

## Annexures

### How can India's Automobile Manufacturing Sector Go Net Zero?

#### Exploring Decarbonisation Pathways

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#### Annexure 1: Industry mapping between ASI data and GCAM

This section presents the classification of industrial categories available in ASI and mapping done of these down to industries added in GCAMv6 structure. Quantity manufactured in each financial year is available in ASI and is compiled by mapping National Industrial Classification (NIC) codes and National Product Classification for Manufacturing Sector (NPCMS) codes for each category. Per unit energy for both auto OEMs and suppliers' industry is calculated by dividing the quantity of fuels (for all fuels including coal, oil, gas, and electricity) consumed indicator for each category by the quantity manufactured taken from ASI.

Data from ASI categories		GCAM classification	
NIC	Category	Subsector	Industry
29101	Manufacture of passenger cars	Passenger cars	Passenger cars
30911	Manufacture of motorcycles, scooters, mopeds etc. and their engine	2W	2W
30912	Manufacture of three-wheelers and their engine	3W	3W
29102	Manufacture of commercial vehicles such as vans, lorries, over-the-road tractors for semi-trailers etc.	LCV	LCV
29202	Manufacture of trailers and semi-trailers for transport of goods or passengers	HCV	HCV
29201	Manufacture of bodies, including cabs for motor vehicles	Bodies of vehicle	Suppliers
29303	Manufacture of car seats	Seat	Suppliers
29103	Manufacture of chassis fitted with engines for the motor vehicles included in this class	Chassis	Suppliers
29104	Manufacture of motor vehicle engines	Engine	Suppliers
29304	Manufacture of motor vehicle electrical equipment, such as generators, alternators, spark plugs, ignition wiring harnesses, power window and door systems, assembly of purchased gauges into instrument panels, voltage regulators, etc.	Electrical equipment generator, ignition	Suppliers

29301	Manufacture of diverse parts and accessories for motor vehicles such as brakes, gearboxes, axles, road wheels, suspension shock absorbers, radiators, silencers, exhaust pipes, catalysers, clutches,	other parts & accessories	Suppliers
29209	Manufacture of other attachments to motor vehicles n.e.c.	other parts & accessories	Suppliers
29302	Manufacture of parts and accessories of bodies for motor vehicles such as safety belts, airbags, doors, bumpers	other parts & accessories	Suppliers
30313	Manufacture of parts and accessories of three wheelers and motorcycles including side cars	other parts & accessories	Suppliers

*Table A1: List of Industry codes related to automobile & components & mapping to sectors added in GCAM*

*Source: Authors' compilation*

Note: Battery was also added as one of the component under suppliers and steel and rubber for automobile as separate industries, data for which sourced from literature.

*Table A2: Per unit energy intensity in 2020*

Category	Energy intensity (GJ/unit)
Passenger car	5.97
2W	0.17
3W	0.95
LCV	4.65
HCV	20.96
Bodies for motor vehicles	0.34
Chassis	0.04
Other parts & accessories	0.01
Seat	0.02
Engine	3.67
Electrical equipment generator, ignition	1.75

*Source: Authors' analysis*

## **Annexure 2: Data on auto OEMs and upstream suppliers**

This section captures key data inputs related to automobile production in India, per unit energy requirement to manufacture vehicles and components derived from ASI and other information related to average battery capacity and material use in vehicles.

*Table A3: Automobile production in India*

Category	2014-15	2015-16	2019-20	2020-21
Passenger Cars	24,22,158	25,65,970	21,56,868	17,72,972
Utility Vehicles	6,26,296	7,17,809	11,36,209	11,82,144
Vans	1,72,965	1,81,266	1,31,487	1,07,164
<b>Total Passenger vehicles</b>	<b>32,21,419</b>	<b>34,65,045</b>	<b>34,24,564</b>	<b>30,62,280</b>
M&HCVs	2,68,858	3,41,287	2,32,414	1,81,242
LCVs	4,29,740	4,45,405	5,24,311	4,43,697
<b>Total Commercial vehicles</b>	<b>6,98,298</b>	<b>7,86,692</b>	<b>7,56,725</b>	<b>6,24,939</b>
<b>Three wheelers</b>	<b>9,49,019</b>	<b>9,34,104</b>	<b>11,32,982</b>	<b>6,14,613</b>
Scooters	47,22,747	52,76,138	60,27,198	45,59,222
Motorcycles	1,30,11,219	1,28,16,203	1,43,56,051	1,31,54,501
Mopeds	7,55,345	7,37,886	6,49,678	6,36,218
<b>Total Two wheelers</b>	<b>1,84,89,311</b>	<b>1,88,30,227</b>	<b>2,10,32,927</b>	<b>1,83,49,941</b>

Source: Authors' compilation from [SIAM annual reports](#).

*Table A4: Information on Battery, Steel and rubber use in vehicles*

<b>Battery</b>	
Category	Battery Capacity (in Kwh)
2W	<a href="#">4</a>
3W	<a href="#">8.9</a>
Car	<a href="#">40</a>
LCV	<a href="#">50</a>
HCV	<a href="#">258</a>
<b>Rubber</b>	

Category	<a href="#">Rubber per unit (in kg)</a>
2W	12.6
3W	23.59
Car	84
LCV	402.5
HCV	2572.5
<b>Steel</b>	
Category	<a href="#">Steel per unit (in kg)</a>
2W	117
3W	219.05
Car	780
LCV	3737.5
HCV	<a href="#">5000</a>

Source: Authors' analysis

Note: Around 500 MJ of electricity is required to manufacture each kWh of battery capacity for EVs, not including other steps of the supply chain, such as mining and processing of materials.

### Annexure 3: Other model assumptions

Table A5: Socio-economic assumptions for India

	2020	2025	2030	2035	2040	2045	2050	
Population	1380000	1445010	1503640	1553720	1592690	1620620	1639180	(in thousands)
GDP growth CAGR		7.5%	6.8%	6.1%	5.5%	5.0%	4.5%	

Source: Authors' analysis

Table A6: Primary fuel CO<sub>2</sub> coefficients in GCAM

Fuel	MTC/EJ
Coal	26.3
Gas	15.3
Refined liquids	19.1

*Source: Authors' analysis*