



Light Electric Vehicles, Mobility Vehicles, E-Motorcycles & Micro-EVs (Quadricycles) 2013-2023

By Edward Benjamin
Managing Director, eCycleElectric Consultants

Edited and published by IDTechEx

Contents

Page

1.	EXECUTIVE SUMMARY AND CONCLUSIONS	1
1.1.	Forecast for numbers of LEVs sold globally to 2025	2
1.2.	Pricing	2
1.3.	Market value forecast	3
1.4.	Reasons for growth	6
1.4.1.	Competition and profitability	6
1.4.2.	Opportunities	6
1.4.3.	Typical requirement	7
2.	INTRODUCTION TO LIGHT ELECTRIC VEHICLES	9
2.1.	Definition of a light electric vehicle	9
2.2.	E-motorcycles	10
2.2.1.	E-bikes and e-motorcycles compared	10
2.2.2.	Record-breaking e-motorcycles	12
2.3.	Choices of LEV	13
2.3.1.	Rocket drag bike USA	22
2.3.2.	Moveo foldable scooter Hungary	23
2.4.	The Industry of LEVs	23
2.4.1.	Taiwan and China	24
2.4.2.	Outside Taiwan and China	24
2.4.3.	Too much cost cutting	25
2.5.	Tricycles to reduce accidents and help policing	26
3.	REQUIREMENTS FOR LEVS	29
3.1.	How good does it have to be?	29
3.2.	What retail price?	30
4.	TYPES OF LEV AND REGULATIONS	33
4.1.	What is an electric bicycle?	33
4.1.1.	Pedelec	33
4.1.2.	Power on Demand bikes and other categories	34
4.1.3.	Electric vehicles for disabled and others	34
4.1.4.	Power restriction	34
4.1.5.	Notable regulations	34
4.2.	Universal Technical Terms for Ebikes	35

5.	MOBILITY FOR THE DISABLED – THE SECTOR WITH THE MOST COMPELLING AND ENDURING NEED	37
5.1.	The demographic time-bomb	37
5.1.1.	Ageing population and the dependent elderly	38
5.1.2.	Laws make mobility easier	39
5.2.	Types of mobility vehicle	39
5.2.1.	Growth by new market segments	40
5.2.2.	Interchina Industry Group China	42
5.2.3.	Solar powered power chair in 2013	43
5.3.	Market drivers	44
5.3.1.	Geographical distribution	44
5.3.2.	Needs creating new segments	45
5.3.3.	What is driving regional differences?	47
5.3.4.	Zhejiang R&P Industry China	47
5.3.5.	Pride Mobility, USA	48
5.4.	Listing of manufacturers	49
5.5.	Market forecasts 2012-2022	51
5.5.1.	Growth by creating new markets	51
6.	LEV TECHNOLOGIES	53
6.1.	Battery Technology – as currently used in LEVs, on a pack level	53
6.1.1.	SVRLA strengths and weaknesses	53
6.1.2.	Battery packagers	55
6.1.3.	Battery Packs from China	56
6.1.4.	Power management and user interface	57
6.1.5.	Electric motor controller	58
6.1.6.	Motor Controls:	59
6.1.7.	Accessory features:	59
6.1.8.	Chinese Coin Charger	61
6.1.9.	Energy harvesting	62
6.1.10.	User Interface	62
6.1.11.	Real Time Data Logging and Reporting	64
6.1.12.	Infrastructure challenges and Government incentives	64
6.2.	Examples of battery suppliers to this sector	65
6.2.1.	Advanced Battery Technologies (ABAT) China	65
6.2.2.	Leyden Energy USA	66
6.2.3.	PowerGenix USA	68
6.2.4.	ReVolt Technologies Ltd Switzerland	68
6.2.5.	Toshiba Japan	69
7.	LEV STANDARDS AND COMPONENT INDUSTRIAL TRENDS	71
7.1.	Standards Efforts	71
7.2.	Component industry trends	71

7.3.	LEV electric motor industry	73
7.4.	Controller industry	74
7.5.	Wiring harness and connectors	74
8.	LEV MARKETS, MARKET DRIVERS AND FORECASTS	75
8.1.	Markets by territory	75
8.1.1.	China	77
8.1.2.	Japan	78
8.1.3.	India	78
8.1.4.	Europe	78
8.1.5.	USA	79
8.1.6.	Worldwide	79
8.2.	Markets by providers	79
8.3.	Bicycle Brands with ebikes or expected to have ebikes soon:	80
8.3.1.	USA	80
8.3.2.	European Bike Brands	80
8.3.3.	Netherlands brands:	81
8.4.	Channels of distribution	81
8.5.	Market forecasts and drivers	82
8.6.	Drivers of market	83
8.6.1.	Fuel price	83
8.6.2.	Fuel availability	83
8.6.3.	Efficiency	83
8.6.4.	Cost of government subsidy	84
8.6.5.	Traffic congestion	84
8.6.6.	Parking congestion	84
8.6.7.	Urbanization	84
8.6.8.	Air pollution	84
8.6.9.	Government regulation	84
8.6.10.	Personal responsibility	84
8.6.11.	Total cost of ownership	85
8.6.12.	Aging populations	85
8.6.13.	Living in apartments	85
8.6.14.	Negative factors	85
8.6.15.	Bans in Malaysia and elsewhere?	87
9.	CAR-LIKE VEHICLES NOT HOMOLOGATED AS CARS: MICROEV, QUADRICYCLE, E-TRIKE, NEV, GOLF CAR	89
9.1.	Many names, common factors	89
9.2.	Car-like vehicles that evade restrictions, taxes and other costs	91
9.3.	Philippines: big new commitments to e-trikes	93
9.4.	Listing of manufacturers beyond golf cars	94
9.5.	Golf cars	97

9.5.1.	What is included	97
9.5.2.	Market drivers	98
9.5.3.	Listing of manufacturers	101
9.5.4.	Market forecasts 2012-2023	102
APPENDIX 1: IDTECHEX EV PUBLICATIONS AND CONSULTANCY		107
APPENDIX 2: LISTINGS OF LEV BRANDS, OEMS, COMPONENT MAKERS		125
APPENDIX 3: ADDITIONAL REGULATORY SUPPORT		145

Tables

Page

Table 1.1	LEV number, unit value in dollars ex-factory and total global market value 2012-2023	3
Table 2.1	Prices and performance of electric two wheelers – e-motorcycles and LEVs compared	10
Table 5.1	Statistics relevant to the challenge to society caused by ageing population	38
Table 5.2	Evolution of three families of powered vehicles for the disabled	41
Table 5.3	Evolution of power chairs 1980 to 2010	42
Table 5.4	Evolution of scooters for the disabled 1980 to 2010	43
Table 5.5	The continental percentage split of markets for vehicles for the disabled by value in 2010	45
Table 5.6	The percentage split of market for vehicles for the disabled by country within Europe	45
Table 5.7	The numbers in thousands of scooters plus power chairs that were and will be sold in Europe 2005 to 2015	45
Table 5.8	Features of mobility vehicles that may hold up the price by offering more in future	46
Table 5.9	The percentage distribution of manufacture between Taiwan and Mainland China by value of vehicles for the disabled 2005, 2010 and 2015	49
Table 5.10	Market for EVs for the disabled by geographical region, ex works pricing and percentage split in 2005, 2010 and 2020	49
Table 5.11	82 examples of manufacturers of EVs for the disabled by country	49
Table 5.12	Global sales of EVs used as mobility aids for the disabled by number, ex-factory unit price in thousands of dollars and total value in billions of dollars, 2012-2023, rounded	52
Table 8.1	World e-bike sales (Units) estimated for 2007-2010	77
Table 8.2	Chinese cities banning or restricting electric bikes.	87
Table 9.1	Listing of manufacturers beyond golf cars	94
Table 9.2	MicroEV quadricycle forecasts 2012-2023	97
Table 9.3	19 examples of golf EV manufacturers	102
Table 9.4	Global sales of electric golf cars and motorised caddies in number thousands, ex-factory unit price in thousands of dollars and total value in billions of dollars 2012-2023, rounded	102
Table 9.5	Geographical split of golf EV sales by value 2010, 2015 and 2020	103

Figures

Page

Fig. 1.1	LEV number in thousands 2012-2023	4
Fig. 1.2	LEV unit value in dollars ex-factory 2012-2023	5
Fig. 1.3	LEV total global market value in dollar billions 2012-2023	5
Fig. 2.1	The 2013 Motoczysz	13
Fig. 2.2	Voltitude folding pedelec	14
Fig. 2.3	Chinese domestic ebike left and Currie IZ ViaRapido ebike right	14
Fig. 2.4	Electric motor scooters in China	15
Fig. 2.5	Electric moped by Ultra Motor	15
Fig. 2.6	Electric motorcycle by Vectrix	15
Fig. 2.7	Electric mini scooters by Currie Technologies	16
Fig. 2.8	Segway personal transporter	16
Fig. 2.9	3 wheel LEV with windshield and cover	17
Fig. 2.10	The folding Yike Bike from New Zealand	17
Fig. 2.11	Ebike by Ultra Motor A2B	18
Fig. 2.12	LEV Shop Window with ebike.	18
Fig. 2.13	EU small folding ebike	18
Fig. 2.14	Chinese ebike loaded down	19
Fig. 2.15	Chinese ebike rider	19
Fig. 2.16	Chinese ebike with two riders	20
Fig. 2.17	Ebikes used at Chinese factories	20
Fig. 2.18	China LEVs at stop light	21
Fig. 2.19	Ebike Food Delivery for Papa John's in China	21
Fig. 2.20	Ebike food delivery by A2B Ultra Motor	21
Fig. 2.21	LEV four wheeler for seniors – a crossover from LEVs to mobility for the disabled	22
Fig. 2.22	Shawn Lawless Rocket drag bike	22
Fig. 2.23	Moveo foldable scooter Hungary	23
Fig. 2.24	IBD Bloomfield Bikes Ebike Display in CT USA	25
Fig. 2.25	TriBred electric Trikke patrol vehicle and general purpose version	26
Fig. 2.26	Electric tricycle	27
Fig. 2.27	Examples of three wheel leisure and delivery vehicles promoted at EVS26 in California May 2012	28
Fig. 3.1	Chinese Repair in the Street	30
Fig. 3.2	Chinese Ebike Tire Repair	30
Fig. 3.3	Escooter or Ebike?	31
Fig. 3.4	Traditional Chinese Ebike	31
Fig. 3.5	Optibike USA "The Ferrari of Electric Bikes"	31
Fig. 3.6	Small French Folding Ebike	32
Fig. 3.7	DK City db0 Ebike	32
Fig. 5.1	Percentage of dependent elderly 1970 to 2040	38
Fig. 5.2	New Pihsiang Shoprider pure electric mobility vehicle for the disabled	41

Fig. 5.3	The Electric Car (INEC-KARO) for the disabled from Interchina Industry Group	42
Fig. 5.4	Solar powered power chair vehicle for the mobility impaired	44
Fig. 5.5	Zhejiang R&P Industry ES 413	47
Fig. 5.6	Pride Jazzy – making new things possible	48
Fig. 6.1	Battery pack interiors	55
Fig. 6.2	Controller by Suzhou Bafang	58
Fig. 6.3	Lead Acid Battery Charger by High Power	60
Fig. 6.4	Solar parking lot for charging by Sanyo	62
Fig. 6.5	User Interface by Gepida	63
Fig. 6.6	User Interface by BionX	63
Fig. 6.7	UI 1 Photo with phone Interface	64
Fig. 6.8	Toshiba e-bike battery	70
Fig. 7.1	SVRLA battery sizes by Long	72
Fig. 7.2	Transparent battery box	72
Fig. 7.3	Innovative Chinese motor	73
Fig. 7.4	High speed brushless motor by Bafang	73
Fig. 7.5	Typical connector	74
Fig. 8.1	Example of China exports to the EU	76
Fig. 8.2	Hero Electric of India Flash Ebike 1	77
Fig. 8.3	Electric vehicle energy consumption per passenger kilometer with full occupation.	83
Fig. 9.1	Car-like vehicles not homologated as cars, in the context of two wheelers and Europe. Love them or hate them?	90
Fig. 9.2	The Daimler Smart, left, is a mainstream car subject to tax, insurance, crash tests etc. whereas the G-Whiz from India, right, is registered as a quadricycle and was the best-selling pure electric car in the UK for ten years with sales of only hundreds yearly	91
Fig. 9.3	Renault Twizy quadricycle which is selling over ten thousand within two years from launch. The standard model has no windows	92
Fig. 9.4	Chinese micro-EV cars in China. Most of them have three wheels	92
Fig. 9.5	E-trikes	94
Fig. 9.6	Tonaro golf and general purpose vehicle from China	99
Fig. 9.7	Suzhou Eagle two and four seat golf cars from China	100
Fig. 9.8	Yongkang Fourstar golf vehicles from China	100
Fig. 9.9	Shadong Wuzheng golf cars from China	101
Fig. 9.10	Jinhua Ryder golf car from China	101