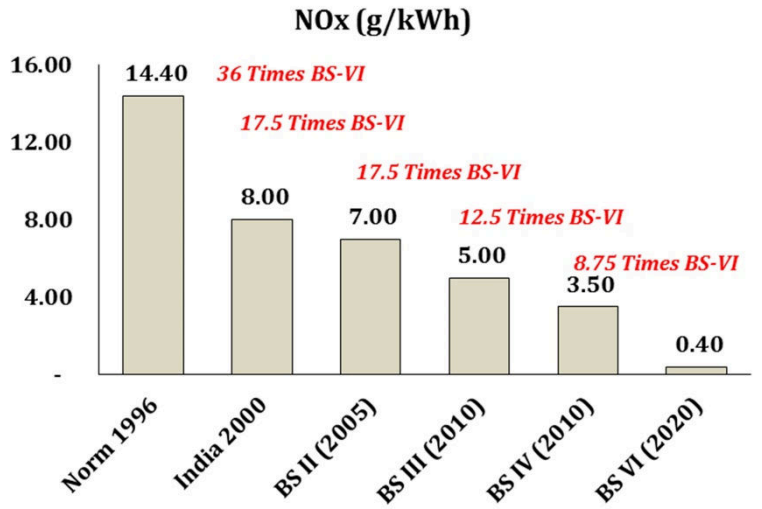
[1] Tentative timeline for application of the proposed Vehicle Scrapping Policy in India: Rules for fitness tests and scrapping centers by 1st Oct 2021/ Scrapping of Govt. and PSU vehicles older than 15 years by 1st Apr 2022/ Mandatory fitness tests for heavy commercial vehicles by 1st Apr 2023/ Mandatory fitness testing in a phased manner for other vehicle categories by 1st Jun 2024

operations with a serious effect on human health. However, chemicals and metals also cause a similar or more serious impact on the total ecology of human surroundings.

PM Emission-India Over The Times (for HCV)



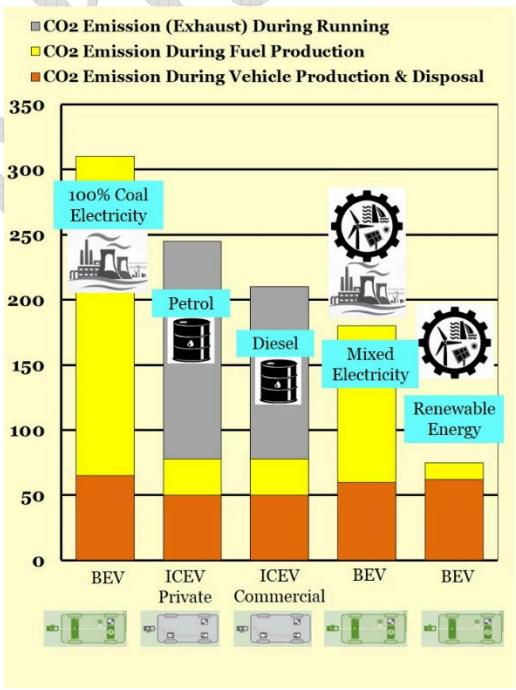
NOx Emission-India Over The Times (for HCV)



From CSE Report On Effective Scrappage Policy And Infrastructure

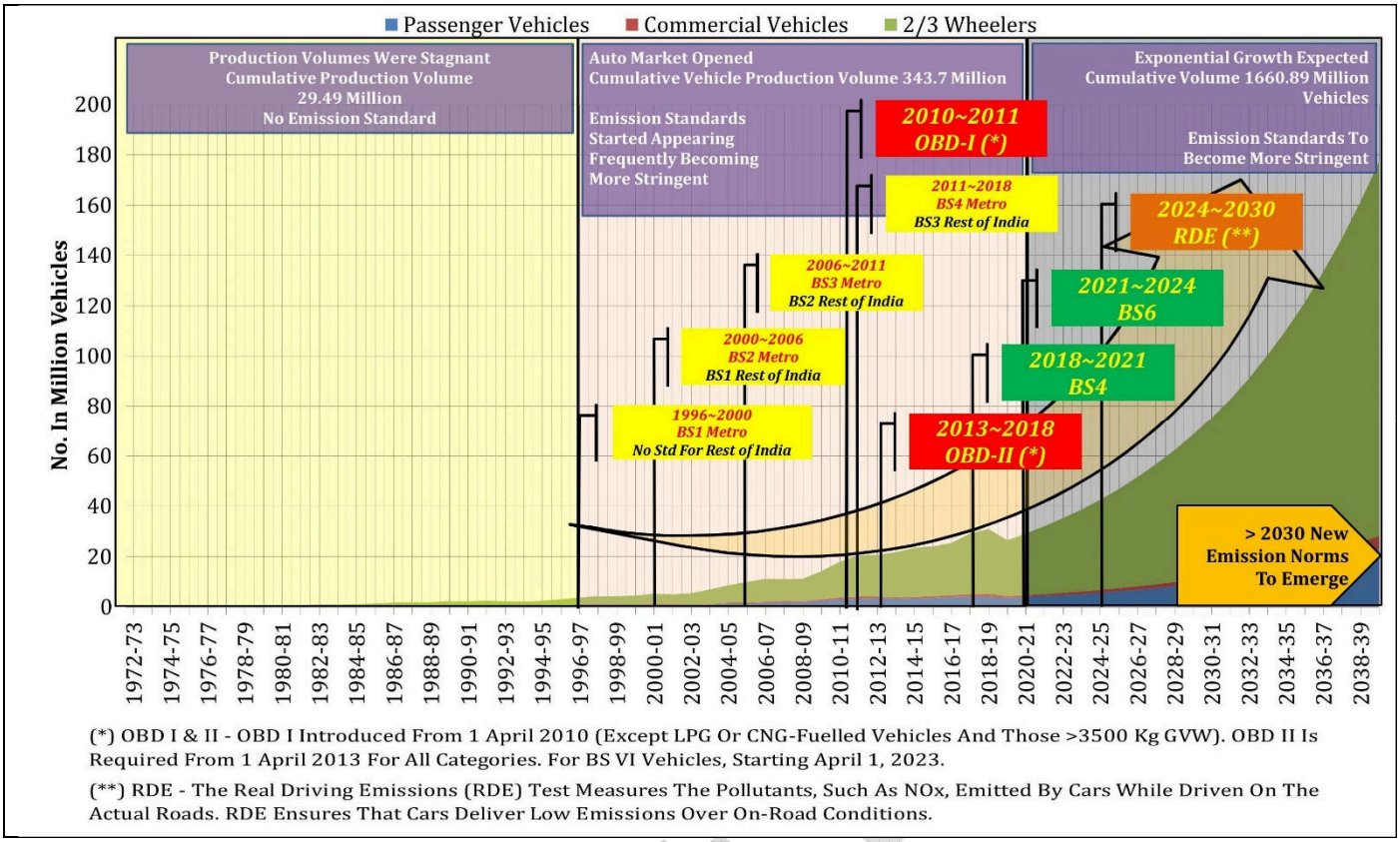
Range Of Life-cycle CO_2 Emissions for Different Vehicle and Fuel Types

EVs are generally much more energy-efficient than those powered by fossil fuels, yet depending on how the electricity is produced for them. The overall result can be more damaging if EVs are made to run on electricity generated in an old-fashioned manner in coal-based power plants instead of making EVs run on energy produced from renewal sources.



To control the release of these harmful exhaust gases into the environment various countries have initiated and implemented different pollution standards for the Automobile manufacturers according to the vehicle type to keep the air quality clean. For example, Environmental Protection Agency (EPA) in the United States government, European Union Research Organization (EURO) in Europe have framed strict rules for vehicles to limit the toxic exhaust emissions releasing into the environment. Taking the EURO emission standard as reference Central Pollution Control Board in India has implemented Bharat emission standards (BS Norms). Moreover, it is updating its regulation at regular intervals of time. The introduction timelines of various emission norms in India with the rise of production volumes are shown below:

Timelines Of Various Emission Norms In India



(*) OBD I & II - OBD I Introduced From 1 April 2010 (Except LPG Or CNG-Fuelled Vehicles And Those >3500 Kg GVW). OBD II Is Required From 1 April 2013 For All Categories. For BS VI Vehicles, Starting April 1, 2023.

(**) RDE - The Real Driving Emissions (RDE) Test Measures The Pollutants, Such As NOx, Emitted By Cars While Driven On The Actual Roads. RDE Ensures That Cars Deliver Low Emissions Over On-Road Conditions.

The graph shows the following aspects: exponentially rising production volumes, more and more vehicles on the road, stricter emission norms with quicker up-gradation. The latter has also been brought to India for two reasons – first to avoid degradation of the environment and second with an open market scenario, to restrict various automobile MNCs coming to India and dumping their obsolete technologies to make a profit from the Indian market.

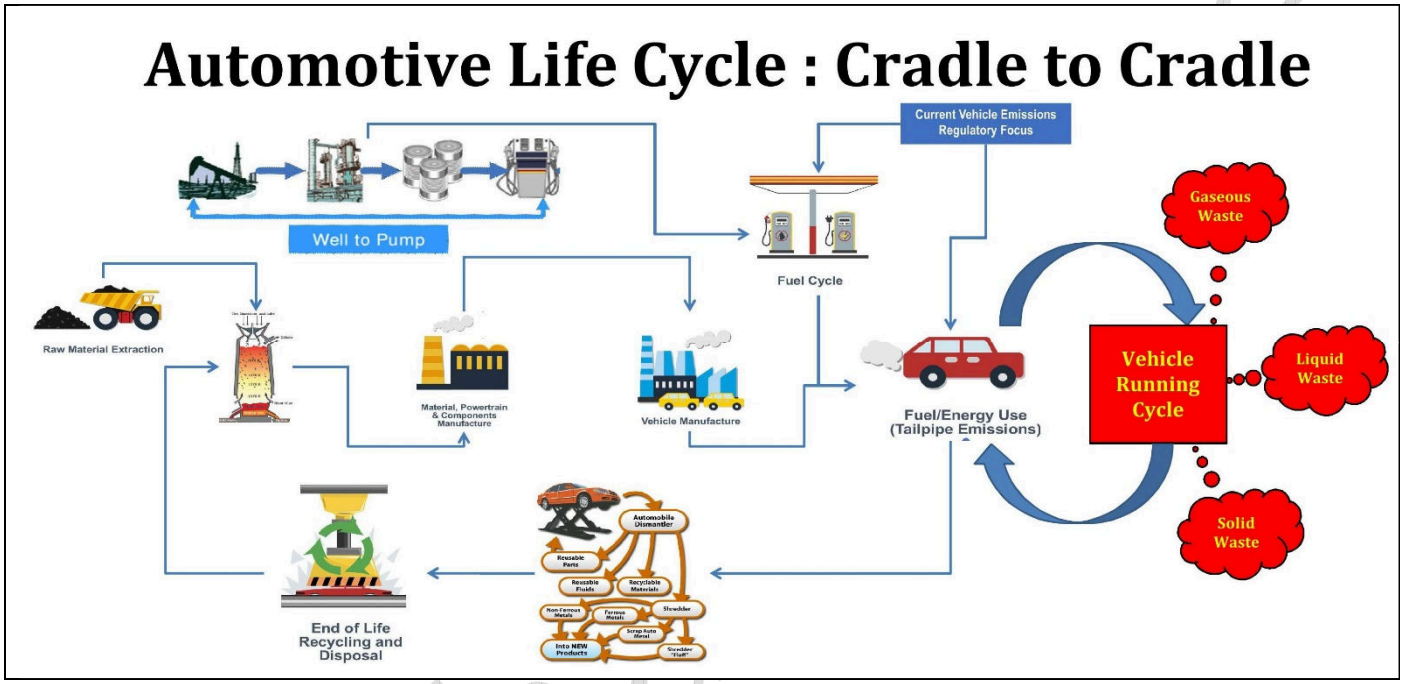
When newer vehicles with better technologies emerged, the time was ripe to bring a set of regulations to remove the older ones from the road in a phased manner. Hence, the current "Vehicle Scrappage Policy 2021" by GOI is a well-timed and positive step in the right direction. The policy has perfect timing because of three reasons – first for the disposal of older vehicles, which have more toxic pollutants coming out of their old engines and their now-obsolete technology. Secondly, because of older technologies, only these vehicles may be highly unsafe on current roads, expressways and high-speed motorways. Thirdly, if the numbers of vehicles are not controlled by making these old vehicles off-road, traffic-related issues as well air/ land pollution cannot be managed.

GOI controlled the fuel quality, a contributor for ICEV performance, also promoted alternative fuel automobile technologies based on CNG, Bio, Electric, Hybrid, Hydrogen/ Fuel Cell, etc. The new "Vehicle Scrappage Policy" will have a positive impact on improving vehicle performance. By reducing the precious oil import bill, the policy will also help to reduce environmental pollution. Moreover, it will provide incentives for people for buying new vehicles post disposal of their obsolete vehicles. However, such a recycling policy should be based on the vehicle's performance rather than its age. When it starts performing continuously poorly, it must be disposed of by diverting it to an organized and professional recycling setup, which will pave the way for a modern "Vehicle Recycling Industry" which must never be called "Vehicle Scrapping Industry".

What is the End-of-Life (EOL) for a Vehicle?

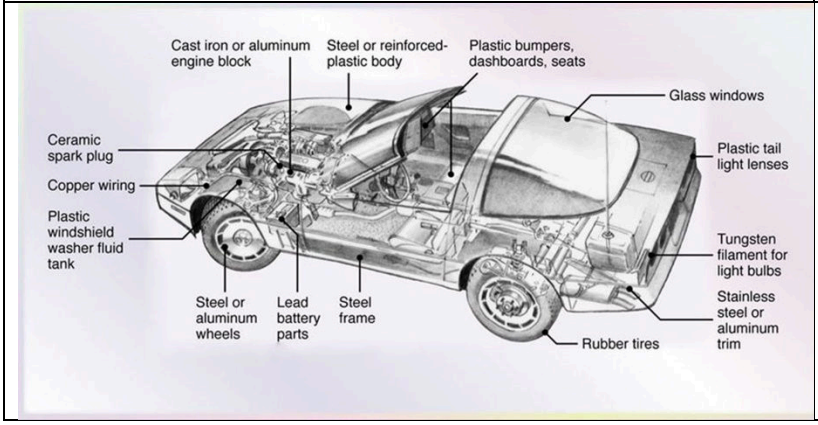
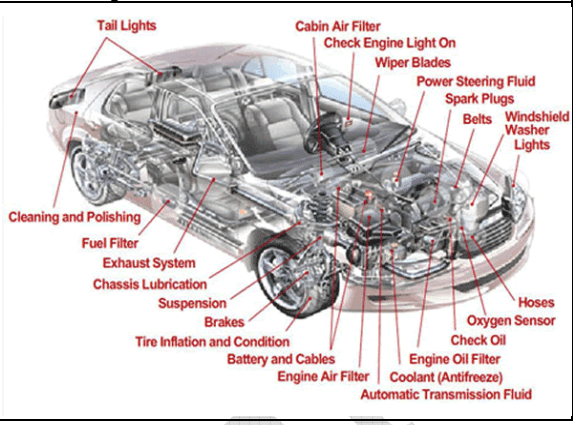
Regardless of its age and weight, a vehicle mostly consists of about 75% metal, both ferrous and non-ferrous. The remaining 25% of the vehicle weight consists of tires, plastic, rubber, plastic, gases, glass, fabrics, fluids, antifreeze, lubricants, gasoline and various electronic components. When these vehicles reach the end of their life or are discarded many of these items could be salvages and recycled back in the main industry, reducing the burden on primary industry feeding to the automobile industry and eliminate contamination of the environment.

Understanding Vehicle Recycling: Cradle to Cradle



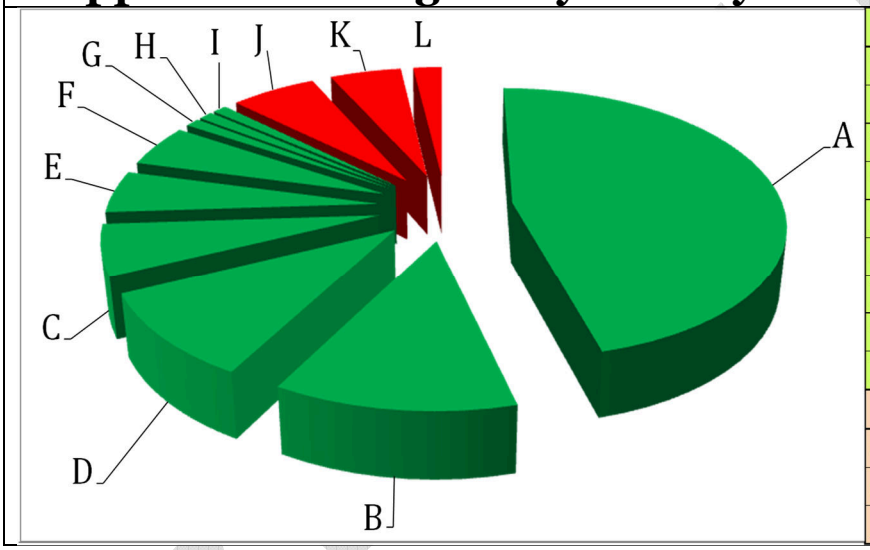
While "scrapping of a vehicle" literally means that old vehicles have reached their EOL or damaged vehicle (accident, natural calamity, or by any other reason) and are not roadworthy anymore. Such vehicles are barred by RTO for registration and hence are sold as junk to scrap dealers. Now, vehicles can also become road unworthy because of many other factors: their technology becomes obsolete, their spares parts are not available, or they develop some irreparable technical snag etc.

Yet, unlike any other scrap items, these road unworthy vehicles are still composite and complex amalgamation of various materials, chemicals, liquids, gases (many of them could be toxic), which, if handled properly, can be effectively recovered from the "Scrapped Vehicle" and be reused. Hence, it is important to understand the term "RECYCLING" in the context of vehicles to which the current "Vehicle Scrappage Policy 2021" of GOI refers. "Recycling" can be termed as bringing maximum materials back to the cradle from where it all began.

Used Material In Automotive	Systems In Automotive
	

Most of these items can be successfully recycled, refurbished, reused if handled carefully. Moreover, they can get a new life: reused in the secondary market as spares or utilized in different forms and applications. Alternatively, they could be recycled into their basic raw materials and could be a feed to the steel, aluminum, plastic, copper, and brass manufacturing industries. The primary goals of the vehicle recycling industry are to salvage these components from an old and used automobile. The below-given chart is an approximate assessment of the recyclability of an average automobile.

Approximate %age Recyclability Of An Average Automobile



Recyclable (R) Materials				
Iron & Steel (R)	A	46%	87%	Recycable
Aluminium (R)	B	12%		
Textiles (R)	C	6%		
Thermoplastic (R)	D	10%		
Rubber (R)	E	5%		
Glass (R)	F	5%		
Magnesium (R)	G	1%		
Thermosets (R)	H	1%		
Fluid & Lubricants (R)	I	1%		
Non Recyclable (NR) Materials				
Other (NR)	J	6%	13%	NonR
Coating (NR)	K	5%		
Adhesive (NR)	L	2%		

Plan-Do-Check-Act Cycle for Improving Vehicle Recycling

While we have heard a lot about PDCA in manufacturing, the below-given applicability of this cycle on the recyclability of vehicles during the various stages of their life is a continual process: from Design and Development to Manufacturing to Sales and Service, and finally to Disposal.

Life Cycle of A Vehicle Under P-D-C-A Lens

Plan: Design & Dev. Stage
- Select Material Judiciously
- More Use Recycled Materials
- Improve Easy Dismantling Of Components Without Compromising On Safety & Structural Stability Of Vehicle

Do: Manufacturing
- Reduce Wastage & Better Resource Utilization
- Internal Recycling of Water, Packaging Materials Etc.
- Discontinuation Of Single Use Pallets
- Avoid All Wastages

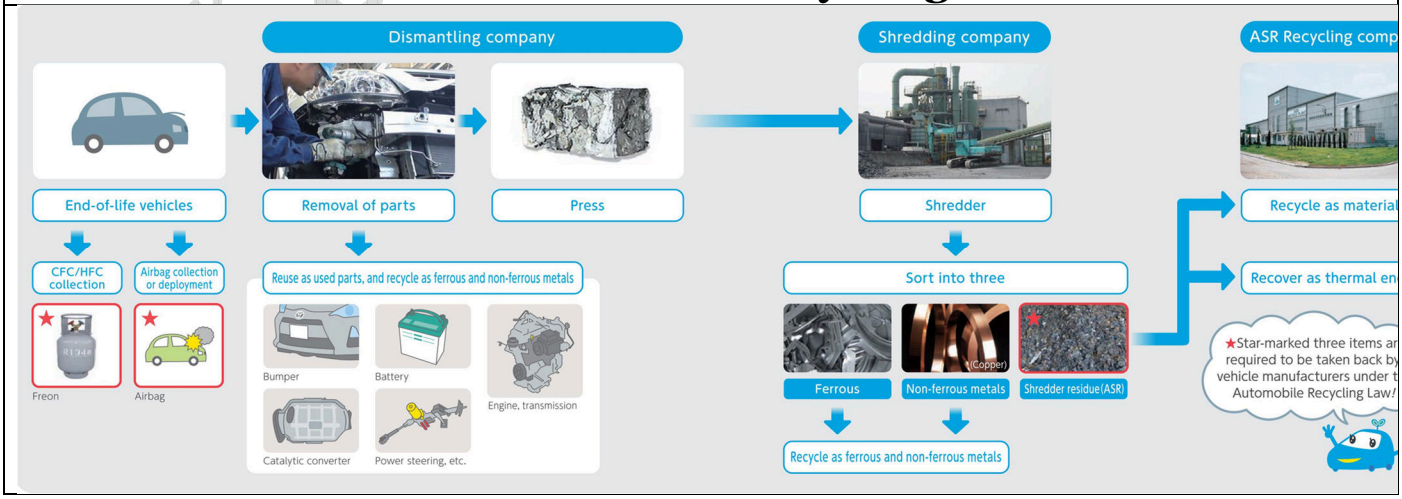
Act: Proper Disposal
- Dismantling Of Vehicle
- Segregation Of Materials
- Collection, Treatment &D Disposal Of Liquids & Gases
- Disposal Of Battery
- Shipment Of Balance Units To Shredder/ Compactors

Check: Sales & Service
- Recycle Of Repaired/ Replaced Parts
- Reduce Unwanted Repairs
- Discontinuation Of Single Use Pallets
- Optimise Shipping Movement (Kit Sizing)
- Proper Handling Of Coolants & Lubricants

Understanding the Best Practices in the Recycling Process:

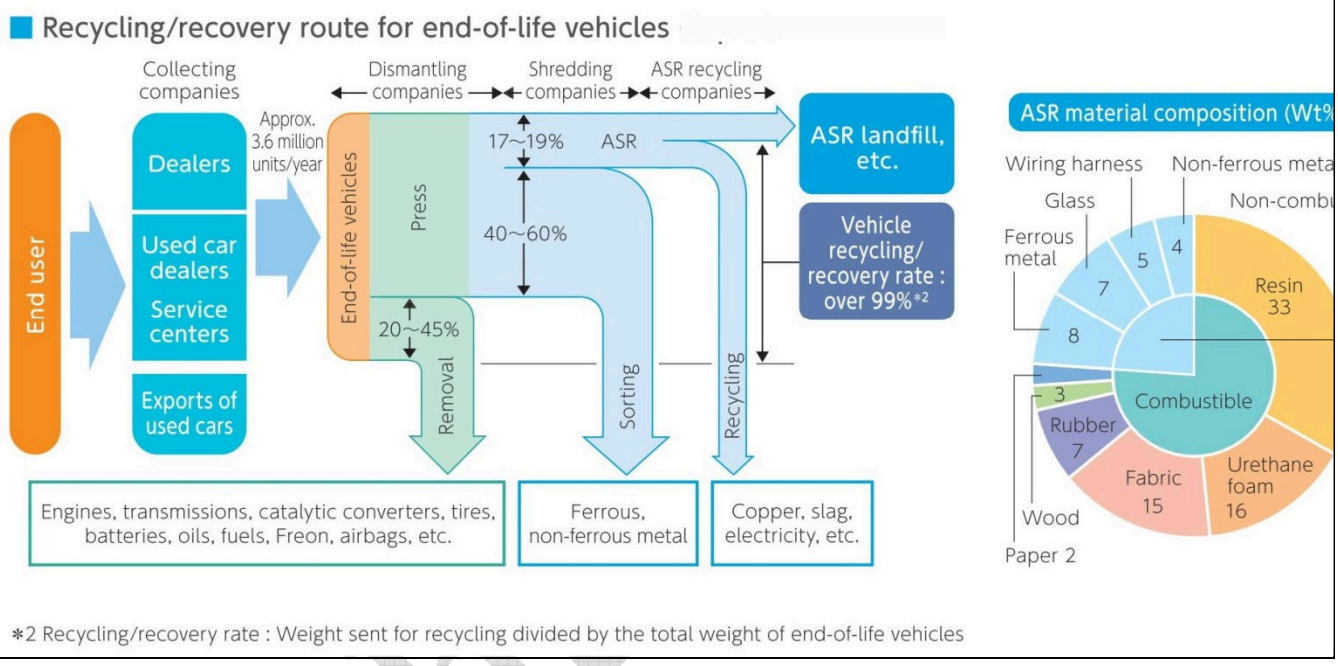
Broadly, the dismantling process is a two-stage process. The first stage process may involve draining out all hazardous fluids and gases, from fuel tanks, transmissions, radiators, and power steering units, HVAC, Airbags, etc. Once removed, these liquids, gases and lubricants can be recycled and depending on the recycling quality, they could be used in the primary or secondary market. Also, some parts like engines, transmissions, doors, bumpers, starters, alternators, water pumps, wiper motors, batteries, catalytic converters, tires, dashboards, electronics, etc. can be refurbished or recycled. They could either be used as spares or be converted into new products. Fluids and gases such as engine oil, coolant, gasoline, HVAC Gas, and Airbag gas need to be carefully handled to prevent their release. They must be stored in double-walled tanks or secondary containment before being reused or recycled.

General Overview Of Recycling Process



In the second step, the vehicle is sent to a recycler or the shredding facility known as ASR (Automobile Shredder residue) plants. These capital-intensive plants have complex material separation operations. The shredder pulverizes the vehicle into fist-sized pieces of materials, which are sent to sophisticated separation technologies. The metal recovery may include the recovery of rare metals and rare earth metals. Such recovery plants then become raw material feedstock for steel mills, electric arc furnaces, aluminum, and other non-ferrous metal smelters to manufacture different products, including new vehicles.

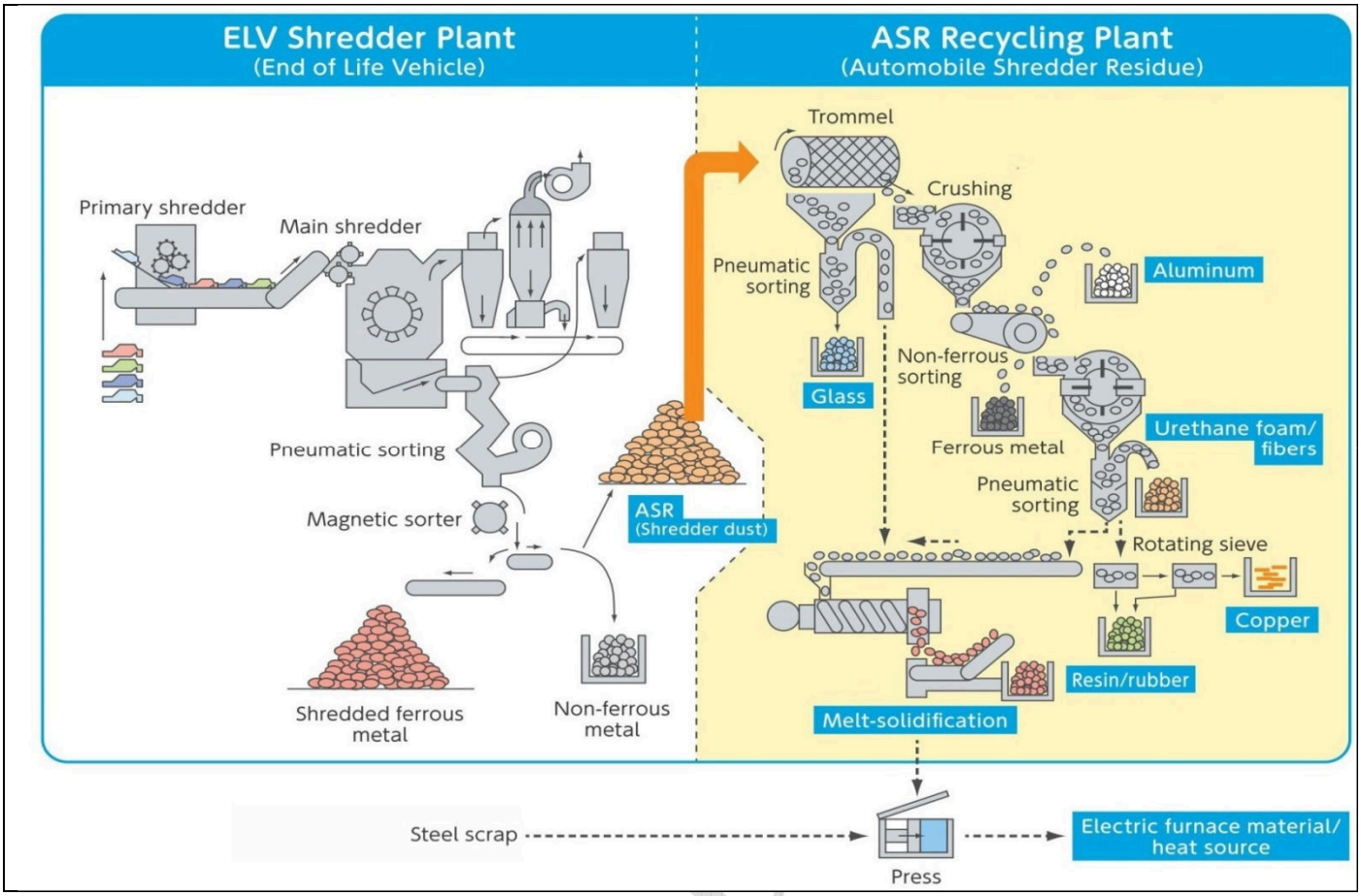
Typical Global Dismantling Flow With Average Recovery Rate



*2 Recycling/recovery rate : Weight sent for recycling divided by the total weight of end-of-life vehicles

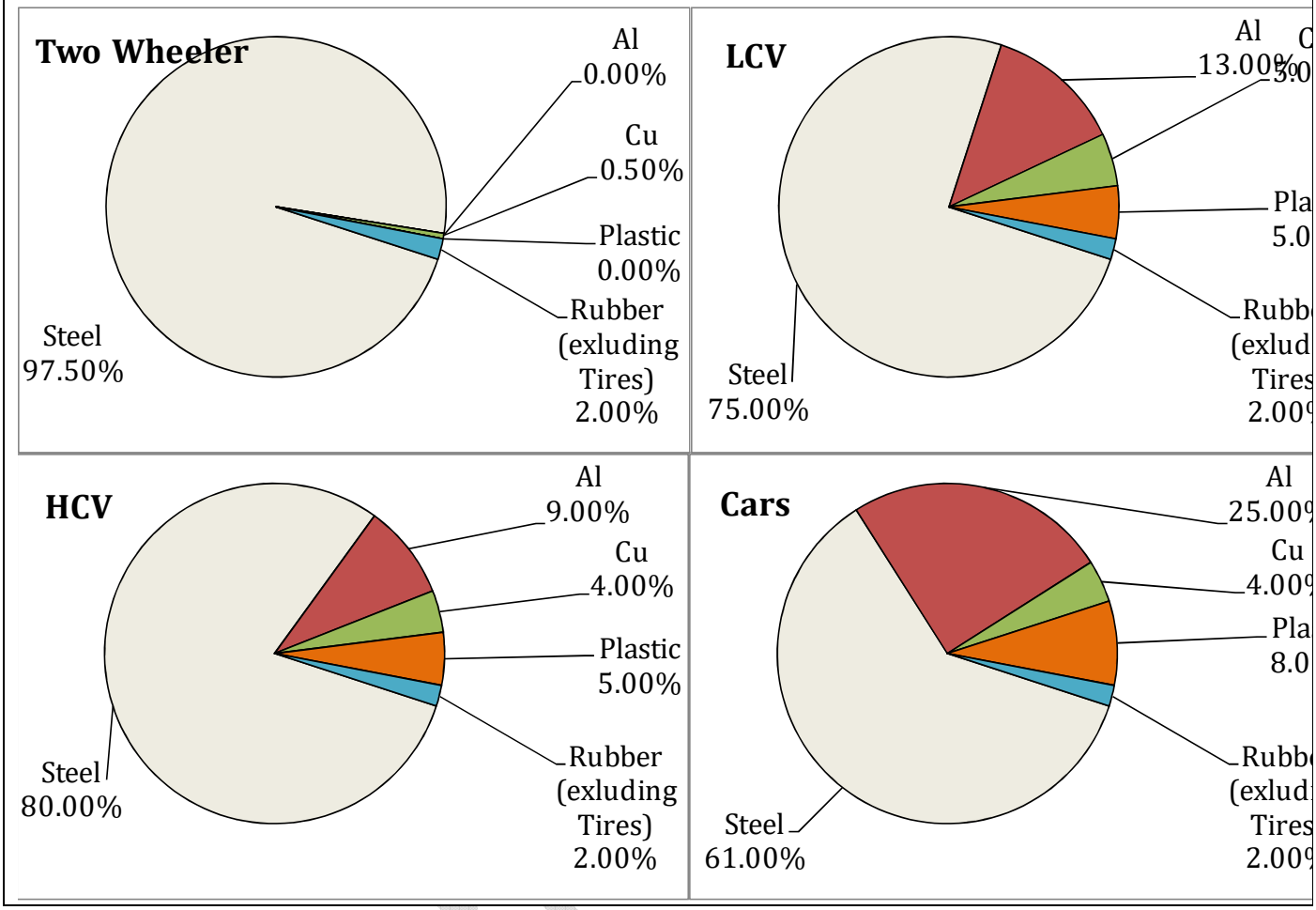
Development and Utilization of ASR (Automobile Shredder Residue) Sorting Technology

For using ASR, it is necessary to shred the shell, post step two of recycling into its basic materials. Since the separation of constituents is required to raise their purity, special sorting technologies are needed before the ASR recycling plant, which may use wind and magnetic sorters to make shredded reside suitable as the feed of the ASR Plant. A simple flow chart of these plants is shown below:



Approximate Scrap Recovery By Various Vehicle Categories	UOM	Kerb Weight	Approx. Scrap Recovery	%age Recovery By Weight
Indica	Kg	1080.00	700.00	64.81%
Ambassador	Kg	1200.00	800.00	66.67%
Two Wheelers	Kg	103.00	80.00	77.67%
Three Wheeler	Kg	975.00	300.00	30.77%
LCV (4Ton)	Kg	2390.00	2000.00	83.68%
HCV (12Ton)	Kg	11990.00	6000.00	50.04%

Major Constituents In Different Categories of Vehicles



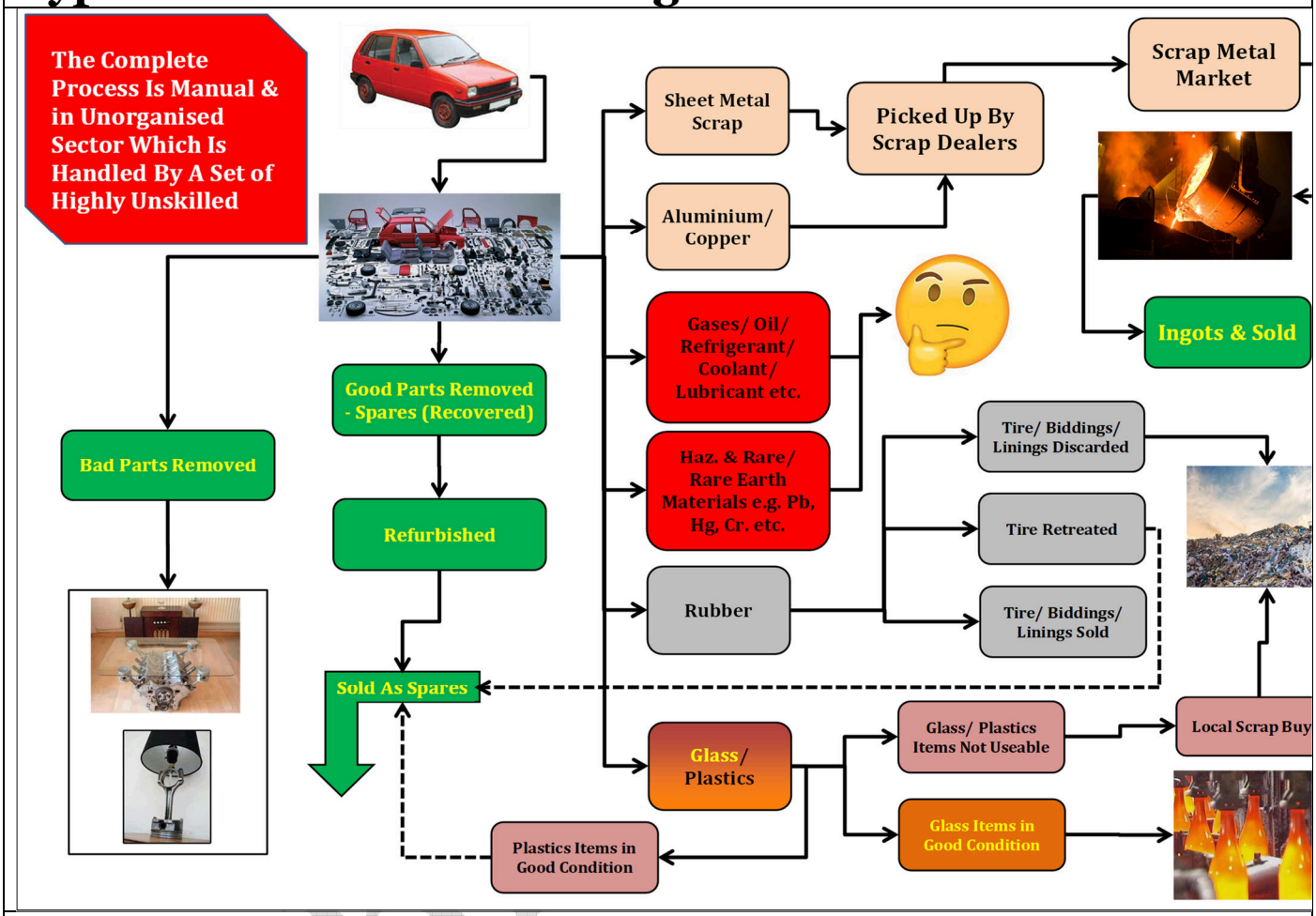
Current Scenario in India

Every year, vehicles that reach the end of their life end up as discarded vehicles. Unlike advanced countries, where the system of automobile recycling has been in practice for quite some time, in India, these vehicles are abandoned or stockpiled at poorly managed local garages most of the time. There are only estimated numbers on how many vehicles reach the end of their useful life annually, leave along estimating the discarded or stockpiled vehicles. However, another challenge in India is that once a vehicle reaches the end of its useful life, it is never properly processed for recovery of reusable or recyclable materials and proper disposal of waste components. Without proper processing, scrapping and recycling, the number of such vehicles has only increased year after year. The vehicles have become a liability for the owners who tend to abandon them on open land or sell them to a regular scrap dealer who is neither equipped nor aware of their disposal methods causing environmental damage. Moreover, the safety concern needs to be considered as well.

Fortunately, after proper training and with facilities and tools hazards can be managed. Furthermore, vehicle components and parts can be recovered. A properly managed discarded vehicle reduces risks to workers, public health, and the environment, lowers disposal costs, saves landfill capacity, and creates opportunities to recover valuable resources and earn revenues from dismantling and scrapping operations.

Until now, India had neither the infrastructure nor the proper regulatory mechanism for the efficient disposal of these end-of-life vehicles. The current way of handling old vehicles had been very crude, as shown in the chart below.

Typical Current Dismantling Flow of A Vehicle In India

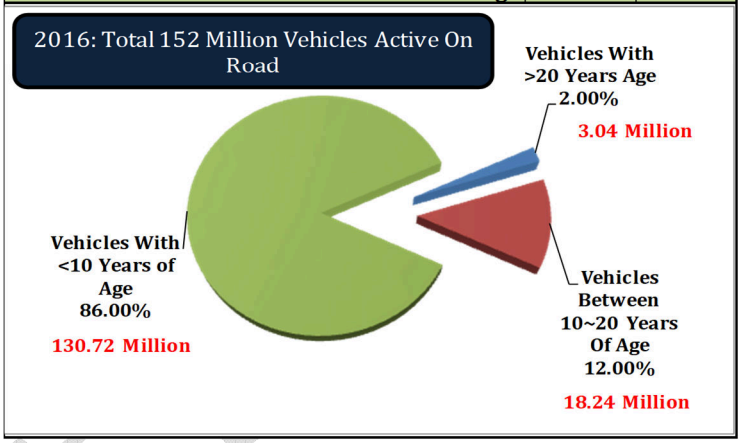


Note: Without a proper recovery system installed, a wide range of materials, including rare earth & rare metals to low-grade used oils have the possibility of seeping into the ground contaminating the soil and groundwater. Industry sources indicate that, if new age recycling methods are adopted, a normal sedan can help to recover materials equivalent to 2,500 kilograms of iron ore and 1,400 kilograms of coal, reduce the release of 1,000 kilograms of carbon dioxide, and save more than one megawatt of energy. In the case of a motorcycle, the corresponding gains are approximately one-eighth of a car's gain. The accrued energy savings are essentially due to the melting of scrap rather than smelting ores. Recycling one kilogram of aluminum saves 14-kilo watts of electrical energy compared to producing virgin metal from bauxite.

Challenges in India

a) **Tracking the Old Vehicles:** The vehicle registration data available with various RTO is cumulative and has not been corrected for scrappage, phase-out, and transfers. Due to no records of de-registration, it is impossible to estimate the precise number of old legacy vehicles by age in India. Thus, whatever data related to vehicles on the road being made available tend to be inflated. Hence, any estimate on the number of vehicles will always be doubtful. But according to the VAHAN database, launched in July 2011, there is a total of 290.85 million registered vehicles in India as of April 2021. With the ongoing implementation of HSRP (High-Security Registration Number Plate), it is relatively easier to know the vintage of vehicles, their level of compliance to regulatory provisions, taxation requirements, etc. More effort is needed to correct the entire national database, particularly for older vehicles when RTOs were not digitalized. Making national-level estimates is still challenging.

Broad Estimates Of Vehicles & Their Age		
Total Vehicles Registered Between 1951~2016	230.00	Million
Loss Of Vehicles Between 1951 ~ 2016	78.00	Million
Total Active Vehicle in 2016	152.00	Million
Based On Above & Rationalised with Production Volumes CSE's Reports Has Projected Age wise Figures Of Vehicles		
Vehicles With >20 Years Age	3.04	Million
Vehicles Between 10~20 Years Of Age	18.24	Million
Vehicles With <10 Years of Age	130.72	Million

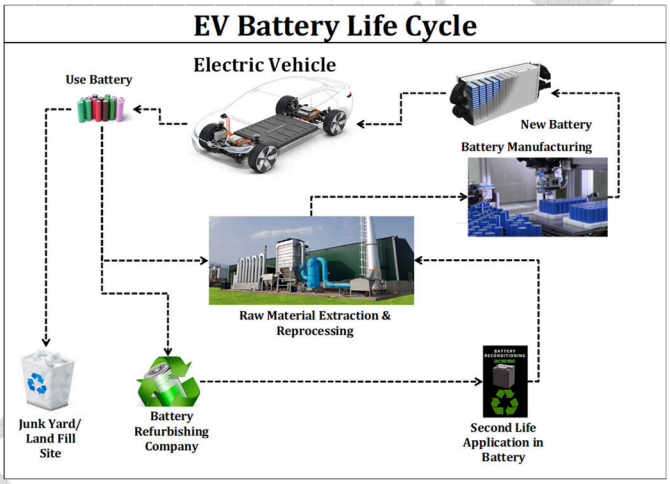


Based On CSE Report "What To Do With Old Vehicles?"

b) **Infrastructure and Technology to Handle the Large Volumes:** The current infrastructure for the vehicle dismantling process in India can be described as miserable since there are mainly parts of local garages. The addition of more such garages in the area grows into an unauthorized disposal market e.g. Mayapuri (Delhi) and Shivajinagar (Bangalore). The workshops in these areas functioned till there were limited numbers of vehicles for scrapping but as the volumes of complex new-age vehicles grow they are becoming obsolete. They were able to manage few vehicles yet in a very unsafe manner exposing their people to various hazards while handling even the small numbers of vehicles. As ten states in India account for 75% of vehicle sales, India needs to maximize the dismantling centers in the outskirts of those cities with a higher concentration of vehicles, good connectivity, and logistics facilities. These recycling facilities must also be state-of-the-art facilities to recover high-quality metals, oils, and other materials as well as waste treatment. The system must have a team of properly trained technicians to assess the reusability of parts that must be dismantled from the vehicle, cleaned, tested, inventoried, and stored in a warehouse until sold.

c) **Tracking, Identification and Accountability**: Once the parts are dismantled from old vehicles and sold as spares, there must be proper traceability of these parts to track their performance of vehicles for retaining their roadworthiness.

d) **Handling of New Age Electrical, Hybrid Vehicles:** With the new focus of Govt. on electrical and hybrid vehicles, as new means of mobility are evolving and rule the mobility world in the coming few decades, the vehicles would also need proper disposal. The vehicles will be disposed of due to age, accidents, damage due to natural calamity, etc. Hence, any vehicle recycling facility must also be prepared to handle these new-age non-ICEVs. The major problem is the handling of the large set of spent Lithium-Ion Batteries (LIB), which need to be taken out of the vehicle when their capacity reduces by about 25%. The typical recycling process for Li-ion batteries will get Lithium out of old batteries as more than 99% of Lithium can be reused. The by-products of the recycled batteries will depend on the process, the battery chemistry and, many other factors. As the recycling of Li-Ion batteries increases, it will help to reduce the price of the batteries. That will, in turn, improve the adoption of EVs.



e) **Landfills:** Although India already has a well-organized and controlled landfill site management system for Hazardous Wastes in operation, the requirements for Automobile waste need to be studied. If needed, a special landfill site may be developed.

f) **Promotion to Set Up ASR Treatment:** Govt. must push the installation of ASR Plant with the latest technology wherever Automobile recycling is done because:

- A modern facility will provide a better and safer working environment.
- It will considerably reduce the landfill area requirements.
- Rubber and plastics and the intrinsic hazardous in their disposal process could be eliminated.
- Currently, vehicles are dismantled on the roadside, scrapped material is dumped within the scrap yards with complete disregard to the safety of labor working in that area. Unhygienic processes result in air pollution as well as groundwater contamination.
- It will provide a safe working atmosphere, in which a new generation of workers could be trained with new skill sets.

New Beginning: Mahindra Signs MOU to Offer First Of Its Kind Vehicle Scrapping Solution in India

India's auto shredding venture and vehicle recycling unit will recycle specialized steels and other non-ferrous metals. The very first Cero plant will be based in the Delhi NCR region. It will be India's first auto recycling facility.

They will be using world-class equipment and processes to recycle vehicles resulting in zero damage to the environment. This recycling initiative also aims to reduce carbon footprint through its eco-friendly practices and symbolizes an effort towards a zero-waste, zero pollution eco-system.

Epilogue: Lesson to Be Learnt from Ship Dismantling In India:

We need to learn and take precautions from shipbreaking in India, which began in Kolkata and Mumbai in the 1910s when environmental concerns and human safety were in the primitive stage in India. In the 1980s, the world started seriously considering India as a destination for recycling old vessels, and business grew to whooping 6000 crores per year. It brought many social and environmental issues.

The serious impact of plastic debris contaminating the soil leading to contamination of the food chain (bio-magnification), degradation due to heavy metals, Iron, Manganese, Chromium, Nickel, Zinc, Copper, Lead, Cadmium and Mercury have been recorded. The same may also happen when such vehicle recycling plants are not regulated correctly. And since, unlike ship breaking facilities, which are far away from human habitat, these recycling automobile recycling facilities will be nearer to human pollution. Accordingly, any malfunctioning will have an impact on the surroundings.

Prabhat Khare
Engineering Consultant, Energy & Safety & Auditor, Trainer
Technical Article Writer
Mobile: +00-91-9910490088
BE (Electrical), Gold Medalist, IIT Roorkee, India
Life Member of National Safety Council of India
BEE Certified Energy Manager form India
Lead Assessor For ISO 9K, 14K, 45K & 50K from BSI
Industry Expert from Tata Motors, Honda Cars & Ashok Leyland
Email: prabhat.pkmail@gmail.com, prabhatkhare22659@gmail.com
LinkedIn: http://in.linkedin.com/in/prabhatkhare2

References:

1. Vehicle Recycling, Toyota Motors, April 2017
2. Development of Scientific Recycling Of End of Life Automobiles In India and The Role of Research & Development, Indian National Academy of Engineering, November 2015
3. Processing End-of-Life Vehicles: A Guide for Environmental Protection, Safety and Profit in the United States-Mexico Border Area, July 2017
4. Auto Salvage Recyclers Environmental Self–Audit Workbook, Indiana Department of Environmental Management, January 2017
5. https://www.cseindia.org/what-to-do-with-old-vehicles--10379
6. https://www.mahindraaccelo.com/greater-noida.php

7. https://www.timesnownews.com/auto/car-news/article/mahindra-signs-mou-to-offer-first-of-its-kind-vehicle-scrapping-solution-in-india/742095
8. https://www.downtoearth.org.in/coverage/bare-facts-21345
9. https://www.eea.europa.eu/signals/signals-2017/infographics/range-of-life-cycle-co2/view