



MATERIALS RECOVERY

2017







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CEO

Qatar government is cognizant of the ill effects on
the environment and the **NEED FOR
A ROBUST MATERIAL
RECOVERY SECTOR**

CEO's MESSAGE

// The material recovery sector presents significant revenue generating opportunities in multiple sub-segments such as CDW, paper and rubber recovery.

Small and medium-sized enterprises (SMEs) are essential enablers of Qatar's aspiration to build a diversified and sustainable economy. As the private sector development arm of the Government, we hold our national strategic development agenda – Qatar National Vision 2030 – central to all of our endeavors.

We hold a firm belief that it is our core responsibility to contribute to the ongoing efforts of diversifying our sources of national income and creating a knowledge-based economy. We always knew that in order to chart the type of progressive economic and social path envisioned by our State, we need to become imaginative and proactive in our approach for our future generations.

In doing so, QDB's role is not limited to financing enterprises, as it provides SMEs and entrepreneurs with a wide range of non-financial services. Our ultimate objective is to become a "partner of first resort" for Qatar's current and future entrepreneurs and SMEs. Thus, we realized that one of the most important ways to achieve our aspiration is through enabling access to granular market insights and trends, which is a pre-requisite for strong business ventures.

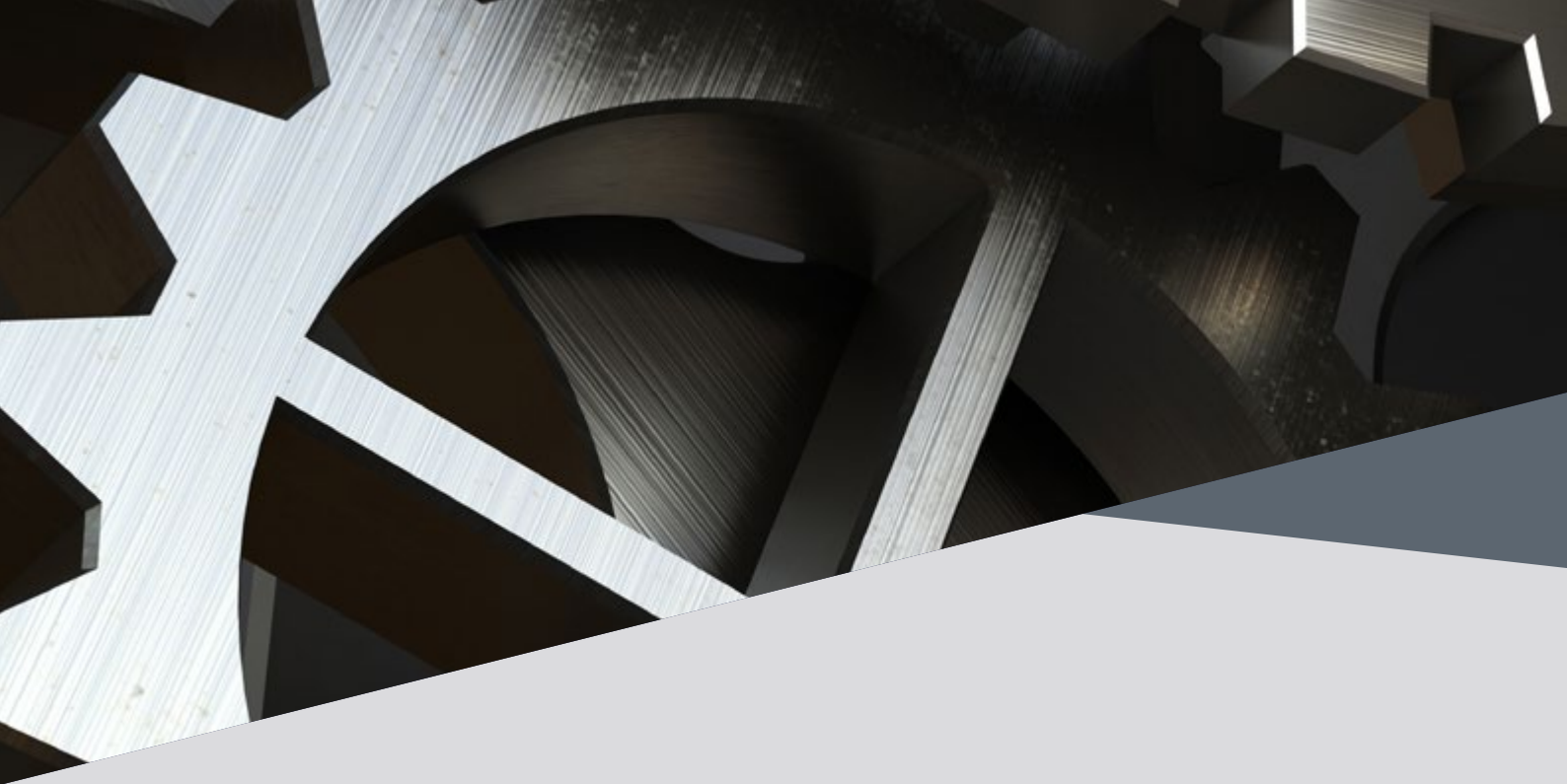
In line with our above objectives to establish a reliable data and analysis, and in order to extend a meaningful support to Qatari entrepreneurs and SMEs, QDB intends to publish a series of reports on potential opportunities available across various sectors in the local market. These series aim to provide entrepreneurs with potential opportunities and perspectives about these sectors, including competitive sectorial landscape and data about existing companies.

This report covers 'Materials Recovery', a sector that is likely to play an instrumental role in dealing with the environmental challenges facing Qatar. Segregation of waste at source is a major challenge facing solid waste management activities in the country. The rate of recovery and recycling of waste is linked to the stage of waste management at which an item is captured and separated.

Needless to say that there is a large quantum of waste generated in Qatar, majority of which is not recovered and ends up in landfills. These landfills are also running out of capacity. Our government is cognizant of the environmental impact of these landfills and the need for a robust material recovery. Various initiatives are currently under consideration, which is likely to transform the material recovery sector, making it more attractive for SMEs.

On behalf of everyone at Qatar Development Bank, I hope that you will benefit from this report.

Abdulaziz bin Nasser al-Khalifa
Chief Executive Officer



List of Charts	08	3 Plastic.....	62
List of Tables.....	12	3.1. Overview of Plastic Scrap.....	62
List of Figures.....	14	3.2. Plastic Recovery Process	66
Acronyms & Abbreviations	16	3.3. Recovered Plastic Applications	68
Executive Summary	18	3.4. Global Plastic Recovery Market Overview....	68
1. Introduction	22	3.5. GCC Plastic Recovery Market Overview	70
1.1. Sector Overview	22	3.6. Qatar Plastic Recovery Market Overview	72
1.2. Materials Recovery Value Chain	24	4 Paper.....	80
1.3. Identified Product Segments.....	24	4.1. Overview of Paper Scrap.....	80
1.4. HS Codes of Product Segments.....	25	4.2. Paper Recovery Process	82
2 Metals	28	4.3. Recovered Paper Applications	83
2.1. Overview of Metal Scrap.....	28	4.4. Global Paper Recovery Market Overview.	83
2.2. Metal Recovery Process	32	4.5. GCC Paper Recovery Market Overview....	85
2.3. Recovered Metal Applications	34	4.6. Qatar Paper Recovery Market Overview ..	88
2.4. Global Metal Recovery Market Overview.	34	5 Rubber	96
2.5. GCC Metal Recovery Market Overview....	40	5.1. Overview of Rubber Scrap	96
2.6. Qatar Metal Recovery Market Overview...	43	5.2. Rubber Recovery Process.....	98
		5.3. Recovered Rubber Applications.....	100
		5.4. Global Rubber Recovery Market Overview	100
		5.5. GCC Rubber Recovery Market Overview	104
		5.6. Qatar Rubber Recovery	
		Market Overview.....	105



TABLE OF CONTENTS

6	E-waste and Battery.....	116	8	Waste Oil.....	150
6.1.	Overview of E-waste and Battery Scrap..	116	8.1.	Overview of Waste Oil.....	150
6.2.	E-waste and Battery Recovery Process...	119	8.2.	Waste Oil Recovery Process	153
6.3.	Recovered E-waste and Battery Applications	122	8.3.	Recovered Waste Oil Applications.....	156
6.4.	Global E-waste and Battery Recovery Market Overview.....	122	8.4.	Global Waste Oil Recovery Market Overview.....	156
6.5.	GCC E-waste and Battery Recovery Market Overview.....	125	8.5.	GCC Waste Oil Recovery Market Overview.....	158
6.6.	Qatar E-Waste and Battery Recovery Market Overview.....	127	8.6.	Qatar Waste Oil Recovery Market Overview.....	159
7	Glass	138	9	Recycled Aggregates	166
7.1.	Overview of Glass Scrap	138	9.1.	Overview of Aggregates	166
7.2.	Glass Recovery Process.....	140	9.2.	Aggregates Recovery Process	168
7.3.	Recovered Glass Applications.....	141	9.3.	Recovered Aggregates Applications.....	170
7.4.	Global Glass Recovery Market Overview	141	9.4.	Global Aggregates Recovery Market Overview.....	170
7.5.	GCC Glass Recovery Market Overview...	143	9.5.	GCC Aggregates Recovery Market Overview.....	171
7.6.	Qatar Glass Recovery Market Overview .	144	9.6.	Qatar Aggregates Recovery Market Overview.....	171
				Conclusion.....	178
				References	180



Chart 1:	Split of MSW in Qatar, 2015 (%).....	22
Chart 2:	Split of CDW in Qatar, (%).....	23
Chart 3:	Number of Registered Vehicles in Qatar, 2010-2025F ('000 Units)	23
Chart 4:	Global Steel Production, 2011-2015 (Million Tons).....	34
Chart 5:	Global Scrap Steel Use, 2011-2015 (Million Tons).....	34
Chart 6:	Split of Global Scrap Steel, By Source (2015).....	35
Chart 7:	Global Steel Scrap Trade, 2011-2015 (Million Tons)	35
Chart 8:	Leading Steel Scrap Importers (2015).....	35
Chart 9:	Leading Steel Scrap Exporters (2015)	35
Chart 10:	Aluminum Consumption, By Sector (2007).....	36
Chart 11:	Global Aluminum Production, 2011-2015 (Million Tons)	37
Chart 12:	Global Aluminum Used Beverage Can Recycling Rates (2009)	37
Chart 13:	Global Aluminum Scrap Trade, 2010-2014 (Million Tons).....	38
Chart 14:	Leading Aluminum Scrap Importers (2014)	38
Chart 15:	Leading Aluminum Scrap Exporters (2014)	38
Chart 16:	Global Copper Production, 2011-2015 (Million Tons)	38
Chart 17:	Copper Consumption, By Sector (2014).....	39
Chart 18:	Global Secondary Copper Production, 2011-2015 (Million Tons).....	39
Chart 19:	Global Copper Scrap Trade, 2010-2014 (Million Tons).....	39
Chart 20:	Leading Copper Scrap Importers (2014)	39
Chart 21:	Leading Copper Scrap Exporters (2014)	39
Chart 22:	GCC Steel Scrap Export, 2012-2014 (Million Tons).....	40
Chart 23:	GCC Steel Scrap Import, 2012-2014 (Million Tons).....	40
Chart 24:	GCC Aluminum Scrap Export, 2012-2014 (Million Tons).....	40
Chart 25:	GCC Aluminum Scrap Import, 2012-2014 (Million Tons).....	40
Chart 26:	GCC Copper Scrap Export, 2012-2014 (Million Tons)	41
Chart 28:	Metal Scrap Generated from MSW in Qatar, 2010-2016E (Tons).....	43
Chart 29:	Metal Scrap Generated from Shredding of ELVs, 2010-2016E (Tons)	44
Chart 30:	Number of ELV in Qatar, 2010-2016E.....	44
Chart 31:	CDW Generated in Qatar, 2010-2016E (Million Tons)	44
Chart 32:	Steel Scrap Generated from CDW in Qatar,	45
Chart 33:	Metal Scrap Generated from Bulky Waste in Qatar, 2010-2016E (Tons)	45
Chart 34:	Qatar's Steel Scrap Export, 2005-2015 ('000 Tons).....	46
Chart 35:	Qatar's Stainless Steel Scrap Export, 2006-2015 ('000 tons)	46
Chart 36:	Qatar's Steel Scrap Import, 2005-2015 ('000 Tons).....	47
Chart 37:	Qatar's Stainless Steel Scrap Import, 2005-2015 ('000 tons)	47
Chart 38:	Qatar's Aluminum Scrap Export, 2005-2015 ('000 Tons).....	48
Chart 39:	Qatar's Aluminum Scrap Import, 2005-2015 (Tons).....	48
Chart 40:	Qatar's Copper Scrap Export, 2005-2015 ('000 Tons)	49
Chart 41:	Qatar's Copper Scrap Import, 2005-2015 (Tons)	49
Chart 42:	Metal Scrap Generation from MSW in Qatar, 2017F-2025F (Tons).....	50
Chart 43:	Number of ELV in Qatar, 2017F-2025F.....	50



LIST OF CHARTS

Chart 44:	Metal Scrap Generation from Shredding of ELVs, 2017F-2025F (Tons)	51
Chart 45:	CDW Generation in Qatar, 2017F-2025F (Million Tons)	52
Chart 46:	Steel Scrap Generation from CDW in Qatar, 2017F-2025F (Tons)	52
Chart 47:	Metal Scrap Generation from Bulky Waste, 2017F-2025F (Tons)	53
Chart 48:	Qatar's Crude Steel Production, 2010-2015 ('000 Tons)	53
Chart 49:	Qatar's Trade of Semi-finished and Finished Steel Products, 2010-2014 ('000 Tons)	53
Chart 50:	Qatar's Apparent Steel Use for Finished Products, 2010-2014 ('000 Tons)	54
Chart 51:	GCC Primary Aluminum Production, 2015 (Million Tons)	54
Chart 52:	Qatar's Primary Aluminum Production, 2011-2015 ('000 Tons)	54
Chart 53:	Qatar's Aluminum Import, 2010-2015 (Tons)	55
Chart 54:	Qatar's Aluminum Export, 2010-2015 (Million Tons)	55
Chart 55:	Qatar's Copper Import, 2010-2015 (Tons)	55
Chart 56:	Qatar's Copper Export, 2010-2015 (Tons)	56
Chart 57:	Qatar's Steel Scrap Export Price, 2005-2015	57
Chart 58:	Qatar's Stainless Steel Scrap Export Price,	57
Chart 59:	Qatar's Aluminum Scrap Export Price, 2005-2015 (QAR/Ton)	58
Chart 60:	Qatar's Copper Scrap Export Price, 2005-2015 (QAR/Ton)	58
Chart 61:	Global Plastic Production, 2004-2014 (Million Tons)	68
Chart 62:	Treatment of Plastic Waste in the EU (2014)	68
Chart 63:	Treatment of Plastic Waste in the US (2013)	69
Chart 64:	Global Plastic Scrap Trade, 2010-2014 (Million Tons)	69
Chart 65:	Leading Plastic Scrap Exporters (2014)	70
Chart 66:	Leading Plastic Scrap Importers (2014)	70
Chart 67:	GCC Plastic Scrap Export, 2012-2014 (Million Tons)	70
Chart 68:	GCC Plastic Scrap Import, 2012-2014 (Million Tons)	70
Chart 69:	Plastic Scrap Generated from MSW in Qatar,	72
Chart 70:	Plastic Products Recovery in Qatar, By Segment (2015)	72
Chart 71:	Qatar's Plastic Scrap Export, 2005-2015 ('000 Tons)	73
Chart 72:	Qatar's Plastic Scrap Import, 2005-2015 ('000 Tons)	73
Chart 73:	Plastic Scrap Generation from MSW in Qatar, 2017F-2025F (Tons)	74
Chart 74:	Plastic Products Consumption in Qatar, By Segment (2015)	75
Chart 75:	Qatar's Plastic Scrap Export Price,	76
Chart 76:	Global Paper and Paperboard Production, 2010-2014 (Million Tons)	83
Chart 77:	Paper Consumption, By Product Segment (2014)	83
Chart 78:	Leading Paper and Paperboard Producers (2014) (Million Tons)	83
Chart 79:	Global Recovered Paper Production, 2010-2014 (Million Tons)	84
Chart 80:	Leading Recovered Paper Producers (2014, Million Tons)	84
Chart 81:	Global Recovered Paper Trade, 2010-2014 (Million Tons)	84
Chart 82:	Leading Recovered Paper Exporters (2014)	84
Chart 83:	Leading Recovered Paper Importers (2014)	85
Chart 84:	GCC Recovered Paper Export, 2012-2014 (Million Tons)	85



Chart 85: GCC Recovered Paper Export (2014)	85
Chart 86: GCC Recovered Paper Import, 2012-2014 (Million Tons).....	85
Chart 87: GCC Recovered Paper Import	86
Chart 88: Paper Scrap Generated from MSW in Qatar,	88
Chart 89: Paper Products Recovery in Qatar, By Segment (2015).....	88
Chart 90: Qatar's Recovered Paper Export, 2005-2015 ('000 Tons).....	89
Chart 91: Qatar's Recovered Paper Import, 2005-2015 ('000 Tons).....	89
Chart 92: Paper Scrap Generation from MSW in Qatar, 2017F-2025F ('000 Tons).....	90
Chart 93: Qatar's Recovered and Scrap Paper Export Price, 2005-2015 (QAR/Ton)	91
Chart 94: Rubber Consumption, By End Use (2015)	96
Chart 95: Global Rubber Production, 2011-2015 (Million Tons)	100
Chart 96: ELT Arising in Europe, 2009-2013 (Million Tons)	101
Chart 97: End-use of ELT Arising in Europe (2013).....	101
Chart 98: ELT Arising in Japan, 2010-2014 (Million Units).....	101
Chart 99: End-use of ELT in Japan, 2010-2014 ('000 tons).....	101
Chart 100: End-use of Thermally Recycled Rubber in Japan (2014).....	102
Chart 101: ELT Arising in the US, 2007-2015 (Million Tons)	102
Chart 102: Tire Recycling Rate in the US, 2007-2015	102
Chart 103: End-use of ELT Arising in the US (2015).....	102
Chart 104: Global Rubber Scrap Trade, 2011-2015 (Million Tons)	103
Chart 105: Leading Rubber Scrap Importers (2015)	103
Chart 106: Leading Rubber Scrap Exporters (2015).....	103
Chart 107: GCC Rubber Scrap Export, 2012-2014 (Tons)	104
Chart 108: UAE Rubber Scrap Export under HS Code 4012, 2012-2015 (tons)	104
Chart 109: GCC Rubber Scrap Import, 2012-2014 (Tons)	104
Chart 110: Number of Tire Scrap Generated In Qatar, 2010-2016E (Million Tires)	105
Chart 111: Tire Scrap Generated in Qatar by Material, 2010-2016E (Tons)	106
Chart 112: Crumb Rubber Segmentation in Qatar, By Size (2015)	106
Chart 113: Qatar's Rubber Scrap Export (HS Code 4004), 2005-2015 ('000 tons).....	107
Chart 114: Qatar's Used Tires Export (HS Code 401220), 2005-2015 (Tons).....	107
Chart 115: Qatar's Rubber Scrap Import (HS Code 4004), 2005-2015 ('000 tons).....	108
Chart 116: Qatar's Used Tires Import (HS Code 401220), 2005-2015 (Tons)	108
Chart 117: Number of Scrap Tire Generation in Qatar, 2017F-2025F (Million Tires)	109
Chart 118: Tire Scrap Generation in Qatar by Material, 2017F-2025F (Tons).....	109
Chart 119: Qatar's Rubber and Rubber Product Import, 2010-2015 (Tons)	110
Chart 120: Qatar's Rubber Scrap Export Price (HS Code: 4004), 2005-2015 (QAR/ton).....	111
Chart 121: Global E-waste Generation, 2010-2014 (Million Tons).....	122
Chart 122: E-waste Generation, By Continent (2014).....	122
Chart 123: E-waste Generation, By Category (2014).....	123
Chart 124: Global Lead Production, 2011-2015 (Million Tons)	123
Chart 125: Global Lead Consumption, By End Use (2015).....	123



LIST OF CHARTS

Chart 126: Lead-Acid Battery Revenue, By Region (2014)	124
Chart 127: Lead-Acid Battery Revenue, By Application (2014)	124
Chart 128: Per-Capita E-waste Generation (Kg) (2014)	125
Chart 129: GCC E-waste and Battery Export, 2012-2014 (Tons).....	125
Chart 130: GCC E-waste and Battery Import, 2012-2014 (Tons)	125
Chart 131: E-waste Generated in Qatar, 2010-2016E (Tons).....	127
Chart 132: Number Of Scrap Batteries Generated In Qatar, 2010-2016E.....	127
Chart 133: Battery Scrap Generated in Qatar by Material, 2010-2016E (Tons).....	128
Chart 134: Qatar's E-waste and Battery Scrap Export,	128
Chart 136: E-waste Generation in Qatar, 2017F-2025F (Tons).....	129
Chart 135: Qatar's E-waste and Battery Scrap Import,	129
Chart 137: Number of Scrap Batteries Generation in Qatar, 2017F-2025F.....	130
Chart 138: Battery Scrap Generation in Qatar by Material, 2017F-2025F (Tons).....	130
Chart 139: Qatar's Lead-Acid Battery Import,	131
Chart 140: Qatar's E-waste and Battery Scrap Export Price, 2005-2015 (QAR/Ton)	132
Chart 141: Glass Scarp in the US, 2012-2013 (Million Tons).....	141
Chart 142: Glass Recovered in the US (2013).....	141
Chart 143: Global Glass Scrap and Cullet Trade, 2011-2015 (Million Tons)	142
Chart 144: Leading Glass Scrap Exporters (2015)	142
Chart 145: Leading Glass Scrap Importers (2015)	143
Chart 146: GCC Glass Scrap Export, 2012-2014 (Tons).....	143
Chart 147: GCC Glass Scrap Import, 2012-2014 (Tons).....	143
Chart 148: Glass Scrap Generated from MSW in Qatar,	144
Chart 149: Qatar's Glass Scrap and Cullets Export,	144
Chart 151: Glass Scrap Generation from MSW in Qatar, 2017F-2025F (Tons)	145
Chart 150: Qatar's Glass Scrap and Cullets Import,	145
Chart 152: Qatar's Glass Scrap Export Prices, 2005-2015 (QAR/Ton)	146
Chart 153: Global Lubricant Market, By End-use (2014).....	156
Chart 154: Global Lubricant Market, 2012-2014 (MMT).....	156
Chart 155: Waste Oil Collection Rate in the EU (2012)	157
Chart 156: WCO Collection in the US, 2010-2015 ('000 tons)	157
Chart 157: Consumption of WCO in the US, 2015.....	158
Chart 158: Source of Biodiesel Generation in the US (2015).....	158
Chart 159: Waste Oil Generated in Qatar, 2010-2016E (Tons)	160
Chart 160: Waste Oil Generation in Qatar, By Source (2015).....	160
Chart 161: Waste Oil Generation in Qatar, 2017F-2025F (Tons).....	161
Chart 162: Composition of CDW in the US (2013)	170
Chart 163: Aggregate Waste Generated from CDW in Qatar, 2010-2016E (Million Tons)	172
Chart 164: Aggregate Waste Generated from CDW in Qatar, 2017F-2025F (Million Tons)	172

LIST OF TABLES

Table 1: Segments Under Materials Recovery.....	24
Table 2: HS Codes of Metal Scrap.....	25
Table 3: HS Codes of Plastic Scrap.....	25
Table 4: HS Codes of Paper Scrap.....	26
Table 5: HS Codes of Rubber Scrap.....	26
Table 6: HS Codes of E-waste and Battery Scrap.....	26
Table 7: HS Codes of Glass Scrap	27
Table 8: HS Codes of Waste Oil.....	27
Table 9: Global Scrap Steel Use, By Region (Million Tons ²⁴).....	36
Table 10: Metal Recovery Companies in the GCC Market.....	42
Table 11: Classification of Plastic.....	63
Table 12: Plastic Recycling Rate in EU (2014).....	69
Table 13: Plastic Recovery Companies in the GCC Market	71
Table 14: Classification of Paper Waste	80
Table 15: Paper Recovery Companies in the GCC Market.....	87
Table 16: Percentage Mix of Rubber and Steel in Different Types of Tires.....	97
Table 17: Rubber Recovery Companies in the GCC Market	105
Table 18: Categories of E-waste	117
Table 19: Classification of Battery (Based On Chemical Composition).....	117
Table 20: E-waste and Battery Recovery Companies in the GCC Market.....	126
Table 21: Categories of Glass Scrap.....	139
Table 22: Glass Container Recycling Rate in the EU (2013)	142
Table 23: Categories of Waste Oil	151
Table 24: Waste Oil Recovery Companies in the GCC Market.....	159
Table 25: Waste Oil Generated by Type of Vehicle.....	159
Table 26: Recycled Aggregates Companies in the GCC Market.....	171





Figure 1: Waste Generated during 2016 (By Segment).....	19
Figure 2: Recycling Value Chain: Materials Recovery A Subset of the Recycling Value Chain	24
Figure 3: Metal Recovery Process	32
Figure 4: Business Model 1: Recovery of Scrap Metal.....	58
Figure 5: Business Model 2: Sorting and Trading of Non-Ferrous Metal Scrap.....	59
Figure 6: SWOT Analysis – Metal Recovery.....	59
Figure 7: Michael Porter’s Five Forces Model – Metal.....	60
Figure 8: Plastic Recovery Process	66
Figure 9: Business Model 1: Recovery of Plastic Granules.....	76
Figure 10: Business model 2: Sorting and Trading of Plastic Scrap	77
Figure 11: SWOT Analysis – Plastic Recovery.....	77
Figure 12: Michael Porter’s Five Forces Model – Plastic	78
Figure 13: Paper Recovery Process	82
Figure 14: Business model 1 (a): Recovery of Scrap Paper by Waste Management Company	92
Figure 15: Business Model 1(b): Recovery of Scrap Paper by Recovery Facility	92
Figure 16: Business Model 2: Export of Paper Bails	92
Figure 17: SWOT Analysis – Paper Recovery	93
Figure 18: Michael Porter’s Five Forces Model – Paper	94
Figure 19: Rubber Recovery Process.....	98
Figure 20: Business Model 1: Recovery of Scrap Tire.....	111
Figure 21: Business Model 2: Trade of Scrap Tire.....	112
Figure 22: SWOT Analysis – Rubber Recovery.....	113
Figure 23: Michael Porter’s Five Forces Model – Rubber.....	114
Figure 24: E-waste Recovery Process.....	119
Figure 25: Lead–Acid Battery Recovery Process.....	120
Figure 26: Business Model 1: Trading of E-waste	132
Figure 27: Business Model 2: Recovery of Lead–Acid Battery.....	133
Figure 28: SWOT Analysis – E-waste–Recovery.....	133
Figure 29: SWOT Analysis – Battery Recovery	134



LIST OF FIGURES

Figure 30: Michael Porter's Five Forces Model – E-waste and Battery	135
Figure 31: Glass Recovery Process	140
Figure 32: Business model 1: Trading of Scrap Glass.....	146
Figure 33: Business Model 2: Recovery of Scrap Glass	147
Figure 34: SWOT Analysis – Glass Recovery	147
Figure 35: Michael Porter's Five Forces Model – Glass	148
Figure 36: Waste Oil Recovery Process.....	153
Figure 37: WCO Recovery Process.....	155
Figure 38: Business Model 1: Recovery of Waste Oil	162
Figure 39: SWOT Analysis- Waste Oil Recovery	163
Figure 40: Michael Porter's Five Forces Model – Waste Oil.....	164
Figure 41: Life Cycle of a Building.....	167
Figure 42: Aggregates Recovery Process	168
Figure 43: Business Model 1: Recovery of Aggregates.....	173
Figure 44: Potential Business Model (B): On-site Recovery	174
Figure 45: Potential Business Model (B): Recovery of Complete CDW	174
Figure 46: SWOT Analysis- Recycled Aggregates	175
Figure 47: Michael Porter's Five Forces Model – Recycled Aggregates.....	176

ACRONYMS & ABBREVIATIONS

BIR	Bureau of International Recycling	LLDPE	Linear low-density polyethylene
BTU	British thermal unit	MDPS	Ministry of Development Planning and Statistics
CDW	Construction and demolition waste	MEK	Methyl Ethyl Ketone
CAGR	Compound Annual Growth Rate	Mm	Millimeter
DSWMC	Domestic Solid Waste Management Company	MMT	Million Metric Ton
E	Estimate	MRF	Material Recovery Facility
ELT	End-of-life tires	MSW	Municipal Solid Waste
ELV	End-of-life vehicle	MwH	Megawatt Hour
EPA	Environmental Protection Agency	OCC	Old Corrugated Containers
EU	European Union	PET	Polyethylene
E-waste	Electronic waste	PP	Polypropylene
F	Forecast	PVC	Poly Vinyl Chloride
FAOSTAT	Food and Agriculture Organization Statistics	QAR	Qatari Riyal
FIFA	Federation International de Football Association	QASCO	Qatar Steel Company
GCC	Gulf Cooperation Council	RCA	Recycled Concrete Aggregates
GDP	Gross Domestic Product	RoW	Rest of the World
GHG	Greenhouse Gases	RTFO	Renewable Transport Fuel Obligation
GPCA	Gulf Petrochemicals and Chemicals Association	SME	Small and Medium Enterprises
GRG	General Rubber Goods	SUV	Sports Utility Vehicle
HCV	Heavy commercial vehicle	Sqm	Square meter
HDPE	High-density polyethylene	UAE	United Arab Emirates
HS Code	Harmonized System Code	UNEP	United Nation Environment Program
ISIC	International Standard Industrial Classification	WAO	World Aluminum Organization
Kg	Kilogram	WCO	Waste Cooking Oil
LDPE	Low-density polyethylene		
LED	Light Emitting Diode		
Li-ion	Lithium Ion		





EXECUTIVE SUMMARY

Qatar will have to transform the way it deals with its waste in terms of source segregation, collection, sorting and regulations, to be able to improve the recovery rate of the Municipal Solid Waste (MSW). This change would significantly reduce the need to extract raw materials, thereby reducing carbon emissions and bringing in several environmental benefits. Material Recovery Facilities (MRFs) would play an important role in providing quality raw materials to the recycling industry. MRFs are designed to separate co-mingled recyclables into their individual material streams and prepare them for sale in local markets or exports depending on the demand and regulations prevalent in the Qatar market.

One of the biggest challenges faced by Qatar in solid waste management is segregation of waste at source. The proportion of waste recovered and recycled is directly related to the stage of the waste management cycle at which an item is captured. The key initiatives to increase material recovery rates include awareness campaigns (typically driven by governments) to highlight the benefits of recycling, development in technology, incentives for recycling, etc. However, these efforts do not bear results if source segregation is limited in the country, which is the case as of today.

Households and small businesses generate a large amount of solid waste. They must be provided with color-coded, see-through, plastic disposal bags to collect:

- Mixed recyclable containers – plastic bottles, trays, glass bottles and jars, metal cans, etc.
- Clean paper, magazines, newspapers, office papers, cardboard, etc.
- Net mixed waste (with food, textiles, wood, rubber, durables, unclean paper, etc.)

The maximum value of the recyclables are retained if the materials are segregated at source ensuring minimal contamination. Hence, source segregation and easy access to public recovery facilities are essential for materials recovery to be a sustainable business.

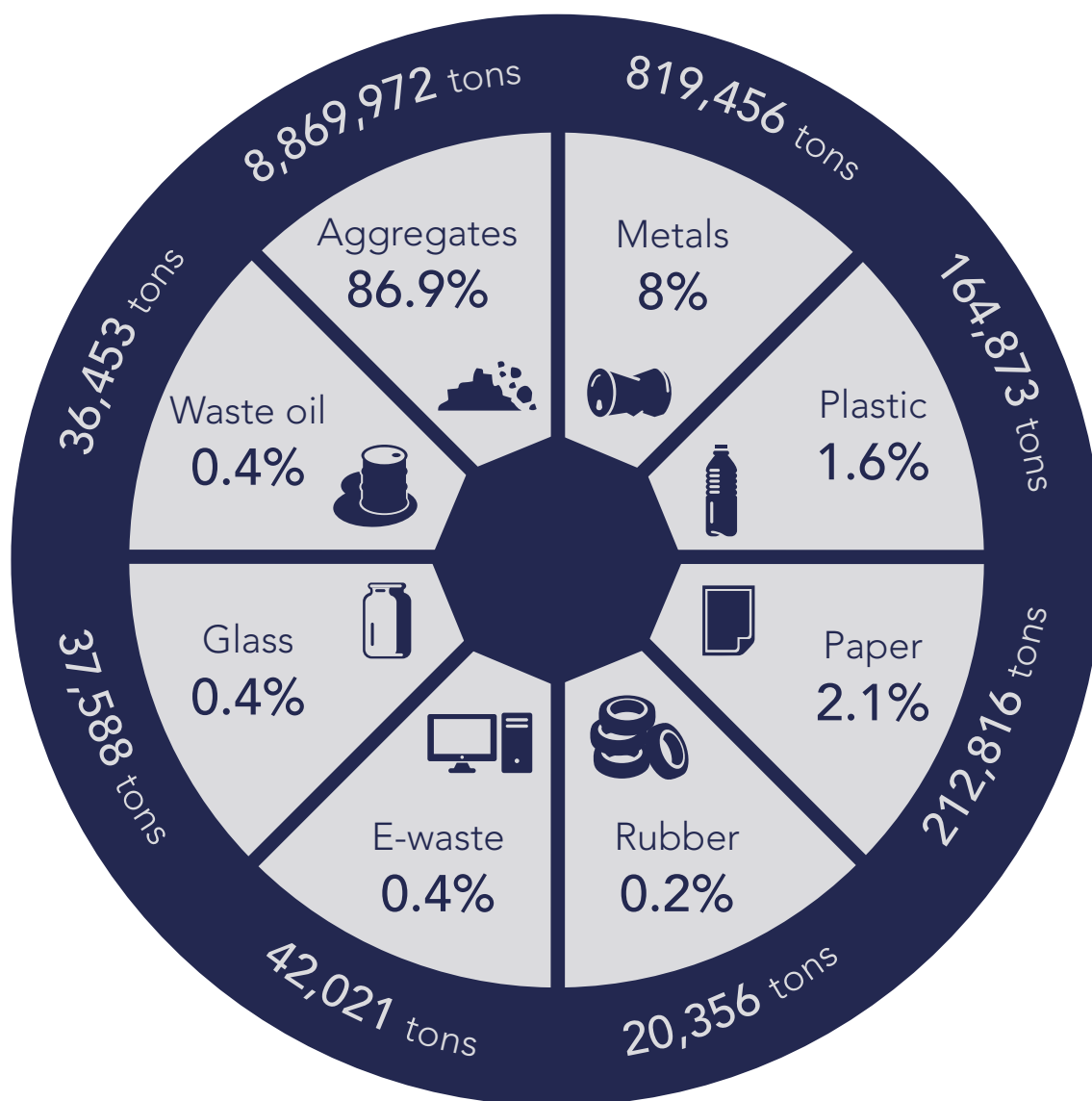
Sources of waste: The key sources of waste generation in Qatar are:

- MSW: Waste generated from households or commercial establishments. This does not include chemical or hazardous wastes.
- CDW: CDW arises from activities such as the construction of buildings and civil infrastructure, total or partial demolition of buildings and civil infrastructure, road planning and maintenance. It is the most sizable waste generated in Qatar and accounts for approximately 80% of volume of aggregated of the waste generated.
- Bulky Waste: Bulky waste refers to waste items that are too large to be disposed by regular waste disposal methods. Bulky waste items include carpets, doors, furniture, white goods, garden waste, plumbing fixtures, etc.
- End of life tires (ELT): A tire is considered at the end of its life when it can no longer be used in vehicles (after having been retreaded or re-grooved).
- End of life vehicles (ELV): Vehicles normally reach the end of their useful lives either due to aging, or due to heavy damage in an accident.



The volume for recycled wastes (metal, plastic and paper) grew by 151% during the period 2001 to 2008 from 10,480 tons to 26,320 tons. The data available for post 2008 is not consistent and hence not published. In 2012¹, 95% of the waste in Qatar was sent to landfills while the remaining 5% was managed in the DSWMC, which started operations in 2011. Following are the key segments identified under the materials recovery facility, which present a good opportunity for recovery and reuse of material as secondary raw material for production of new products. The below figure represents the volume of recyclable wastes generated segment-wise in 2016 only.

Figure 1: Waste Generated during 2016 (By Segment)



¹ MDPS, Environment Statistics Annual Report 2013

Some of the challenges faced by the materials recovery sector in Qatar are:

- Source segregation: Due to lack of awareness among the people about recovery of material as well as lack of government initiatives till date, MSW generated in Qatar is not source-segregated. Recyclable materials generated from households is mixed with the organic waste that results in contamination, which results in a very low recovery rate.
- High content of organic waste: Qatar generates around 1.37 kgs² of MSW per capita on a daily basis, most of which is organic waste (57%) while metals, plastic, paper, glass, rubber have a smaller share in the MSW generated.
- No incentive for recovery facilities: The waste management facilities in Qatar do not receive gate fees or tipping fees as prevalent in the US or European countries.
- Monopoly in the market: Monopoly exists in different segments of the materials recovery sector. In case of steel scrap, QASCO offer a discounted rate to recovery facilities in comparison to the prevalent international market prices. In 2016, the price offered by QASCO for recovered scrap was QAR550 per ton. In case of paper recovery, no export licenses are provided to scrap trading companies except Taher & Taleb. In case of battery recovery, currently, there is only one player in the market i.e. Rassas battery recycling factory.
- Collection process: Collection of waste is not regulated in Qatar and any individual or group of individuals without proper authorization/license from the government is able to collect waste resulting in smaller quantities in the hands of many players. These players often charge higher for scrap, thus decreasing the margins of the recovery facilities.

² MDPS: CHAPTER XI Environment Statistics, Team analysis



1. INTRODUCTION



Materials Recovery includes receiving, sorting and processing of recyclable materials from waste, scrap and other articles to produce an intermediate product or secondary raw materials. Materials recovery, i.e., processing of waste into secondary raw materials is classified in class 3830 under the ISIC, Revision 4. This class includes processing of metal and non-metal waste and scrap and other articles into secondary raw materials, usually involving a mechanical or chemical transformation process and recovery of materials from waste streams. This class specifically excludes manufacture of new final products from secondary raw material, treatment and disposal of non-hazardous waste, treatment of organic waste for disposal, energy recovery or dismantling of automobiles, computers, televisions, etc.

Material recovery and recycling industry not only plays a pivotal role in achieving the aims of environmental sustainability across the globe but also have long-term indirect social and economic advantages.

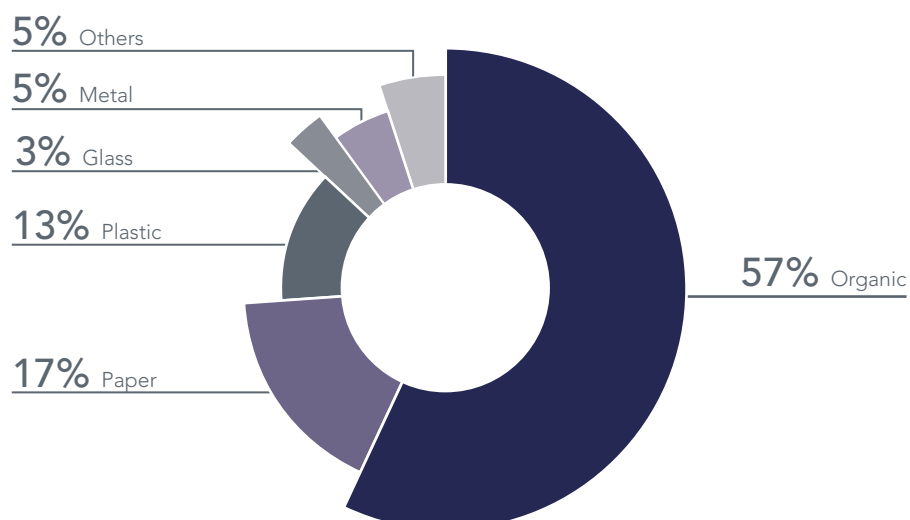
1.1. Sector Overview

The number of people working in the global recycling industry is close to 1.6 million. The recycling industry handles more than 600 million tons of recyclables every year with an annual turnover of more than USD200 billion³.

Material Recovery Facility (MRF) collects scrap generated through households/commercial facilities/industries in different forms i.e. source separated/mixed MSW and processes them for the generation of secondary raw materials that are sold to the recycling facilities for the production of consumer products.

Organic waste comprises of 57% of the MSW generated in Qatar while paper and plastic account for 17% and 13% respectively⁴. Metal scrap generated from MSW and CDW combined is approximately 10% (5% for each segment) while bulky waste constitute 10% of the metal scrap and shredding of cars generate approximately 74% of the metal scrap (Chart 1).

Chart 1: Split of MSW in Qatar, 2015 (%)



Source: Research paper by Imad A. Khatib: Municipal Solid Waste Management in Developing Countries

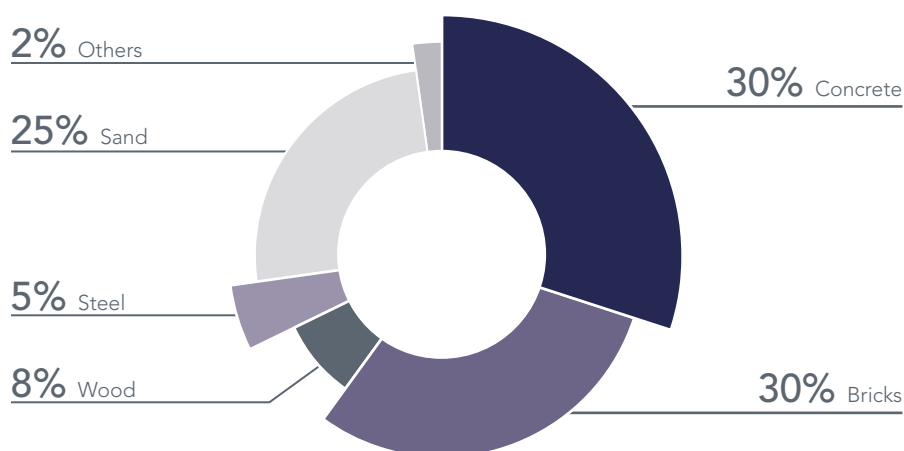
³ Bureau of International Recycling, bir.org

⁴ Research paper by Imad A. Khatib: Municipal Solid Waste Management in Developing Countries



Concrete, bricks and sand are the major components of CDW and account for combined 85% while wood account for the remaining 8%⁵ (Chart 2).

Chart 2: Split of CDW in Qatar, (%)

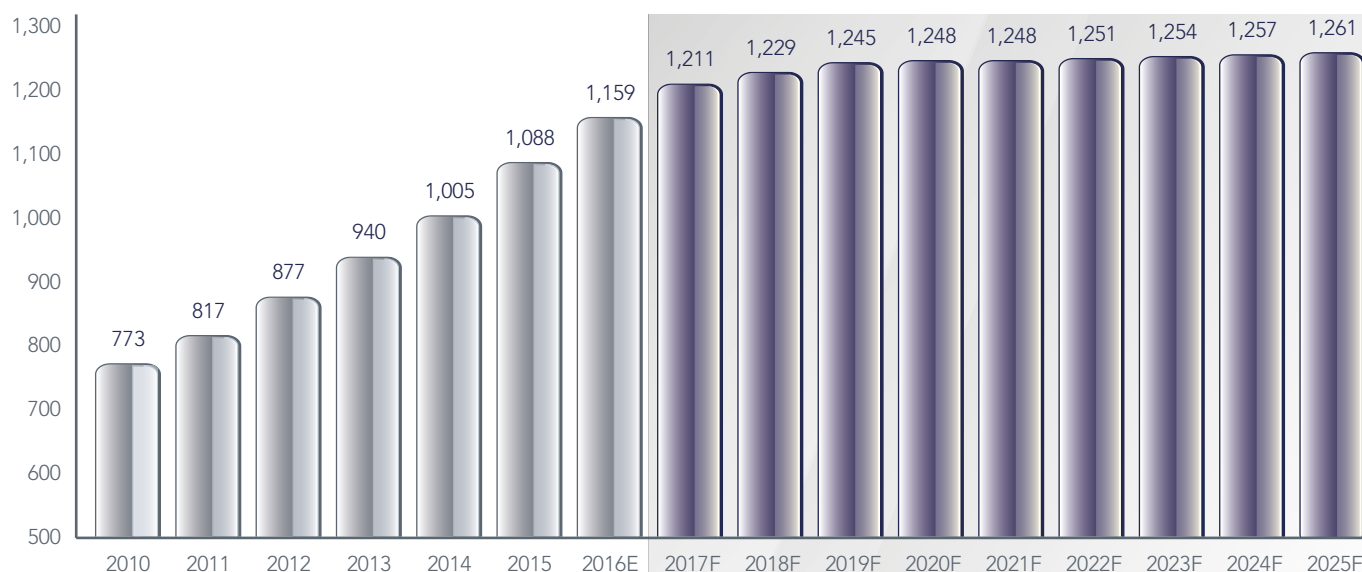


Source: Primary Research

As per the data from MDPS⁶, Qatar had 772,539 registered vehicles in 2010 and increased to 1,088,321 registered vehicles in 2015. This figure is expected to reach 1,260,572 in 2025.

The number of registered vehicles is used to estimate ELV scrap, ELT scrap, scrap batteries and waste oil generation (Chart 3).

Chart 3: Number of Registered Vehicles in Qatar, 2010-2025F ('000 Units)



Source: MDPS Transport and communication statistics-2013 and 2014

⁵ Primary Research

⁶ MDPS: Transport and communication statistics-2013 and 2014

1.2. Materials Recovery Value Chain

Materials Recovery forms a subset of the broader recycling value chain. The key activities covered under materials recovery are:

Figure 2: Recycling Value Chain: Materials Recovery A Subset of the Recycling Value Chain



Sorting: Material recovery facilities sort the material into various sub-categories for further processing. The materials recovered could either be source separated or mixed. Different materials require different technologies for sorting. The process of separation could either be manual or mechanical.

Processing: Once the material is sorted into various categories, the material recovery facility further processes it or treats it to convert it into an intermediate product or a secondary raw material.

The manufacture of new final products from secondary raw materials do not fall under the gamut of materials recovery. Recycling of materials into the final product and their incineration or disposal into a landfill do not form part of materials recovery.

1.3. Identified Product Segments

Based on the above description, materials recovery sector has been classified and studied under eight segments as follows:

Table 1: Segments Under Materials Recovery

	This segment involves the recovery and processing of scrap metal from end-of-life products or structures, as well as from manufacturing scrap. Metals are further classified into ferrous and non-ferrous metals.		This segment covers the recovery of glass from glass wastes such as broken glass, disposed glass and packaging products.
Metals		Glass	
	This segment involves the recovery and processing of scrap plastic received especially from industries and offices. It is further categorized into common polymers such as PE, PP and PET.		This segment covers the following sub-segments:
Plastic		Waste oil	<ul style="list-style-type: none"> Lube oil: Recovery of waste lube oil generated from automotive segment, industrial and marine industry. Waste Cooking Oil (WCO): Recovery of WCO from restaurants and the potential for its collection in domestic market.
	This segment involves the recovery of paper from used paper items such as cardboard, newsprint and magazines, manuals and booklets and assorted office papers mostly collected from commercial establishments.		This segment covers the recovery of aggregates from CDW, which can be reused as aggregates required for the construction industry.
Paper		Recycled aggregates	

1.4. HS Codes of Product Segments

1.4.1. Metal Scrap

Table 2: HS Codes of Metal Scrap

HS Codes and Description of Metal Scrap		
HS Code	Product Type	Description
72040000	Ferrous scrap	Ferrous waste & scrap, re-melting scrap ingots of iron or steel
72041000	Ferrous scrap	Waste and scrap, of cast iron (excluding radioactive)
72042100	Ferrous scrap	Waste and scrap of alloy steel: of stainless steel
72042900	Ferrous scrap	Waste and scrap of alloy steel: other
72043000	Ferrous scrap	Waste and scrap of tinned iron or steel
72044100	Ferrous scrap	Other waste and scrap: turnings, shavings, chips, milling waste, sawdust, filings, trimmings and stampings
72044900	Ferrous scrap	Other waste and scrap
72045000	Ferrous scrap	Remelting scrap ingots
74040000	Copper scrap	Waste and scrap, of copper (excluding ingots or other similar unwrought shapes, of remelted copper waste and scrap, ashes and residues containing copper, and waste and scrap of primary cells, primary batteries and electric accumulators)
76020000	Aluminum scrap	Waste and scrap, of aluminum (excluding slags, scale and the like from iron and steel production, containing recoverable aluminum in the form of silicates, ingots or other similar unwrought shapes, of remelted waste and scrap, of aluminum, ashes and residues from aluminum production)

1.4.2. Plastic Scrap

Table 3: HS Codes of Plastic Scrap

HS Codes and Description of Plastic Scrap		
HS Code	Product Type	Description
39150000	Plastic scrap	Waste, parings & scrap, of plastic
39151000	Plastic scrap	Waste, parings and scrap of polymers of ethylene
39152000	Plastic scrap	Waste, parings and scrap of polymers of styrene
39153000	Plastic scrap	Waste, parings and scrap of polymers of vinyl chloride
39159000	Plastic scrap	Waste, parings and scrap of other plastics (except PET, PS and PVC)

1.4.3. Paper Scrap

Table 4: HS Codes of Paper Scrap

HS Codes and Description of Paper Scrap		
HS Code	Product Type	Description
47070000	Paper scrap	Waste & scrap of paper or paperboard
47071000	Paper scrap	Unbleached kraft paper or paperboard or corrugated paper or paperboard
47072000	Paper scrap	Other paper or paperboard made mainly of bleached chemical pulp, not colored in the mass
47073000	Paper scrap	Paper or paperboard made mainly of mechanical pulp (for example, newspapers, journals and similar printed matter)
47079010	Paper scrap	Other, including unsorted waste and scrap: old news papers
47079090	Paper scrap	Other, including unsorted waste and scrap: other

1.4.4. Rubber Scrap

Table 5: HS Codes of Rubber Scrap

HS Codes and Description of Rubber Scrap		
HS Code	Product Type	Description
40040000	Rubber scrap	Waste, parings and scrap of rubber (other than hard rubber) and powders and granules obtained therefrom
40122000	Rubber Scrap	Used pneumatic tyres of rubber

1.4.5. E-waste and Battery Scrap

Table 6: HS Codes of E-waste and Battery Scrap

HS Codes and Description of E-waste and Battery Scrap		
HS Code	Product Type	Description
85480000	E-waste	Waste and scrap of primary cells, primary batteries and electric accumulators; batteries, primary batteries and spent electric accumulators; electrical parts of machinery or apparatus, not specified or included elsewhere in chapter 85 (detailed description available)
85481000	E-waste	Waste and scrap of primary cells, primary batteries and electric accumulators; spent primary cells, spent primary batteries and spent electric accumulators
85489000	E-waste	Waste and scrap: other

1.4.6. Glass Scrap

Table 7: HS Codes of Glass Scrap

HS Codes and Description of Glass Scrap		
HS Code	Product Type	Description
70010000	Glass scrap and cullet	Cullet and other waste and scrap of glass; glass in the mass

1.4.7. Waste Oil

Table 8: HS Codes of Waste Oil

HS Codes and Description of Waste Oil		
HS Code	Product Type	Description
27109100	Waste lube oil	Waste oils containing polychlorinated biphenyls [PCBs], polychlorinated terphenyls [PCTs] or polybrominated biphenyls



2. METALS

2.1. Overview of Metal Scrap

2.1.1. Description

Scrap metal recovery consist of recovery and processing of scrap metal from end-of-life products, structures and from manufacturing scrap that is converted to primary raw material and used in the production of recycled goods.

Metals are classified as ferrous and non-ferrous:

- **Ferrous metals:** These are combinations of iron with carbon. Some common ferrous metals include carbon steel, alloy steel, wrought iron and cast iron.
- **Non-ferrous metals:** These do not contain iron as a component. It includes aluminum, copper, lead, tin, zinc and others.

The properties of metals provide a unique advantage for their reuse. Unlike other recycled materials, such as plastic and paper, metals are repeatedly recyclable without any degradation of their properties. Metals from secondary sources are just as good as metals from primary sources.

Aluminum, Copper and Lead accounts for approximately 85% of the non-ferrous metals in the world⁷. Approximately 80% of the lead across the globe is used for the production of batteries and thus it is covered in the e-waste and batteries chapter.

Please note that Zinc and Tin is not covered as a part of this report because:

1. Zinc is mainly used in coating steel and as alloys and not in pure form. In addition, it has a relatively long service life (>40 years on average) and a global recycling rate as low as 30%⁸.
2. Tin is consumed in very small quantities (production in 2014 was 0.3 million tons) as compared to other non-ferrous metals across the globe.



⁷ World Mining Data

⁸ American Galvanizers Association



2.1.2. Classification

Steel: Steel is one of the most frequently used metals across the world. It finds its usage in several sectors such as automotive, appliances and construction.

Classification of Metal Scrap

Home scrap⁹

Home scrap, also known as run-around scrap, comprises trimmings or rejects generated within a steel mill during the process of producing iron and steel. As the scrap never leaves the steel mill site and has known physical properties and chemical composition, it is typically, immediately or quickly reprocessed.

Type of metal scrap



New scrap

New scrap, also known as prompt scrap, is generated within manufacturing plants involved in fabricating steel products. This scrap is returned directly to the mill that produced the steel, usually within weeks or months. The chemical composition of this scrap is generally known. Moreover, it is typically clean, which means that it is not mixed with other materials.

Old or obsolete scrap

Old scrap, also known as obsolete scrap, is steel that has been discarded at the end of product life. The greatest volume of old scrap is composed of junk vehicles, old appliances and machinery, old railroad tracks and steel from demolished buildings. This steel is mixed in solid waste, which also includes cans and other containers as well as a wide variety of discarded consumer products. Since old scrap is composed of materials that have been in use for years or decades, its chemical composition and physical characteristics are not usually known. It is mixed with other trash. For these reasons, it is most challenging and costly to reuse/recycle old scrap.

⁹ Dovetail Partners INC., dovetailinc.org

Copper: Copper is one of the most generally used non-ferrous metals and is among the few materials that can be recycled repeatedly without any loss of performance. There is no difference in the quality of recycled copper (secondary production) and mined copper (primary production).

Copper wiring and plumbing are integral to manufacturing appliances, and heating and cooling systems. It is an essential component in the motors, wiring, radiators, connectors, brakes and bearings used in automobiles.

The largest category of copper scrap is obsolete scrap¹⁰, the demand for which tends to fluctuate depending on copper prices and other commercial considerations. The extent of recycling of old copper scrap reduces when prices are low. Old scrap, also called post-consumer scrap, consists of discarded electric cables, junk automobile radiators and air conditioners, and innumerable other products.



Aluminum: The high intrinsic value of aluminum scrap has been the most important factor for its recovery. Recycling of aluminum products needs about 5% of the energy and emits only 5% of the greenhouse gases as compared to primary aluminum production.

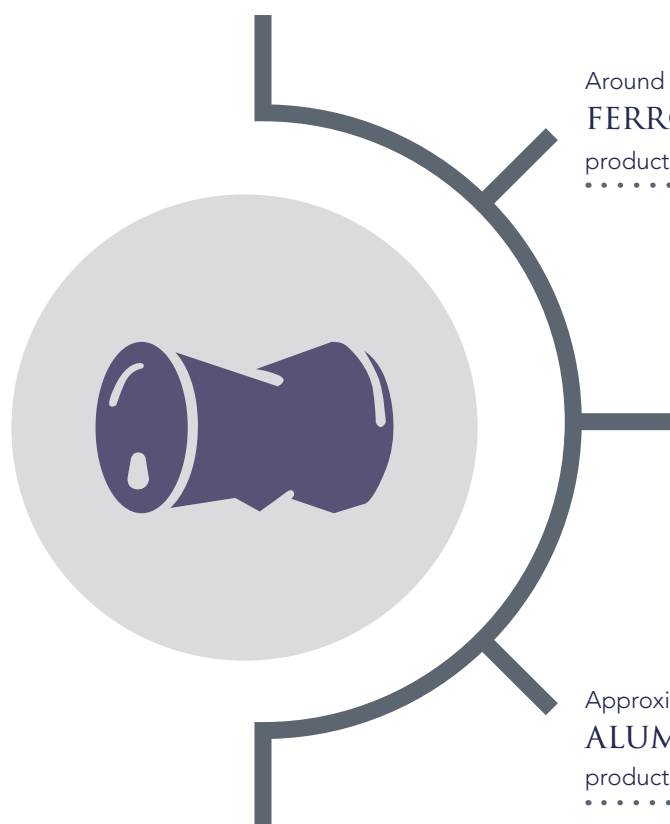
Aluminum cans are the most recycled items¹¹. However, other aluminum recyclables include lawn furniture, aluminum foil (cleaned of food residue), car parts, cookware, window frames and even aircraft parts.

¹⁰ "Overview of Recycled Copper-Copper Applications in Health & Environment", copper.org

¹¹ "Aluminum Recycling: Yes You Can", greenliving.com

2.1.3. Benefits of Metal Recovery

Recycling **ONE KG** of steel helps prevent the emission of **TWO KGS** of greenhouse gases into the atmosphere. For every ton of steel recycled **1,131 KGS** of iron ore, **633 KGS** of coal and **54 KGS** of limestone is saved¹².



Around **58%** of CO₂ emissions can be reduced by using **FERROUS SCRAP** instead of virgin materials in the production of **STEEL AND IRON**¹³.

Recycling just **ONE ALUMINUM** CAN save sufficient energy that can be used to run a **100-WATT LIGHT BULB** for around **20 HOURS**, a **TV SET** for around **2 HOURS** and a **COMPUTER** for around **3 HOURS**¹⁴.

Approximately **92% OF ENERGY** can be saved by using **ALUMINUM SCRAP** instead of virgin materials, in the production of various aluminum products¹⁵.

Recycling copper is a highly eco-efficient way of reintroducing a valuable material back into the economy. The recycling of copper requires up to **85% LESS ENERGY** than primary production. Around the world, recycling of copper (approximately 4 million tons in 2015) can reduce **CARBON DIOXIDE** emissions by **40 MILLION TONS** annually and save an equivalent of **100 MILLION MWH OF ELECTRICITY**¹⁶.

¹² "Steel recycling factsheet", recyclingweek.planetark.org

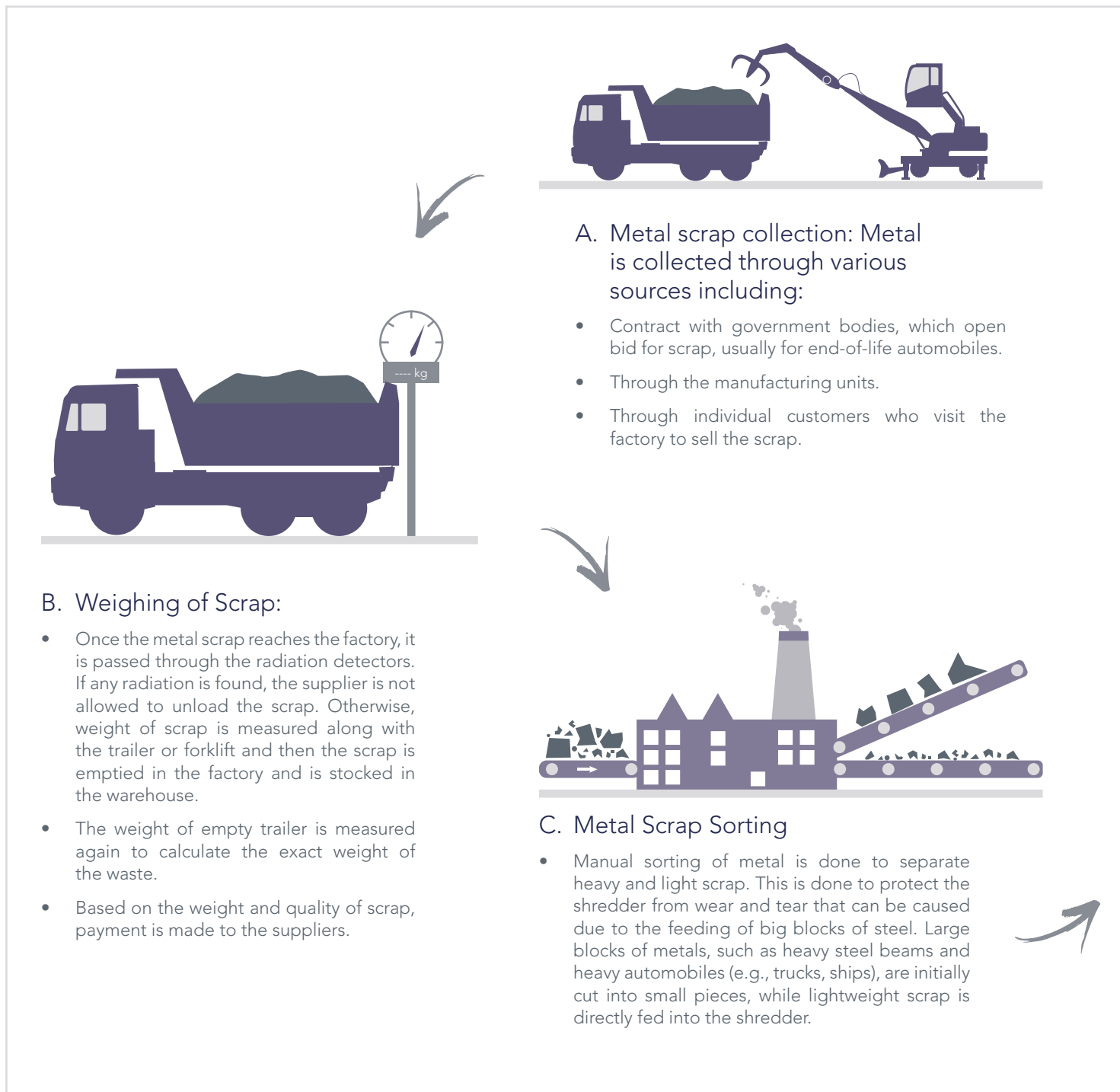
^{13, 14, 15} Metal Recycling Facts And Figures – Basic Facts About Ferrous and Non-Ferrous Metals, thebalance.com

¹⁶ International Copper Association: Copper Recycling, copperalliance.org

2.2. Metal Recovery Process

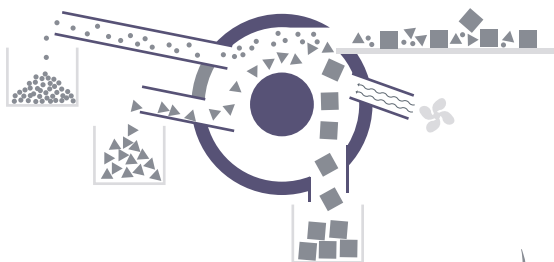
Metal scrap arises from end-of-life products (old or obsolete scrap) as well as from scrap generated in the manufacturing process. While a substantial portion of metal comes from the commercial sector, there are also residential sources for metal recycling, including appliances, electric cables, aluminum cans, tins and automobiles.

Figure 3: Metal Recovery Process



D. Shredding

- Metal scrap passes through the rollers, which crush the material and control the flow of the material entering the mill.
- The scrap then passes through the hammer mill that cuts the scrap until pieces are small enough to fit through the opening in grates below it.
- Small pieces of shredded scrap fall on the conveyor belt. These include steel and other non-ferrous metals such as copper and aluminum, and also non-metallic materials such as foam, plastic and sponge, which are removed in the subsequent stages.

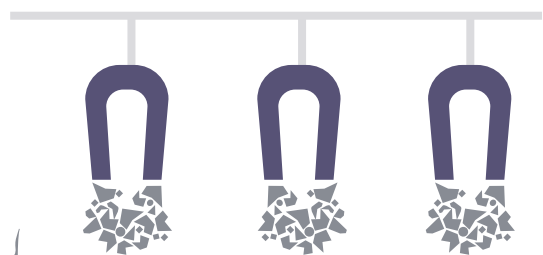


E. Separation of Light Waste

- The shredded scrap then passes through the cyclone area. In this step, light waste such as sponge and dust are removed by the method of air separation.

F. Extraction of Shredded Steel

- The shredded scrap is then moved to the magnetic strip, which separates the shredded steel from non-ferrous metals and non-metallic materials.



G. Manual Separation of Non-Ferrous and Non-Metallic Scrap

- Manual separation is done to recover recyclable materials such as copper and aluminum from chunks of non-metallic materials that are dumped in the landfills.
- Extracted ferrous and non-ferrous metals are sold to recycling companies, which further process the metal into the desired product.

2.3. Recovered Metal Applications

Recycled metal can be used in almost as many applications and products as virgin metal, for example, packaging, construction and automotive products. Recovered metals are bought by the recycling facilities/virgin metal production facilities and are converted into sheets/billets of metals. These are then sold to automotive factories, packaging units etc. Some of the key applications of recovered metals in the end-use industry include:

- **Packaging:** Recycled aluminum and steel are reused for food packaging. Presently, most canned goods contain some percentage of recycled metal and many are made from 100%-recycled materials.
- **Construction:** Scrap iron and aluminum can be used in the construction industry.
- **Transportation:** Recovered metals can be used in the manufacture of automobiles, aircrafts, etc.
- **Home furnishings:** Metal furniture is often made of recycled metals and are as durable. Gliders, benches, tables and even lamps are some of the home furnishings made from scrap metal.
- **Machinery and equipment:** There is a growing trend of using recycled steel and iron in factory equipment and assembly lines.
- **Electrical applications:** These include wires, circuits, switches and electromagnets.

2.4. Global Metal Recovery Market Overview

Metal recycling market has gained much prominence over the years due to the shifting of focus toward environmental sustainability and resource conservation, as recycling metals use a large amount of natural resources (such as petroleum, natural gas and water) and energy to produce virgin metals.



¹⁷ World steel recycling in figures 2011–15, Page 8, bir.org

¹⁸ World steel recycling in figures 2011–15, Page 12, bir.org

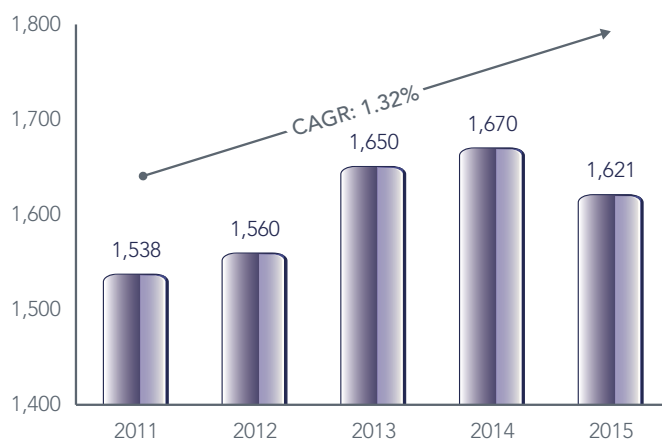
¹⁹ "Low trends", recyclingtoday.com

In addition, rapid industrialization and requirement of metal in countries such as India, Singapore, Malaysia, China, South Korea, Indonesia and Thailand have increased the demand for recycled metal.

A. Ferrous Metals

As per the UNEP World Steel Recycling report 2011–15, (Chart 4) world production of steel has increased from 1,538 million tons in 2005 to reach over 1,621 million tons in 2015¹⁷.

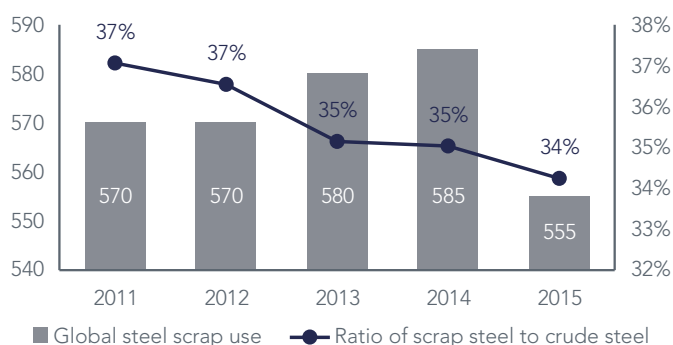
Chart 4: Global Steel Production, 2011-2015 (Million Tons)



Source: World-Recycling Report 2011–15

Scrap steel usage increased from 570 million tons in 2011 to 585 million tons in 2014, post which it witnessed a decline in 2015 by 5%¹⁸. The ratio of steel scrap to crude steel used in steel making has witnessed a decline over the years owing to the decrease in the price of virgin material and oversupply of steel in China. This decrease in the price of virgin metal has led to the reduction in prices of recycled metal, thus making it non-viable for recyclers to sell the recycled material. As a result, the recycling companies have reduced their recycling rates and have started piling up the raw material in the warehouses¹⁹ (Chart 5).

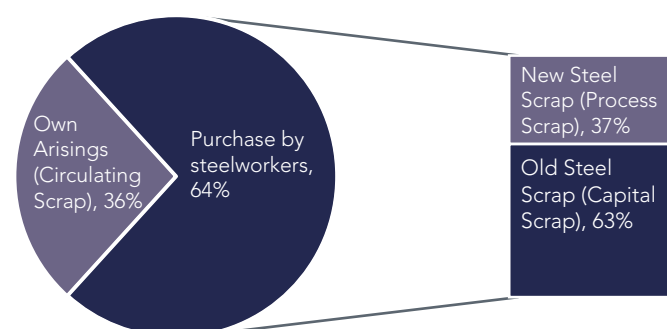
Chart 5: Global Scrap Steel Use, 2011-2015 (Million Tons)



Source: World-Recycling Report 2011–15

Out of the total 555 million²⁰ tons of scrap steel used in 2015, 200 million tons (36%) of scrap was the circulating scrap, while recyclers bought the remaining 355 million tons (64%) of scrap. Of the total scrap bought, new steel scrap (process scrap) constituted 37% (120 million tons) while old scrap (capital scrap) had a share of 63% (235 million tons) (Chart 6).

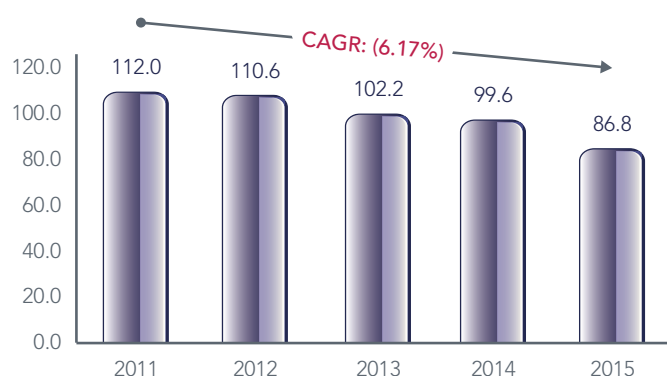
Chart 6: Split of Global Scrap Steel, By Source (2015)



Source: World-Recycling Report 2011–15

During 2011 and 2015, global trade of ferrous scrap (HS Code-7204) declined from 112 million tons to reach 86.8 million tons, witnessing a negative CAGR of 6.17%²¹ (Chart 7).

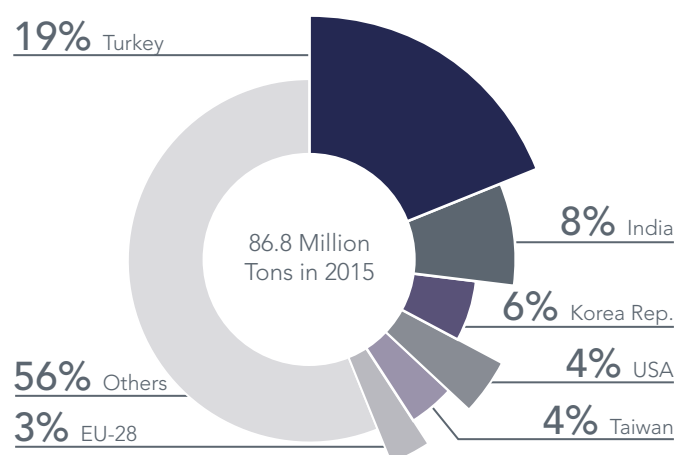
Chart 7: Global Steel Scrap Trade, 2011-2015 (Million Tons)



Source: World-Recycling Report 2011–15

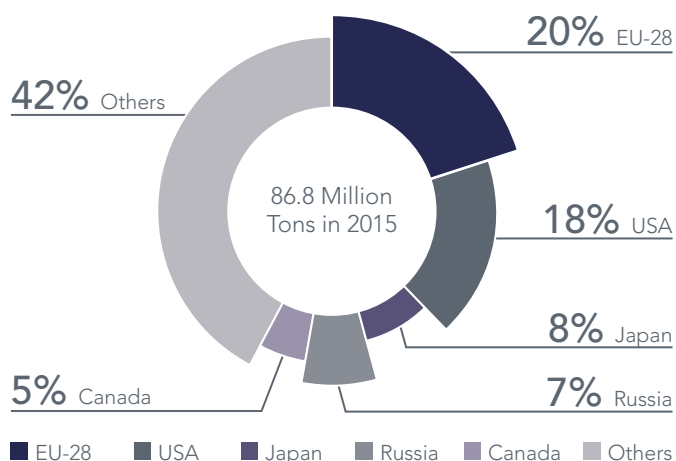
Leading importers of steel scrap in 2015 included Turkey, India, the Korean Republic, the US, Taiwan and EU-28, having a combined share of 44%²² (38.4 million tons) while leading exporters included EU-28, the US, Japan, Russia, Canada and Australia accounted for combined exports of 49.9 million tons (58%) in 2015. (Chart 8 and 9)²³.

Chart 8: Leading Steel Scrap Importers (2015)



Source: World-Recycling Report 2011–15

Chart 9: Leading Steel Scrap Exporters (2015)



Source: World-Recycling Report 2011–15

²⁰ World steel recycling in figures 2011–15, Page 12, bir.org

^{21,22,23} World steel recycling in figures 2011–15, Page 24, bir.org

In terms of percentage of scrap steel use vs crude steel production, Turkey was leading in 2015 and used 26.1 million tons of scrap steel (83%). It was followed by the US (72%) and EU-28 (55%). Other countries that had a high steel scrap recovery rate included the Korean Republic (43%), Japan (32%), Russia (24%) and China (10%) (Table 9).

Table 9: Global Scrap Steel Use, By Region (Million Tons²⁴)

Year	Parameter	China	EU-28	Japan	USA	Russia	Korea Rep.	Turkey
2011	Crude steel production	702	177.8	107.6	86.4	68.9	68.5	34.1
	Scrap steel use	91	100.1	37.2	63	21	30.8	30.8
	Scrap relative to crude steel	13%	56%	35%	73%	30%	45%	90%
2012	Crude steel production	731	168.6	107.2	88.7	70.2	69.1	35.9
	Scrap steel use	84	94.2	35.5	63	20.1	32.6	32.4
	Scrap relative to crude steel	11%	56%	33%	71%	29%	47%	90%
2013	Crude steel production	822.0	166.4	110.6	86.9	69.0	66.1	34.7
	Scrap steel use	85.7	90.3	36.7	59	19.4	32.7	30.4
	Scrap relative to crude steel	10%	54%	33%	68%	28%	49%	88%
2014	Crude steel production	822.8	169.3	110.7	88.2	71.5	71.5	34
	Scrap steel use	87.5	91.6	36.9	62.0	19.3	32.6	28.2
	Scrap relative to crude steel	11%	54%	33%	70%	27%	46%	83%
2015	Crude steel production	803.8	166.1	105.2	78.9	70.9	69.7	31.5
	Scrap steel use	83.3	91.1	33.6	56.5	17.3	29.9	26.06
	Scrap relative to crude steel	10%	55%	32%	72%	24%	43%	83%

Source: World Recycling Report 2011–2015

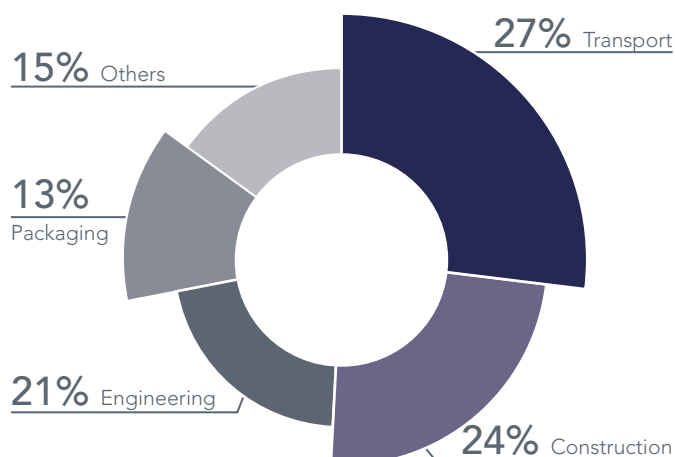
B. Non-Ferrous Metals

i. Aluminum:

As per World Aluminum Organization (WAO), the cumulative production of aluminum since 1880 is estimated to be 900 million tons. Owing to the 100% recycling capability of aluminum, 75% of the aluminum produced historically until 2010 was still in productive use i.e. recovered, recycled and reused²⁵.

In 2007, about 27% of the aluminum was used in transport, 24% in construction and buildings, 21% in engineering sector, 13% in packaging and the remaining 15% for other applications²⁶ (Chart 10).

Chart 10: Aluminum Consumption, By Sector (2007)



Source: International Aluminum Institute

²⁴ World steel recycling in figures 2011 – 2015, bir.org

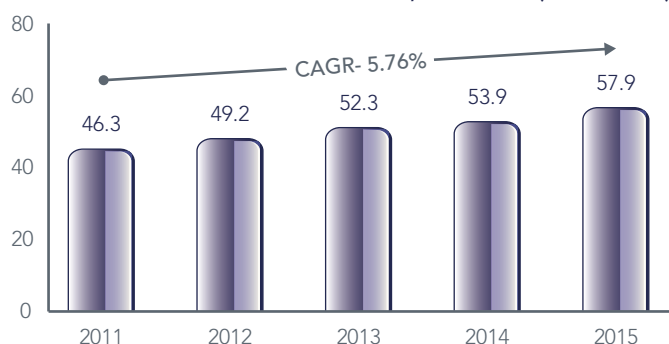
²⁵ The International Aluminum Institute, recycling.world-aluminium.org

²⁶ International Aluminum Institute-Global Aluminum Recycling 2009, Page 17, recycling.world-aluminium.org

The global demand for aluminum scrap is growing rapidly due to the relatively higher prices of the virgin metal. As per the estimate from WAO, recycling aluminum that is currently in use globally would equal to 17 years' worth of the current annual primary aluminum production.

As per WAO, production increased from 46.3 million ton in 2011 to reach 57.9 million metric ton in 2015, at a CAGR of 5.76%²⁷ (Chart 11).

Chart 11: Global Aluminum Production, 2011-2015 (Million Tons)

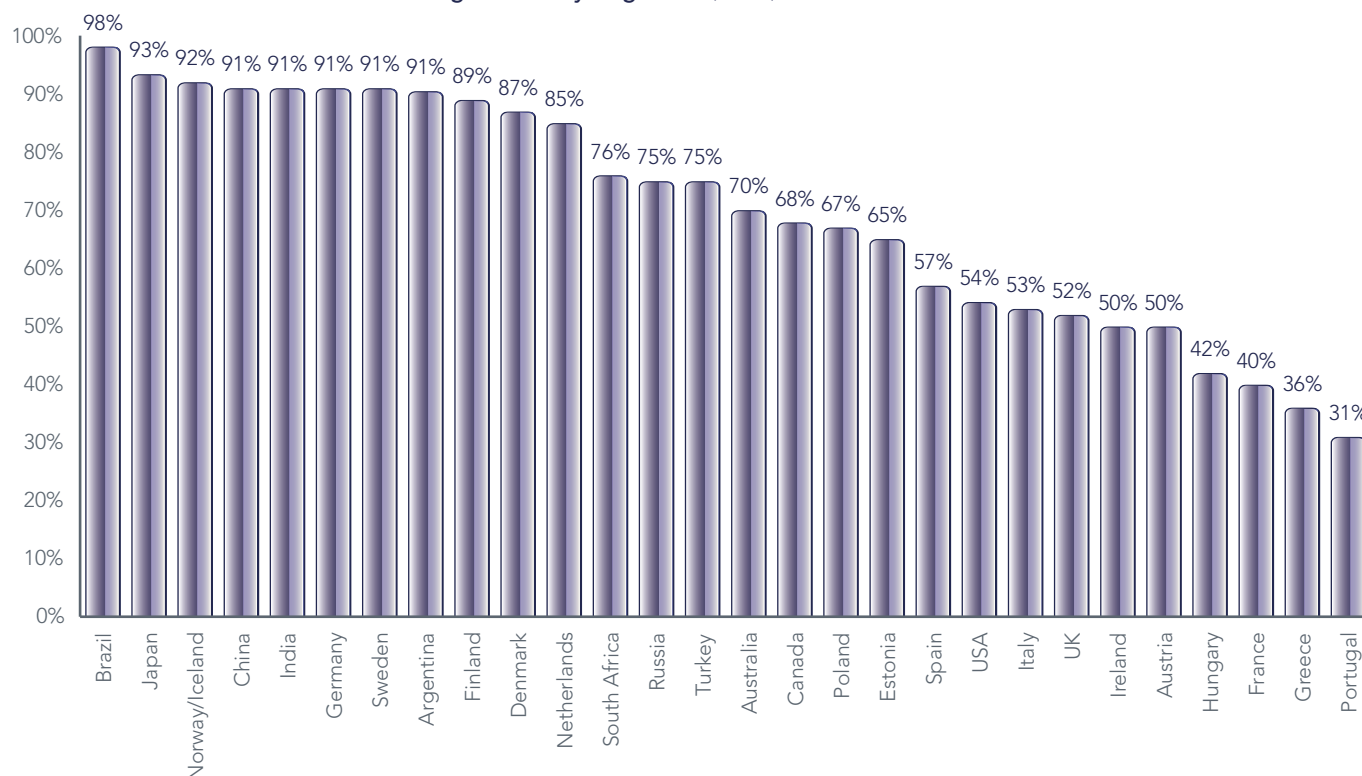


Source: World Aluminum Organization

According to BIR report²⁸, the amount of aluminum scrap consumption increased from 10.9 million tons in 2001 to 18.3 million tons in 2011. Presently, recycled aluminum produced from old scrap originates 42% from transport, 28% from packaging, 11% from engineering and cables, and only 8% from building applications, owing to their long product life.

Brazil²⁹ has been the market leader in recycling used beverage cans for over 10 years and has registered a recycling rate of 98% in 2009, followed by Japan³⁰, which has separate collection networks through the country's 1,850 municipalities. Approximately 50% of used cans are collected via municipality offices, which use separate bins for different materials. In 2012, Japan recycled or reused 18 billion cans, totaling almost 285,000 tons of aluminum of a total 19.12 billion consumed, while Brazil recycled 198,800 tons of can scrap, corresponding to 14.7 billion units. Norway, China, India, Germany and Sweden had a recycling rate of over 90% in 2009 (Chart 12)³¹.

Chart 12: Global Aluminum Used Beverage Can Recycling Rates (2009)



Source: World Aluminum Organization

²⁷ The International Aluminum Institute, recycling.world-aluminium.org

²⁸ Global non-ferrous scrap flows 2000-2011, Page 10, bir.org

²⁹ "Brazil: Global Leader in Can Recycling", recycling.world-aluminium.org

³⁰ "Japan: 5 Key Factors for UBC Recycling Success", recycling.world-aluminium.org

³¹ The International Aluminum Institute, recycling.world-aluminium.org

During 2010 and 2014, the global trade of aluminum scrap (HS Code-7602) witnessed a CAGR of 2.5% to reach 8.9 million tons in 2014 from 8.1 million tons in 2010. (Chart 13).³²

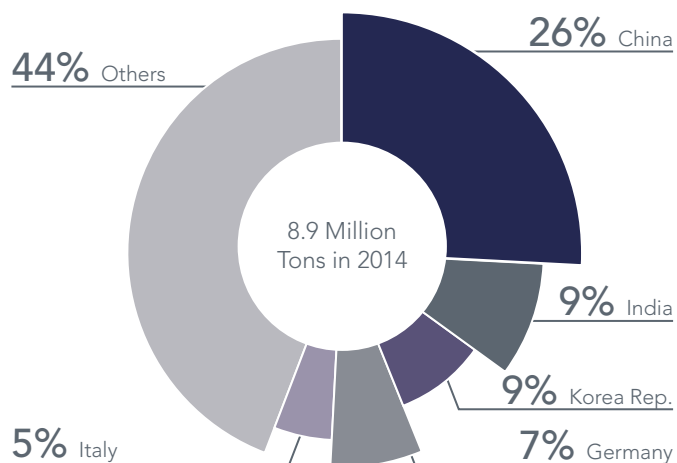
Chart 13: Global Aluminum Scrap Trade, 2010-2014 (Million Tons)



Source: Trademap

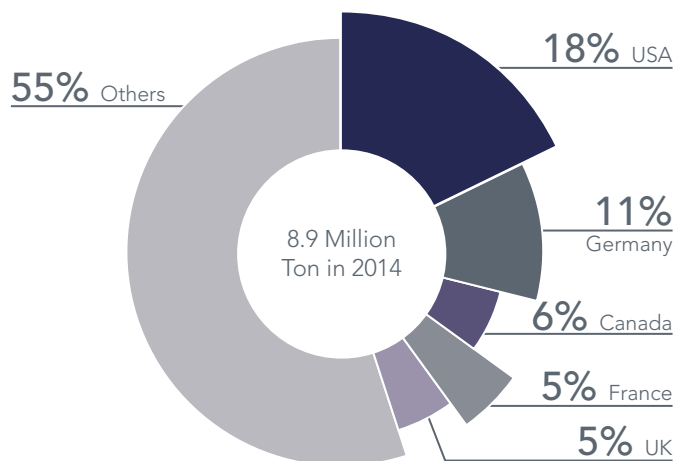
The leading importers of aluminum scrap in 2014 included China, India, the Korean Republic, Germany and Italy with combined share of 56% (5 million tons) in the imports (Chart 14), while leading exporters such as the US, Germany, Canada, France and the UK had combined export of 45% (4 million tons). (Chart 15)

Chart 14: Leading Aluminum Scrap Importers (2014)



Source: Trademap

Chart 15: Leading Aluminum Scrap Exporters (2014)

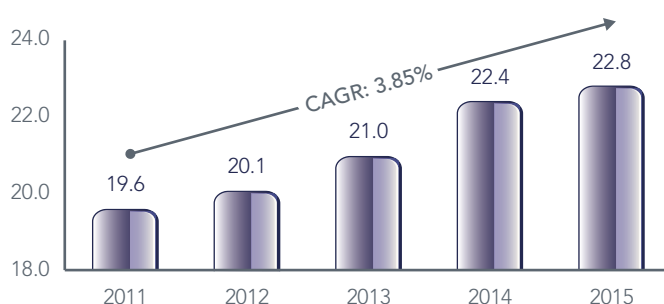


Source: Trademap

ii. Copper:

As per the International Copper Study Group, production of Copper increased from 19.6 million tons in 2011 to reach 22.8 million tons in 2014 at CAGR of 3.85%. Out of the production of 22.8 million tons of copper in 2015, recycled copper production was 3.95 million tons³³ (Chart 16).

Chart 16: Global Copper Production, 2011-2015 (Million Tons)



Source: The World Copper Factbook 2015

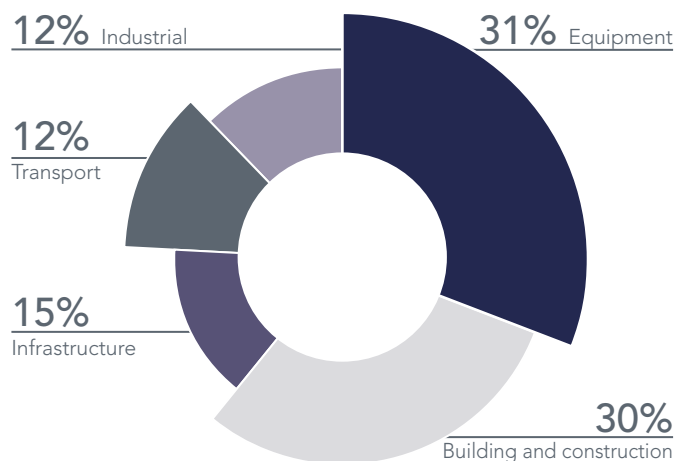
Equipment and building & construction sector consume approximately 61% of the copper produced globally. Other consumers of copper include transportation, infrastructure and industries³⁴ (Chart 17).

³² Trademap

³³ World refined copper production and usage trends 2010-2016, icsg.org

³⁴ The World Copper Factbook 2015, Page 50, icsg.org

Chart 17: Copper Consumption, By Sector (2014)

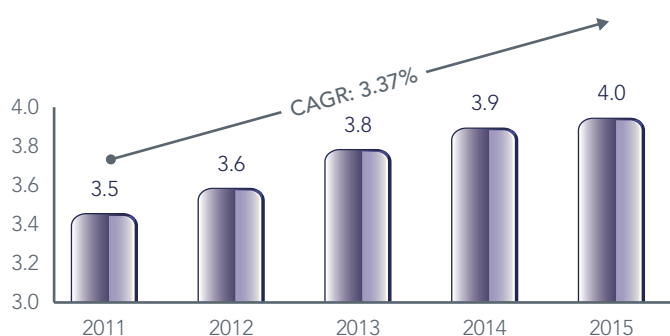


Source: The World Copper Factbook 2015

Copper is among the few materials that do not degrade or lose their chemical or physical properties in the recycling process. Thus, recycled copper (also known as secondary copper) cannot be distinguished from primary copper (copper originating from ores), once reprocessed.

Global production of secondary copper increased from 3.5 million tons in 2011 at a CAGR of 3.37% to reach 4 million tons in 2015³⁵. In 2013, Europe had the highest recycling rate of 47% followed by Asia with 36% and North America with 31%. The remaining continents had a recycling rate of 26%³⁶ on average (Chart 18).

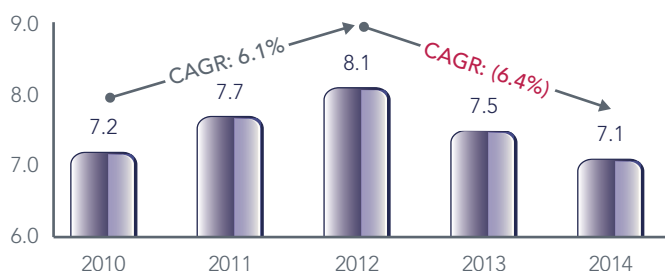
Chart 18: Global Secondary Copper Production, 2011-2015 (Million Tons)



Source: The World Copper Factbook 2015

The global trade of copper scrap (HS Code-7404) increased during 2010 and 2012 from 7.2 million tons to 8.1 million tons. However, post 2012 global trade has seen an annual decrease of 6.4% and thus global trade in 2014 reached 7.1 million tons³⁷ (Chart 19).

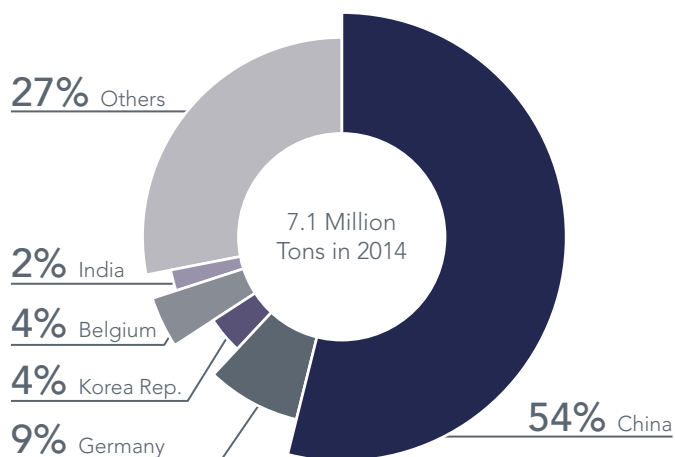
Chart 19: Global Copper Scrap Trade, 2010-2014 (Million Tons)



Source: Trademap

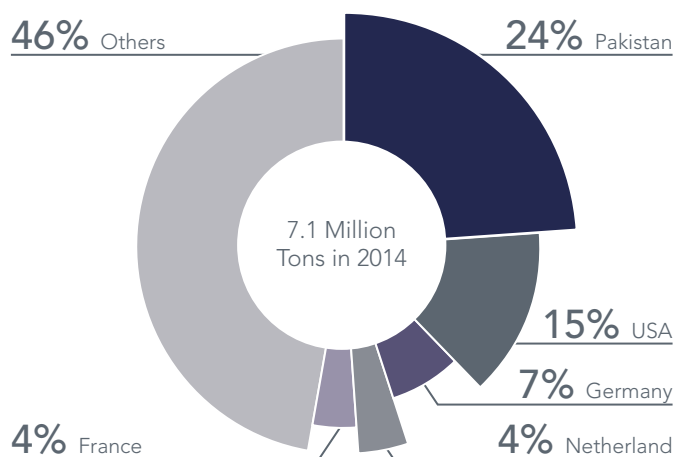
In 2014, China was the leading importer of copper with 54% (3.8 million tons) of the global imports³⁸. Germany, the Korean Republic, Belgium and India held a combined share of 19% (1.3 million tons) in the global imports (Chart 20). For exports, Pakistan was the leading exporter with 24% (1.7 million tons) share followed by the US with a million ton (15%) of exports³⁹ (Chart 21).

Chart 20: Leading Copper Scrap Importers (2014)



Source: Trademap

Chart 21: Leading Copper Scrap Exporters (2014)



Source: Trademap

³⁵ World refined copper production and usage trends 2010-2016, icsg.org

³⁶ The World Copper Factbook 2015, Page 53, icsg.org

^{37,38,39} Trademap

2.5. GCC Metal Recovery Market Overview

2.5.1. Market Overview

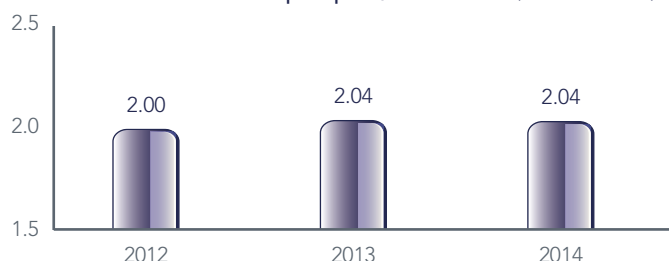
There is a steady increase in metal scrap generation in the Middle East mainly due to the demolition activities, which occur when buildings reach their end of life. In Qatar, CDW has been a major source of metal scrap as the country is preparing for future commitments such as FIFA 2022. In addition, rapid increase in population has resulted in increase of automobile consumption, which is an important source of metal scrap.

Cheaper energy prices for recycling, strict regulations on automobile usage, focus on green marketing are key drivers for the end-of-life vehicles recycling market in the GCC. Currently, end-of-life or obsolete scrap in GCC accounts for 53% of metal scrap⁴⁰ and is expected to grow to 72% by 2019.

A. Ferrous Metals

Ferrous scrap exports from GCC countries in the year 2014 increased to 2.04 million tons from 2 million tons in 2012, witnessing a CAGR of 0.9%. However, the export quantity during 2013 and 2014 saw a dip by a negligible margin of 0.26%. This was due to fluctuation in oil prices and decrease in demand for steel in the international market. The UAE was the leading exporter with 60% exports followed by Qatar with 24%⁴¹ (Chart 22).

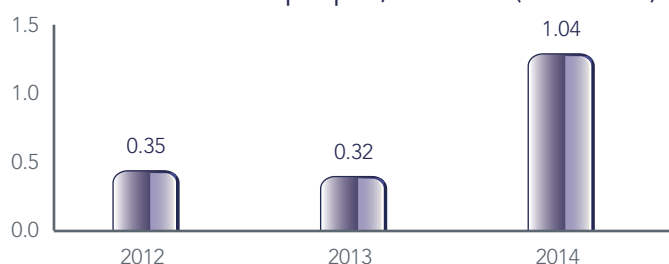
Chart 22: GCC Steel Scrap Export, 2012-2014 (Million Tons)



Source: Trademap

Imports of ferrous scrap reached 1.04 million tons in 2014, witnessing a massive CAGR of 71% during 2012 and 2014. Saudi Arabia was the leading importer in 2014 with 35.5% (0.4 million tons) of the imports while the UAE and Kuwait had 30.5% (0.3 million tons) and 16.9% (0.2 million tons) shares, respectively⁴² (Chart 23).

Chart 23: GCC Steel Scrap Import, 2012-2014 (Million Tons)



Source: Trademap

⁴⁰ "2016 ISRI Convention: Crossroads of opportunity", recyclingtoday.com
^{41,42} Trademap

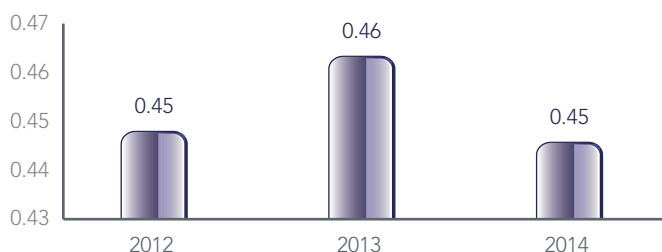
B. Non-Ferrous Metals

i. Aluminum:

In the GCC, the aluminum recycling market is at a nascent stage as the region primarily focused on exports owing to the under-developed downstream industry. Compared with the global recycling rates for aluminum, Middle East recycles only 20% of the scrap generated, which includes smelter re-melting, scrap generation and secondary re-melting while the rest is exported to other countries⁴³. The remaining 80% of the scrap is exported to India, South Korea, Pakistan, China, Europe and North America, among other markets.

Exports of aluminum scrap decreased by 0.25% between 2012 and 2014, to reach 446,015 tons in 2014 from 448,266 tons in 2012. In 2014, Saudi Arabia was the leading exporter of aluminum scrap with 42.6% (189,858 tons) of the exports. Export quantity from Saudi Arabia saw an increase of 7.3%, while the UAE, which accounted for 39.7% (176,900 tons) of the regional exports, saw an increase of 5.9% in the export quantity. Oman, Kuwait and Qatar witnessed a decrease in their exports by 58%, 7% and 10% respectively in 2014⁴⁴ (Chart 24).

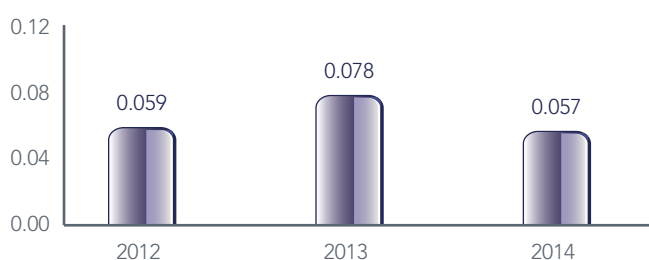
Chart 24: GCC Aluminum Scrap Export, 2012-2014 (Million Tons)



Source: Trademap

Imports of aluminum scrap decreased from 59,086 tons in 2012 to 56,989 tons in 2014 at negative CAGR of 1.79%. The UAE was the leading importer of aluminum scrap in GCC and imported 55,907 tons (98.1%) of the total GCC imports in 2014 – a decrease of 23.9% from 2013⁴⁵ (Chart 25).

Chart 25: GCC Aluminum Scrap Import, 2012-2014 (Million Tons)



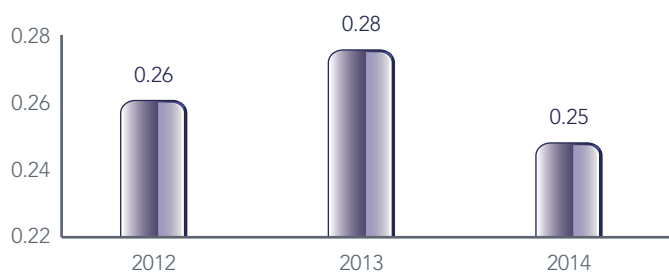
Source: Trademap

⁴³ "Middle East aluminum scrap market at nascent stage", recyclinginternational.com
^{44,45} Trademap

ii. Copper:

As per Trademap statistics, the export of copper scrap from GCC decreased from 260,900 tons in 2012 to reach 248,223 tons in 2014, witnessing a negative CAGR of 2.46%. Among GCC countries, Saudi Arabia was the leading exporter and accounted for 108,336 tons (47.94%) followed by the UAE with 105,417 tons (42.47%). However, the UAE saw a 9.45% decrease in exports while Saudi Arabia saw an increase of 7.15% in its exports⁴⁶ (Chart 26).

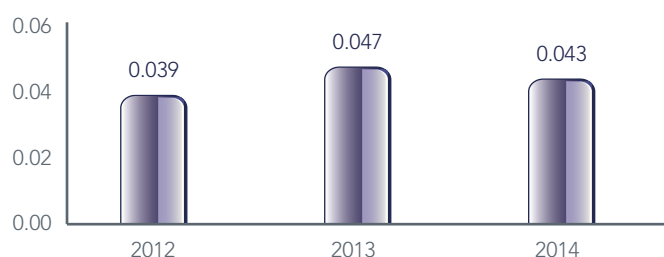
Chart 26: GCC Copper Scrap Export, 2012-2014 (Million Tons)



Source: Trademap

The imports saw an increase of 6.21% during 2012 and 2014 and accounted for 43,480 tons in 2014, while the imports in 2012 were 38,543 tons. In 2014, the UAE imported 40,354 tons (92.8%) of the total GCC imports while 3,023 tons (6.9%) was imported by Saudi Arabia⁴⁷ (Chart 27).

Chart 27: GCC Copper Scrap Import, 2012-2014 (Million Tons)



Source: Trademap

Saudi Arabia has a well-established metal recycling industry. However, it exports most of the metal scrap generated in the country⁴⁸ because of the better selling prices of scrap metals in other countries. UAE has high imports of metal scrap due to the developed metal recycling industry as well as downstream industry and also because of ideal geographical presence⁴⁹. UAE imports the scrap, refines them and export it to within GCC and to China, India and Pakistan.



^{46, 47} Trademap

⁴⁸ "Saudi Arabia becomes an export hub for aluminium scrap in the East", Alcircle.com

⁴⁹ "Press release: UAE Recycles 5 Million Tonnes Of Scrap Metal Annually", Gogreen.com

2.5.2. Leading Companies in the GCC Market

Some of the leading metal recovery companies operating in the GCC region include:

Table 10: Metal Recovery Companies in the GCC Market

Company	Year of Establishment	Country	Activity	Annual Capacity (tons)	Type of Metal
Emirates Recycling	2001	UAE	<ul style="list-style-type: none"> Collection Recovery Recycling 	18,000	Non-ferrous metals
Bee'ah*	2007	UAE	<ul style="list-style-type: none"> Collection Recovery 	NA	Ferrous and non-ferrous metals
Zone Waste Management & Recycling	1999	UAE	<ul style="list-style-type: none"> Collection Recovery Recycling 	NA	Non-ferrous metals
Sharif Metals	1963	UAE Kuwait Saudi Arabia	<ul style="list-style-type: none"> Collection Recovery Recycling 	NA	Ferrous and non-ferrous metals
NESMA Recycling	1988	Saudi Arabia	<ul style="list-style-type: none"> Recovery Recycling 	NA	Ferrous and non-ferrous metals
Al-Qaryan Group	1988	Saudi Arabia	<ul style="list-style-type: none"> Recovery Recycling 	NA	Ferrous and non-ferrous metals
Al-Bawardi Metal Recycling	1957	Saudi Arabia	<ul style="list-style-type: none"> Collection Recovery Recycling 	NA	Ferrous metals
Kuwait Waste Collection & Recycling Company**	1980	Kuwait	<ul style="list-style-type: none"> Collection Recovery 	48,000	Non-ferrous metals
Crown Industries	1997	Bahrain	<ul style="list-style-type: none"> Collection Recovery Recycling 	NA	Ferrous and non-ferrous metals

* Bee'ah collects 500,000 tons of MSW annually and recovers 67% of the waste. This is mix of paper, plastic and aluminum cans

** Capacity of Kuwait Waste includes other products such as paper, glass, plastic and waste oil.

2.6. Qatar Metal Recovery Market Overview

2.6.1. Historical and Current Waste Generation

Metal scrap in Qatar is generated through various sources such as Municipal Solid Waste (MSW), scrapping of end-of life cars and tire recycling (covered in rubber section-Chapter 5). The demand for material recovery services is equal to the scrap that is generated, as it can either be utilized within the country or exported. However, the recovery rate for most materials is very low due to the lack of source segregation and contamination.

A. Metal Scrap Generated From MSW:

MSW comprises approximately 5% metals⁵⁰. Steel accounts for 70% of the metal waste in MSW while the remaining 30% comprises mainly aluminum. From 2010 to 2015, the metal scrap generated increased from 42,332 tons to reach 58,313 tons, witnessing a CAGR of 6.6%⁵¹. In 2016, the metal scrap due to MSW is estimated to be 62,596 tons.

Steel scrap generated during 2010 and 2015 increased from 29,632 tons to 40,819 tons while aluminum scrap increased from 12,699 tons to 17,494 tons. In 2016, steel and aluminum scrap from MSW are estimated to be 43,817 tons and 18,779 tons, respectively (Chart 28).

Metal Scrap Major Sources in Qatar

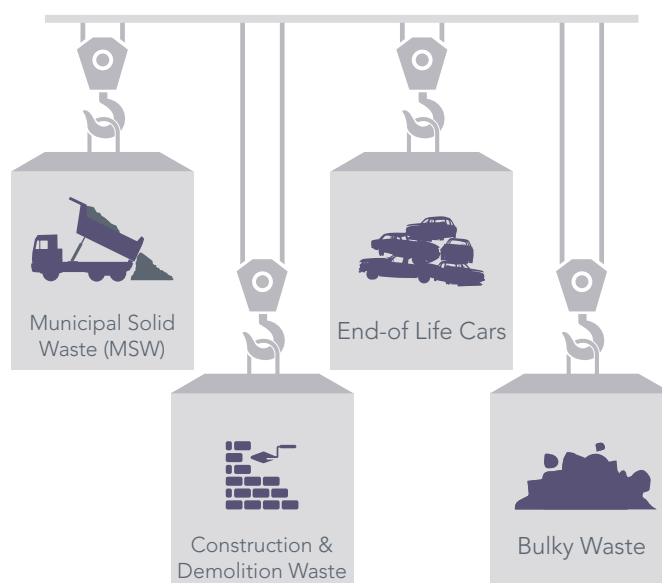
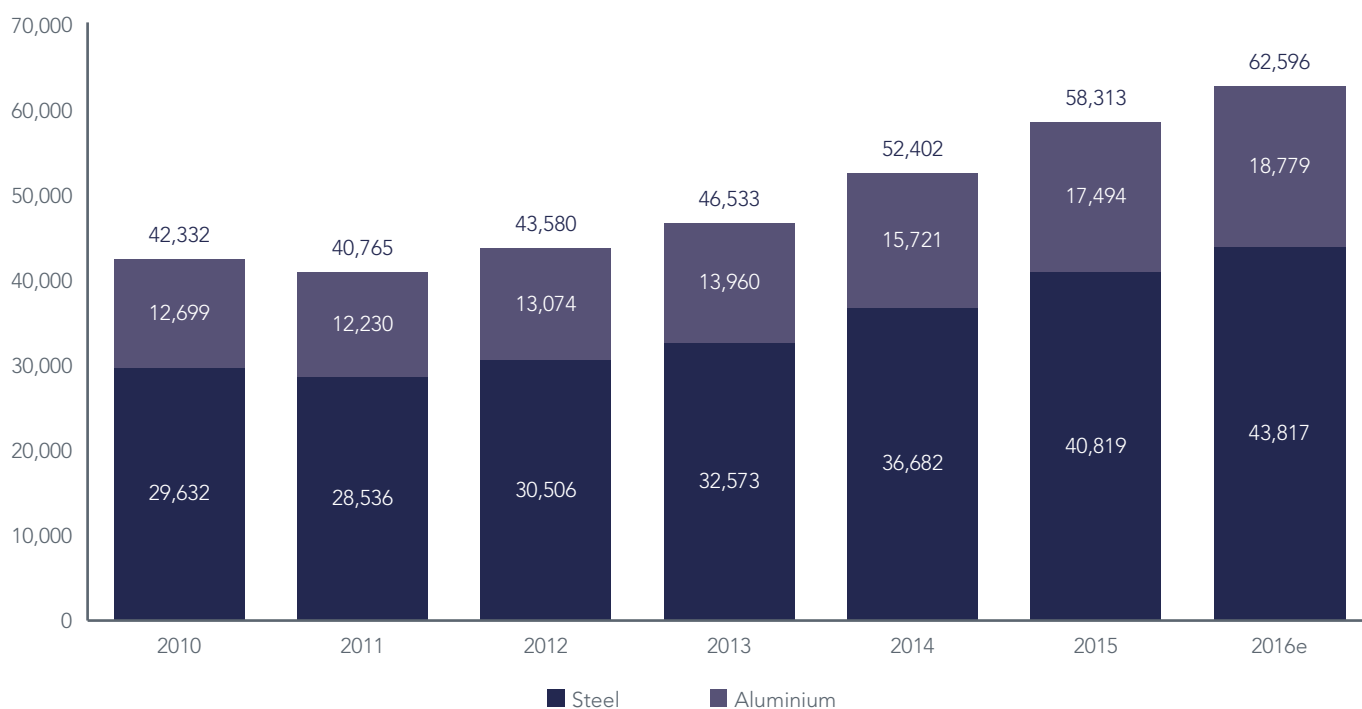


Chart 28: Metal Scrap Generated from MSW in Qatar, 2010-2016E (Tons)



Source: MDPS Environment Statistics 2014, Primary Research

⁵⁰ Primary research, Team analysis

⁵¹ MDPS Environment Statistics 2014, Team analysis

B. Metal Scrap Generated from Shredding ELV:

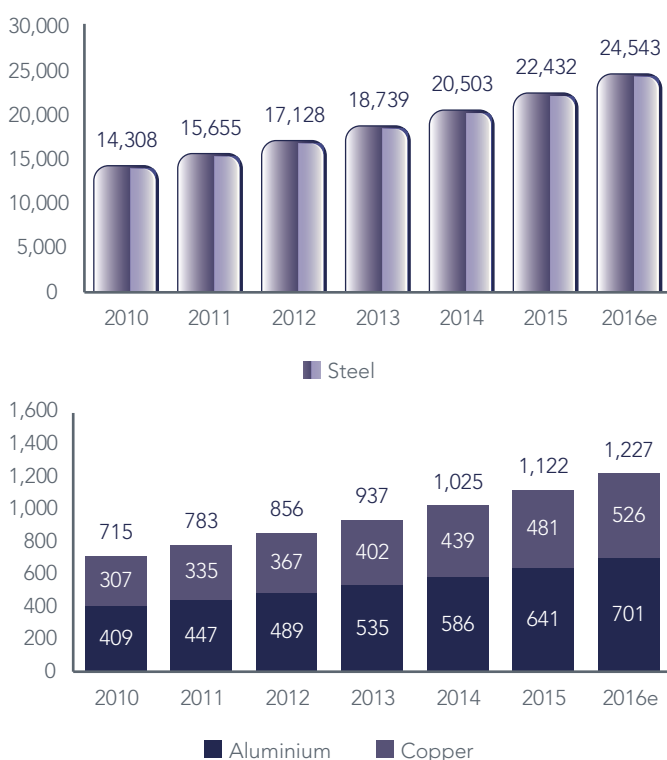
Metal scrap is generated by shredding end-of-life cars. Steel scrap accounts for close to 70% of the shredded material⁵². Aluminum and copper scrap accounts for 1–2% each, while other waste, such as plastic, foam and rubber, is dumped into the landfill and accounts for approximately 26.5% of the shredded material.

Shredding of cars is assumed to start in the eleventh year and 90% of the cars are expected to be shredded by the eighteenth year. The average weight of a car is assumed 1.5 tons.

During 2010, it is estimated that approximately 13,627 ELVs were shredded, generating 20,440 tons of scrap. Steel accounted for 14,308 tons (70 %) while aluminum, copper and other waste accounted for 409 tons (2%), 307 tons (1.5%) and 5,417 tons (26.5%), respectively.

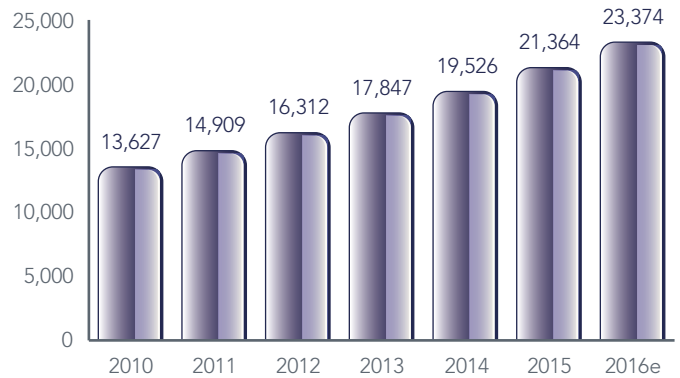
From 2010 to 2015, the number of cars reaching their end of life increased to 21,364 and consequently, the total amount of scrap generated increased to 32,046 tons, witnessing a CAGR of 9.4%. In 2016, it is estimated that approximately 23,374 cars will be shredded, thus generating 35,061 tons of scrap (Chart 29 & 30).

Chart 29: Metal Scrap Generated from Shredding of ELVs, 2010-2016E (Tons)



Source: MDPS Transport and communication statistics-2013 and 2014, Primary Research

Chart 30: Number of ELV in Qatar, 2010-2016E



Source: MDPS, Team Analysis

C. Metal Scrap Generated from CDW:

Metal is found in small amounts in CDW in the form of fasteners and steel rebars that are used in the foundation and columns. Steel scrap accounts for approximately 5% of the CDW⁵³ generated in the country. The data until 2014 for CDW has been extracted from MDPS (Chart 31).

Chart 31: CDW Generated in Qatar, 2010-2016E (Million Tons)

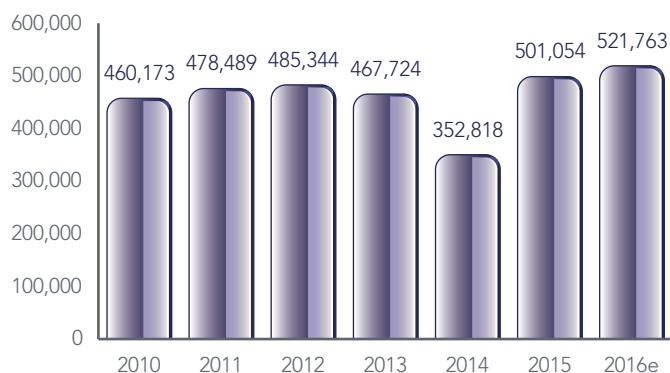


Source: MDPS Environment Statistics 2014

^{52, 53} Primary research

Steel scrap generated from CDW increased from 460,173 tons in 2010 to 467,724 tons (210 tons per million of construction GDP) in 2013. However, due to a slowdown in the real estate sector during 2014, the scrap generated also saw a decline and was reported to be 352,818 tons. However, based on the estimates, CDW generation in 2016 is estimated to reach 521,673 tons, witnessing a revival as a result of the increase in construction activities (Chart 32).

Chart 32: Steel Scrap Generated from CDW in Qatar, 2010-2016E (Tons)



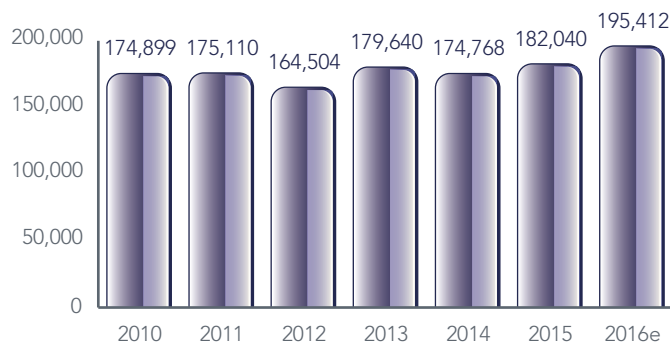
Source: MDPS Environment Statistics 2014, Primary Research

D. Metal Scrap Generated from Bulky Waste:

Bulky waste refers to waste items that are too large to be disposed by regular waste disposal methods. Bulky waste items include carpets, doors, furniture, white goods, garden waste and plumbing fixtures. Metal scrap⁵⁴ accounts for close to 10% of the bulky waste generated. The data for bulky waste generated in the country until 2014 has been extracted from MDPS. Bulky waste generated on a daily basis per capita in 2014 was approximately 2.14 kg decreasing from 2.93 kg in 2010.

During 2010 and 2015, metal scrap from bulky waste increased from 174,899 tons to 195,412 tons, witnessing a CAGR of 0.8%. As per the estimates, metal scrap generated from bulky waste in 2016 is estimated to be 195,412 tons (Chart 33).

Chart 33: Metal Scrap Generated from Bulky Waste in Qatar, 2010-2016E (Tons)



Source: MDPS Environment Statistics 2014, Primary Research

⁵⁴ Primary research



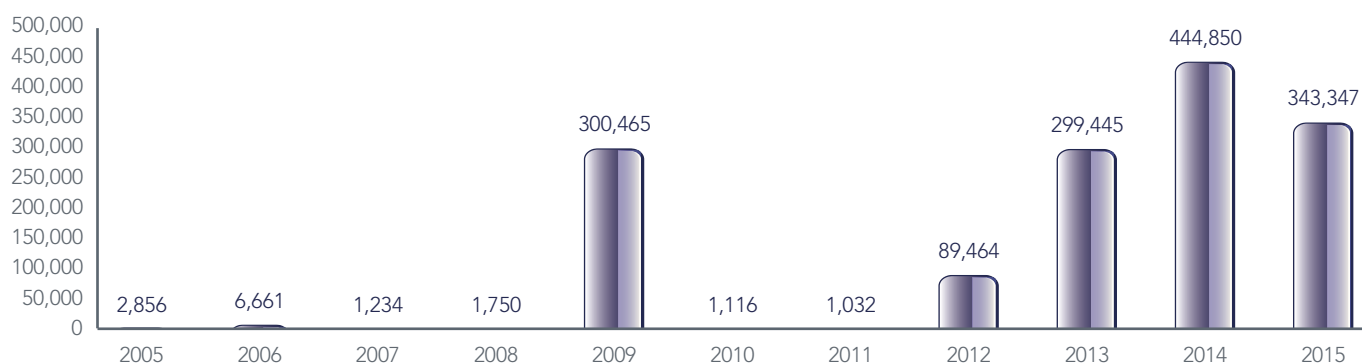
2.6.2. Analysis of Exports and Imports

Import and export analysis has been sub-divided into ferrous and non-ferrous metals, as per metal classification.

A. Ferrous Metals

Exports⁵⁵: Exports of ferrous scrap (HS Code: 7204 excluding 72042100 i.e. stainless steel) increased exponentially during 2005 and 2015. The export quantity reported an increase from 2,856 tons in 2005 to 343,346 tons in 2015. However, the spike in export of ferrous scrap was witnessed in 2012, when exports jumped to 89,463 tons. Post 2012, the exports registered a CAGR of 56.6% until 2015, despite the decrease in export quantity during 2015 by 22.8%, compared to that in 2014 (Chart 34).

Chart 34: Qatar's Steel Scrap Export, 2005-2015 ('000 Tons)



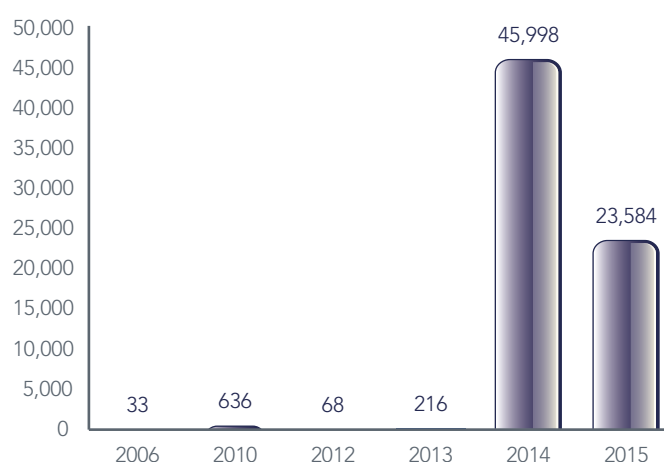
Source: Trademap

During 2015, the export of ferrous scrap was mainly registered under HS Code 72045000 (remelted scrap ingots) that accounted for 92.9% (340,998 tons) of the exports, while HS Code-72042100 (waste and scrap consisting stainless steel) accounted for 6.4% (23,584 tons) of the exports.

Data for trade under 72045000 has been reported since 2012 and has witnessed a CAGR of 56.7% thereafter, until 2015. In 2015, most of the exports under this HS code was to the UAE, which accounted for 81.5% (278,023 tons) share. South Africa, Djibouti and Ethiopia were the other countries to which Qatar exported scrap ingots with a combined share of 19.5% (62,964 tons).

Between 2005 and 2011, the export of stainless steel waste witnessed massive fluctuations and there were no exports of stainless steel waste except for 2006 and 2010. However, the export quantity saw a six-fold increase between 2012 and 2015, and correspondingly the quantity increased from 68 tons in 2012 to 23,584 tons in 2015. The UAE accounted for the major chunk, i.e., 99% of the exports, while Bahrain was the only other importer with a minimal quantity of 13 tons (Chart 35).

Chart 35: Qatar's Stainless Steel Scrap Export, 2006-2015 ('000 tons)



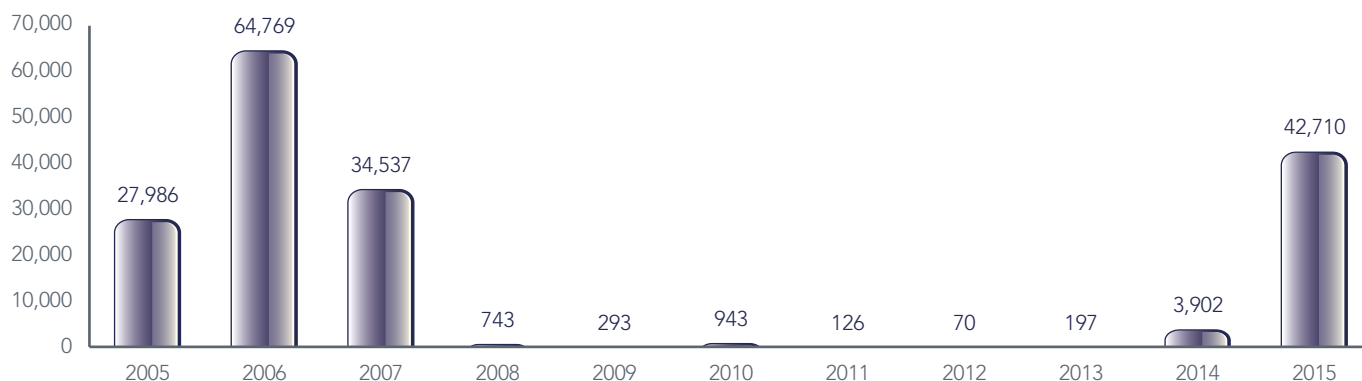
Source: Trademap

Imports⁵⁶: The ferrous scrap imports after witnessing an upsurge of 1.3 times during 2005 and 2006, saw a steep decline until 2011 when the imports registered an all-time low quantity of 126 tons. The trade decreased for two continuous years and saw a marginal improvement in 2013.

^{55, 56} Trademap

Post 2013 until 2015, imports witnessed a seven-fold increase in 2015 with imports reaching 42,709 tons (Chart 36).

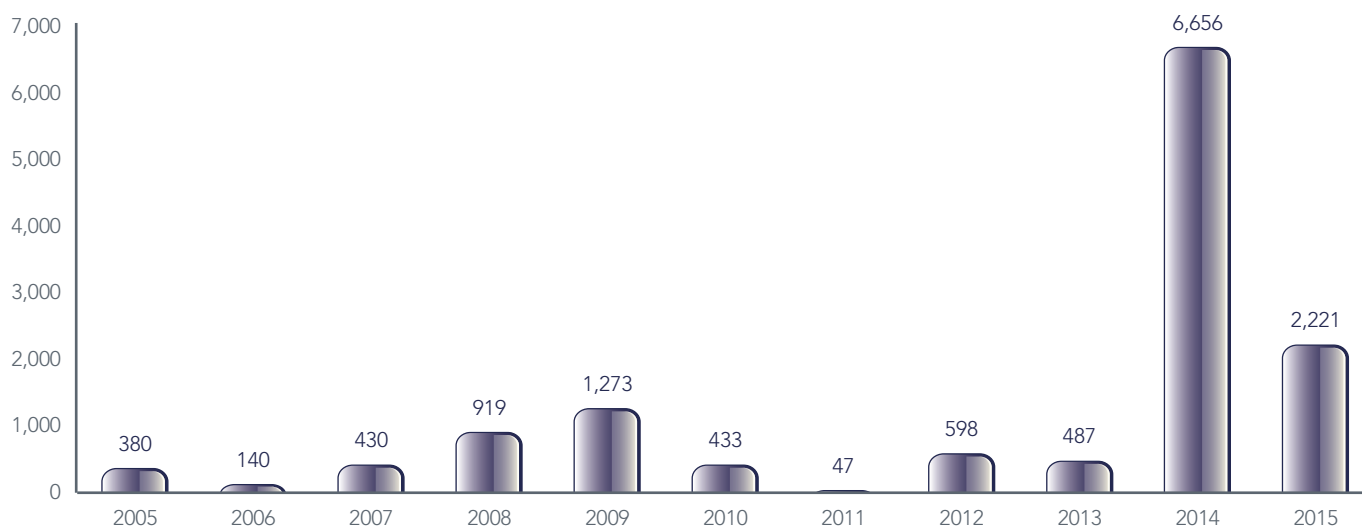
Chart 36: Qatar's Steel Scrap Import, 2005-2015 ('000 Tons)



Source: Trademap

Imports of different product segments in 2015 saw a huge variation compared to that in 2014. During 2014, HS Code-72042100 (waste and scrap of stainless steel) accounted for 63.0% (6,665 tons) of the imports while in 2015, the share declined to 4.9% (2,221 tons) (Chart 37).

Chart 37: Qatar's Stainless Steel Scrap Import, 2005-2015 ('000 tons)



Source: Trademap

Similarly, for other HS codes (72041000, 72042900, 72043000 and 72044900) which had a combined share of 36.9% (3,895 tons) in 2014, saw a minimal import of 1.8 tons in 2015.

In 2015, HS Code 72044100 (turnings, shavings, chips, milling waste, sawdust, filings, trimmings and stampings, whether or not in bundles) accounted for 95.1% (42,705 tons) of the total imports, increasing from 4.4 tons in 2014. During 2015, this commodity was imported primarily from the US and other countries such as Germany, China and the Netherlands, valued for less than 1% of the total imports. However, the reason behind this abrupt increase in the imports is unknown.

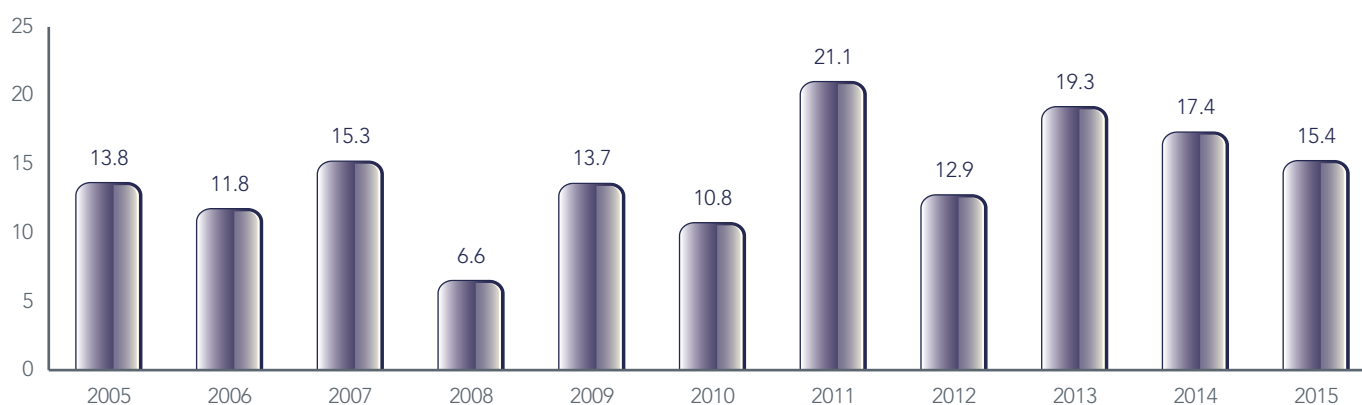
B. Non-Ferrous Metals

i. Aluminum

Exports⁵⁷: Aluminum scrap exports (HS Code: 7602) have seen a bi-annual decrease in the exports since 2005, except for 2015 when the export quantity declined for two continuous years. During 2005 and 2015, the exports increased marginally from 13,752 tons to 15,352 tons, registering a CAGR of 1.1%.

During 2005 and 2015, exports were registered only under one HS Code 76020000 except for 2014 when HS Code 76029999 (aluminum waste categorized as confidential) reported exports of 12,661 tons (68.2% of the exports). The major importing countries of aluminum scrap were the UAE and India with 88.6% and 9.1% shares, respectively (Chart 38).

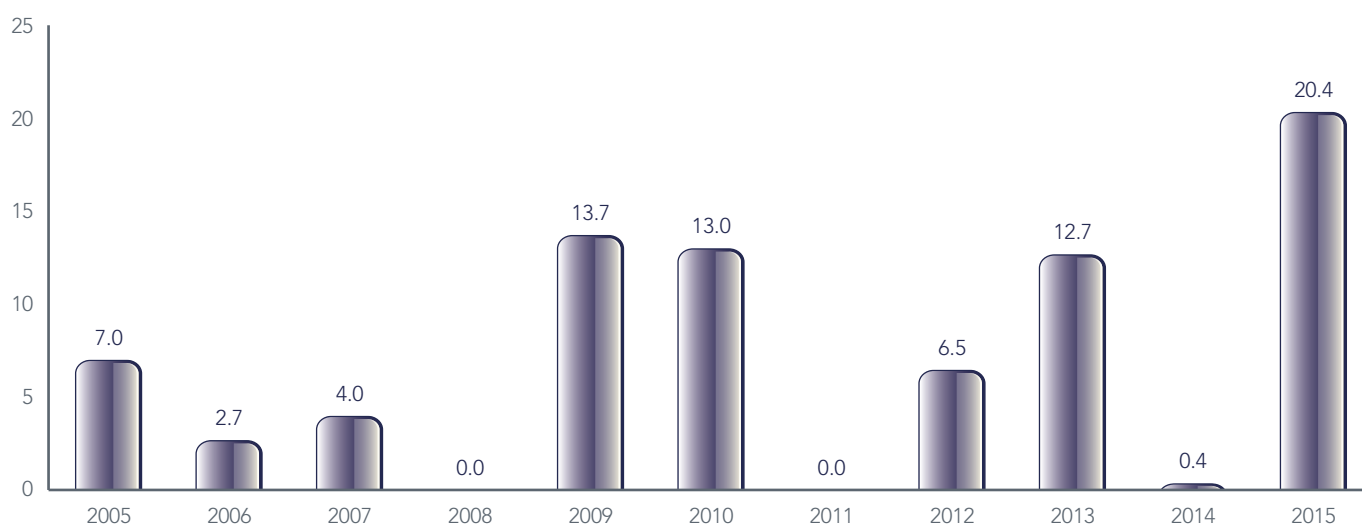
Chart 38: Qatar's Aluminum Scrap Export, 2005-2015 ('000 Tons)



Source: Trademap

Imports⁵⁸: Despite the fact that imports of aluminum scrap in the country registered a CAGR of 11.1% during 2005 and 2015 (HS Code: 7602), the quantity imported was negligible. In 2015, China and the Korean Republic were the only exporters of aluminum waste to Qatar with a combined quantity of 20 tons (Chart 39).

Chart 39: Qatar's Aluminum Scrap Import, 2005-2015 (Tons)



Source: Trademap

Although there are few recovery facilities for aluminum, there are no recycling facilities except QATALUM and hence, the amount of aluminum scrap imports in the country is minimal.

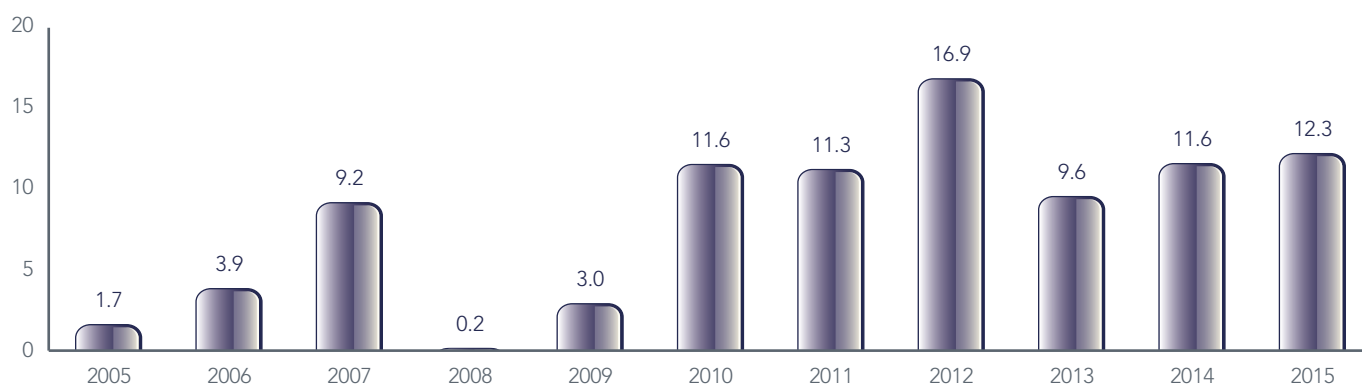
^{57,58} Trademap

ii. Copper

Exports⁵⁹: During the period of analysis, i.e., between 2005 and 2015, the exports of copper scrap (HS Code: 7404) have gone through two major downfalls. One of them was in 2008 when exports declined to 179 tons after witnessing an increase of 1.4 times during 2005 and 2007. The reported exports in 2005 and 2007 were 1,664 tons and 9,240 tons respectively. Post this decline in 2008, the exports saw a double-fold increase until 2012 when it was reported to be 16,914 tons. The other drop was observed in 2013 when the exports declined by 43.2%. However, there was a revival during 2014 and 2015 when the copper scrap exports witnessed a CAGR of 13% and reportedly, the exported quantity in 2015 reached 12,277 tons.

During 2005 and 2015, exports were done only under one HS Code 74040000, except for 2014, when HS Code 74049999 (copper waste categorized as confidential) reported exports of 7,937 tons (68.2% of the exports). Major importing countries of aluminum scrap were the UAE and India with 93.9% and 2.9% shares, respectively (Chart 40).

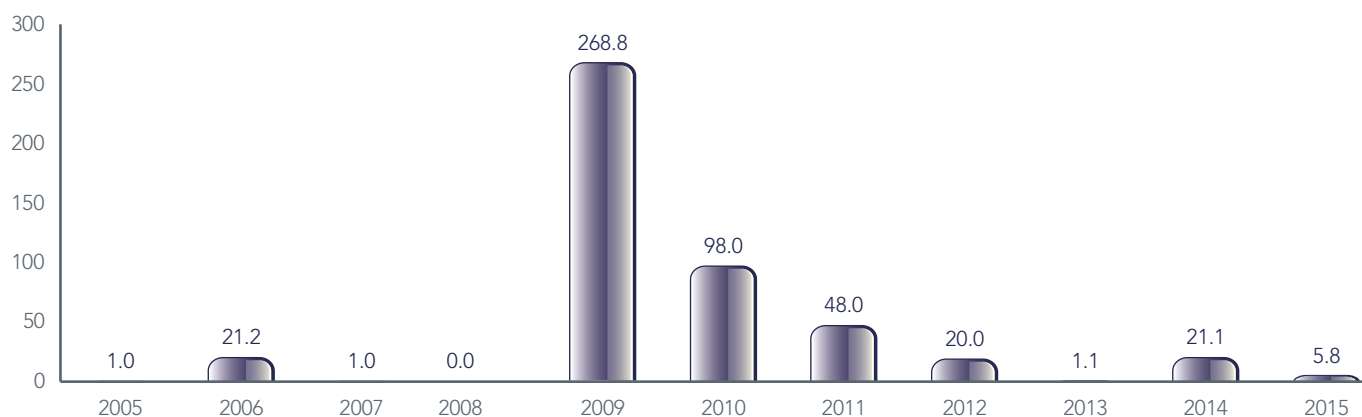
Chart 40: Qatar's Copper Scrap Export, 2005-2015 ('000 Tons)



Source: Trademap

Imports⁶⁰: Copper scrap imports (HS Code: 7404) in the country have been negligible. This is evident from the fact that during 2005 and 2015, the maximum scrap was imported in 2009 when the imports accounted for 269 tons. After 2009, copper scrap has seen a negative CAGR of 47% until 2015, when only five tons of scrap were imported (Chart 41).

Chart 41: Qatar's Copper Scrap Import, 2005-2015 (Tons)



Source: Trademap

Trade data clearly indicates that due to absence of any recovery facility for copper in Qatar, there is limited import of copper scrap in the country. In addition, the exports are primarily on account of re-export. This shows that there is very low amount of copper recovered in Qatar.

^{59,60} Trademap

2.6.3. Waste Generation Forecast

A. Metal Scrap Generated from MSW:

The amount of MSW generated over the next few years is estimated based on the average per capita MSW generated during the period 2008 to 2014, which is equal to 1.37kgs per person per day. Metal accounts for approximately 5% of the MSW generated. Steel accounts for 70% of the metal waste in MSW while the remaining 30% primarily comprises aluminum.

The current metal scrap generation from MSW is 62,596 tons and this is estimated to reach 66,027 tons in 2017 and 70,135 tons in 2025, witnessing a CAGR of 0.76% during 2017 and 2025. Steel scrap is estimated to increase from 43,817 tons in 2016 (current generation) to reach 46,219 tons in 2017 and 49,095 tons in 2025 (Chart 42).

Chart 42: Metal Scrap Generation from MSW in Qatar, 2017F-2025F (Tons)



Source: MDPS: Environment Statistics 2014, Team Analysis

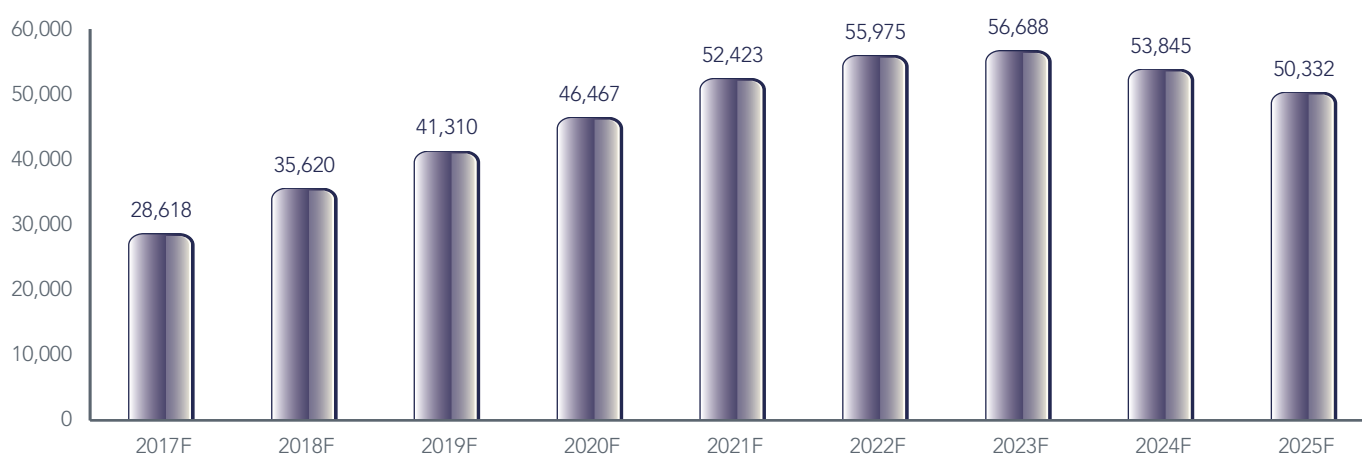
B. Metal Scrap Generated from Shredding ELV:

The number of vehicles per 1,000 people in Qatar has gradually reduced from 502 vehicles in 1999 to 450 vehicles in the year 2015. However, this number is relatively constant from last six years and thus, this per capita number is multiplied with the population estimate to arrive at the estimated number of registered vehicles over the next few years.

Shredding of car is assumed to start in the eleventh year and 90% of the cars are expected to be shredded by the eighteenth year. The average weight of a car is assumed to be 1.5 tons.

Vehicles reaching their end of life annually are expected to increase from 23,374 in 2016 to 28,618 in 2017 and increasing further to reach 50,332 in 2025 (Chart 43).

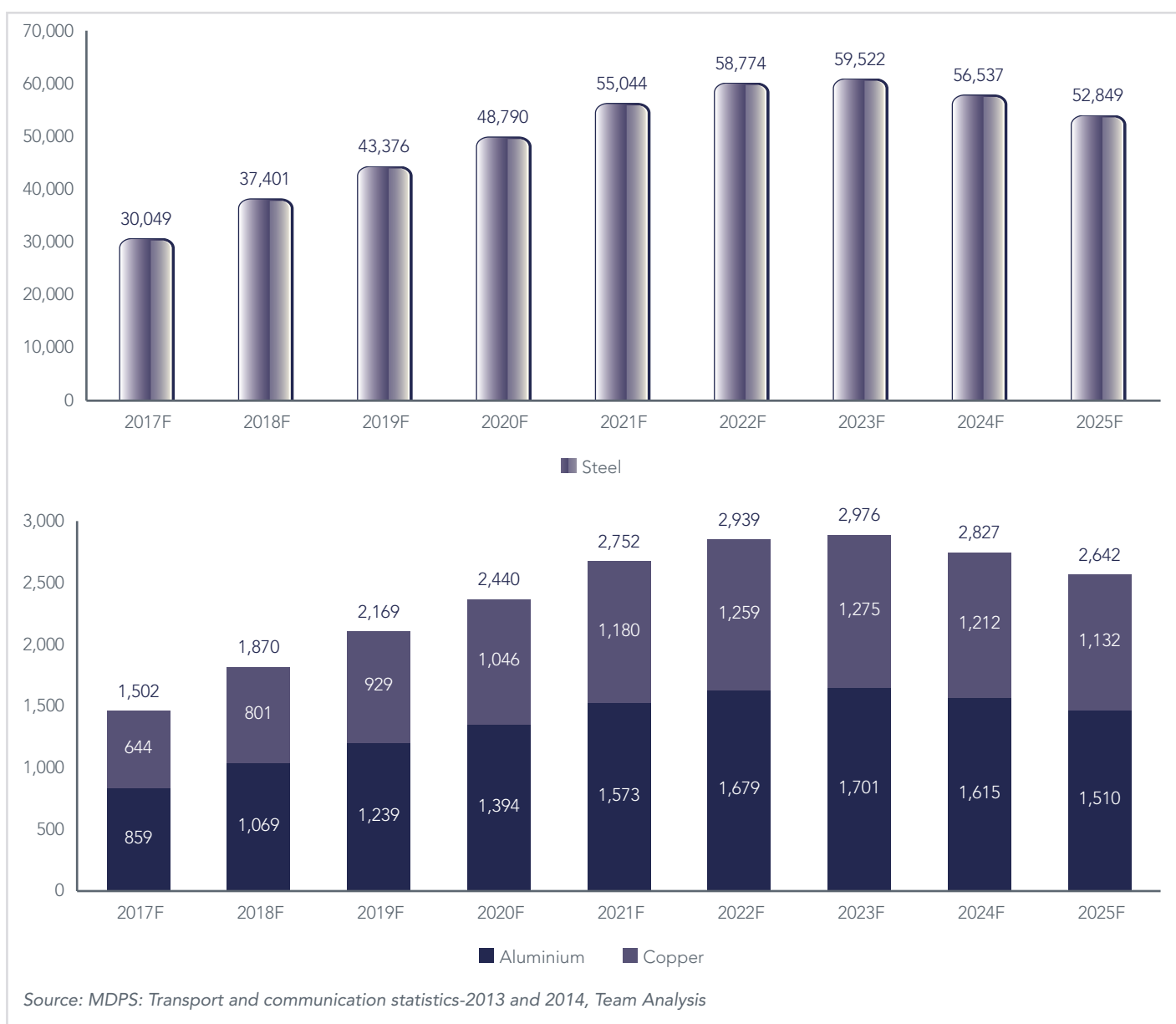
Chart 43: Number of ELV in Qatar, 2017F-2025F



Source: MDPS: Transport and communication statistics-2013 and 2014, Team Analysis

The metal scrap estimated to be generated from shredding of ELVs in 2016 was 25,770 tons and is estimated to reach 62,499 tons in 2023. Hereafter until 2025, the metal scrap generation is expected to decrease to 55,491 tons in 2025. This can be attributed to the decrease in number of automobile registrations during 2013–15 due to the slowdown in the market. Composition of the scrap (i.e., percentage of steel, copper and aluminum) is estimated to be same as that in 2016 (Chart 44).

Chart 44: Metal Scrap Generation from Shredding of ELVs, 2017F-2025F (Tons)

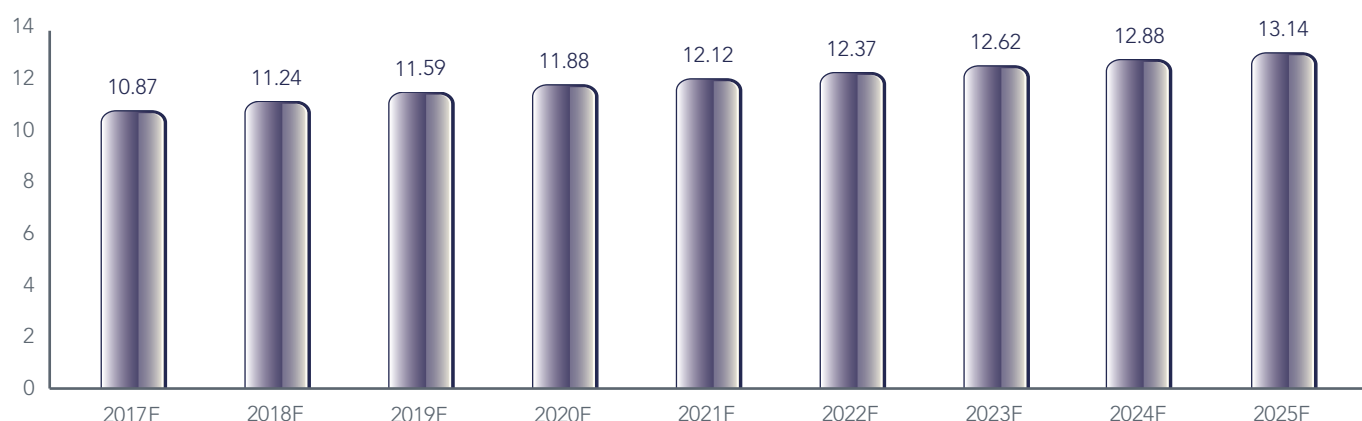


C. Metal Scrap Generated from CDW:

The CDW generated during 2008–14 is regressed with the real construction GDP to arrive at the forecast for CDW generated over the next few years. Steel scrap is estimated to account for approximately 5% of the CDW.

CDW is expected to increase from 10.87 million tons in 2017 to reach 13.14 million tons in 2025. (Chart 45)

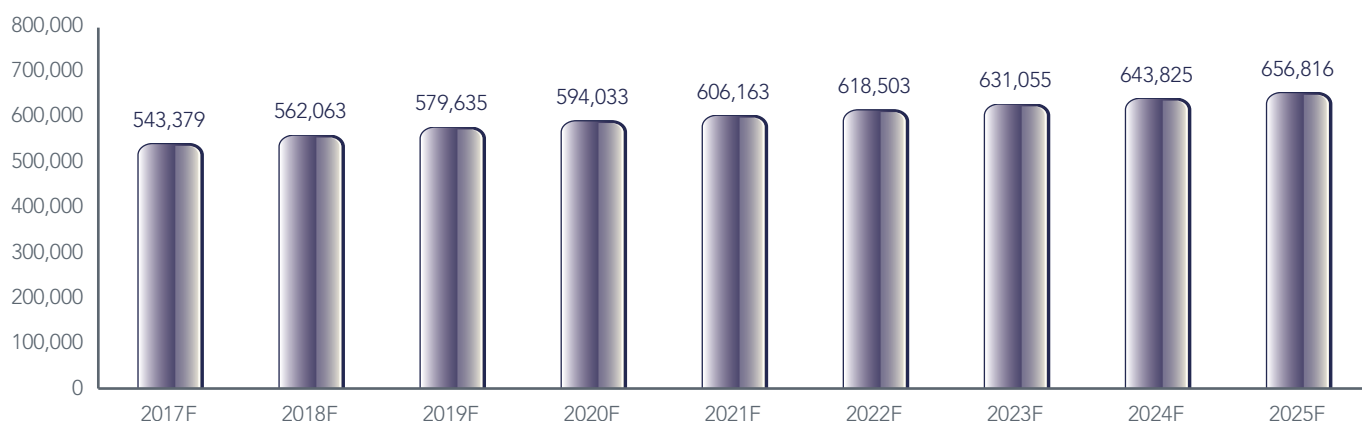
Chart 45: CDW Generation in Qatar, 2017F-2025F (Million Tons)



Source: MDPS Environment Statistics 2014, Team Analysis

Due to this, steel scrap generated from CDW is estimated to increase from 521,763 tons in 2016 to 543,379 tons in 2017. Hereafter, it is expected to witness a CAGR of 2.4% to reach 656,816 tons in 2025, owing to the increase in construction and demolition activities in the country owing to FIFA 2022 (Chart 46).

Chart 46: Steel Scrap Generation from CDW in Qatar, 2017F-2025F (Tons)



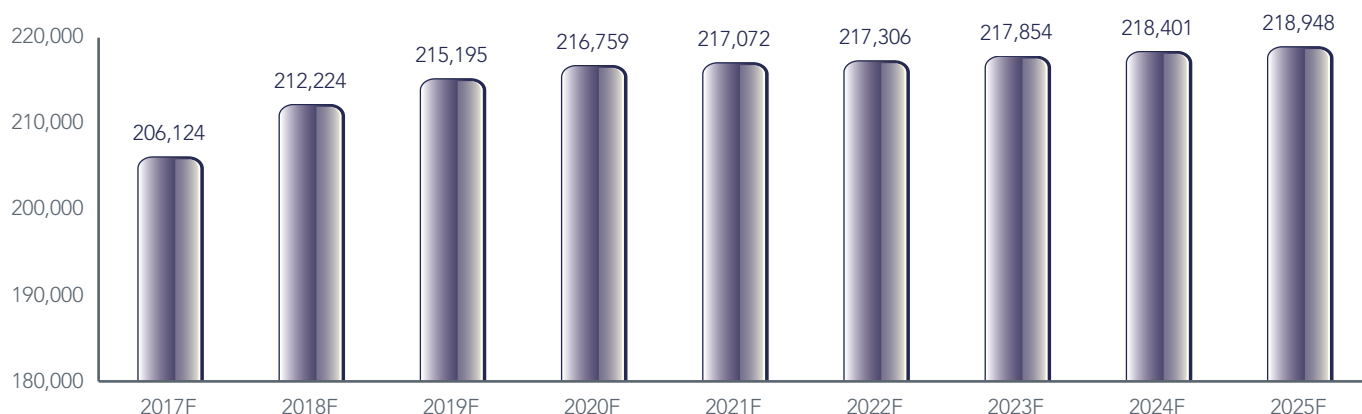
Source: MDPS Environment Statistics 2014, Team Analysis

D. Metal Scrap Generated from Bulky Waste:

The bulky waste generated per capita is approximately 2.14kg per day. The per capita waste generation is multiplied with the population estimate to arrive at the estimated bulky waste generated over the next few years. Metal accounts for close to 10% of the bulky waste generated.

Presently, 195,412 tons of metal scrap is generated due to bulky waste. This is estimated to reach 206,124 tons in 2017 and 218,948 tons in 2025, witnessing a CAGR of 0.8% (Chart 47).

Chart 47: Metal Scrap Generation from Bulky Waste, 2017F-2025F (Tons)



Source: MDPS Environment Statistics 2014, Team Analysis

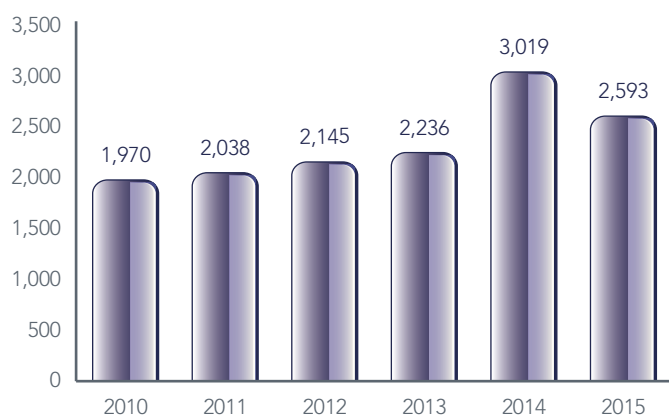
2.6.4. Demand for Recovered Material

Metal recovered from different sources of waste can be used for various metal applications. The demand for different ferrous and non-ferrous metals and the replacement capability for recovered metals in Qatar is explained as below:

A. Ferrous Metals

Local production: Qatar produced 2.6 million tons of crude steel in 2015, increase from 1.9 million tons in 2010. All of the production was done through electrical furnace. In 2014, QASCO⁶¹ produced 2.87 million tons (94.9%) of the total country's production. The remaining 5.1% of production by small players operating in the market such as Seashore steel, Al-Watania Steel etc. (Chart 48).

Chart 48: Qatar's Crude Steel Production, 2010-2015 ('000 Tons)



Source: World Steel Association

Imports: Qatar's import⁶² of semi-finished and finished steel products increased from 136,000 tons in 2010 to 300,000 tons in 2015. Long steel products accounted for 34% (102,000 tons), flat products for 33.3% (100,000 tons) while tubular products accounted for 89,000 tons (29.7%) (Chart 49).

Chart 49: Qatar's Trade of Semi-finished and Finished Steel Products, 2010-2014 ('000 Tons)



Source: World Steel Association

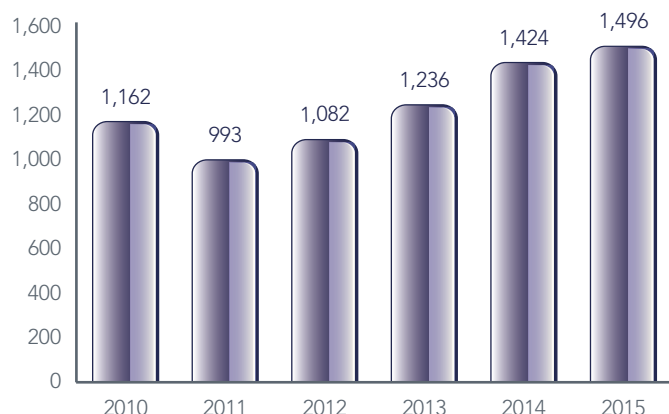
Exports: Qatar's export⁶³ of steel semi-finished and finished steel products decreased from 900,000 tons in 2010 to 45,000 tons in 2014. All of the exports were done in form of ingots.

⁶¹ QASCO Annual Report-2014, qatarsteel.com.qa

^{62, 63} Steel Statistical Yearbook 2016, worldsteel.org

Consumption: Apparent consumption⁶⁴ of steel in finished steel form increased from 1.1 million tons in 2010 to 1.5 million tons in 2015 (Chart 50).

Chart 50: Qatar's Apparent Steel Use for Finished Products, 2010-2014 ('000 Tons)



Source: World Steel Association

Replacement Opportunity for Recovered Steel:

QASCO releases tenders periodically in the market for sourcing steel scrap/recovered steel from the domestic market. However, there are certain standards, which are required to be adhered. In case, the supplier fulfills the requirement, it can supply the steel scrap/recovered steel to QASCO as per their requirement.

The recovery company can also supply recovered steel to other small companies operating in Qatar but they cannot export steel in any form without approval from QASCO.

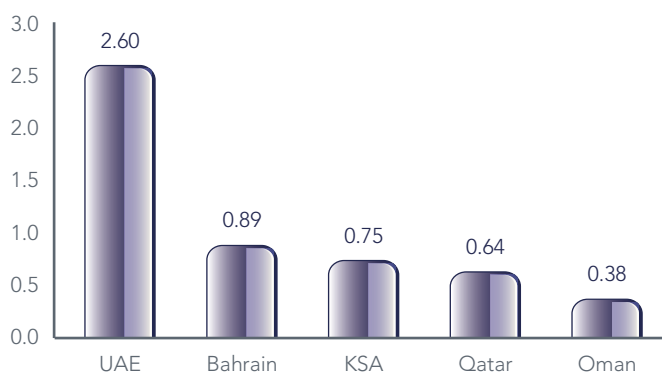
Thus, the supply for recovered steel is only limited to domestic market.

B. Non-Ferrous Metals

i. Aluminum

GCC region has seen a continuous growth in the primary aluminum production over the years. This is evident from the fact that production capacity of primary aluminum in the region has increased from 2,731,757 tons⁶⁵ in 2010 to 5,260,500⁶⁶ tons in 2015. This increase is mainly attributable to the low energy and labor costs in the region compared to the European countries (Chart 51).

Chart 51: GCC Primary Aluminum Production, 2015 (Million Tons)



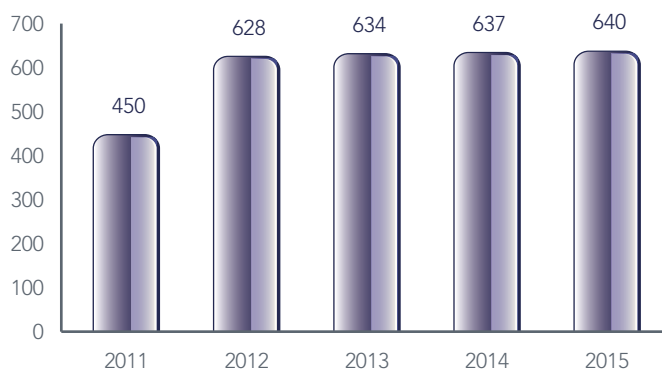
Source: Gulf Aluminum Council

The region consumes only 20% of the primary aluminum⁶⁷ produced in GCC while the remaining (80%) is exported to other countries.

Local production: Qatar started primary aluminum production post 2007 through the establishment of QATALUM, a JV between Qatar Petroleum and Norsk Hydro USA in the year 2011.

The company has expanded its production capacity over the period of 5 years. In 2015, they produced 640,000⁶⁸ tons of primary aluminum, an increase from 450,000 tons in 2011 (Chart 52).

Chart 52: Qatar's Primary Aluminum Production, 2011-2015 ('000 Tons)



Source: USGS

QATALUM produces 300,000 tons of foundry alloys while it produces 340,000 tons of extrusion ingots.

Of the foundry alloys produced by QATALUM, 75% (225,000 tons) of them goes into the automotive industry while the remaining 25% is used in other industries.

Within the foundry alloys used for automotive industry, 1/3rd (75,000 tons) is made from primary aluminum while the remaining (150,000 tons) is made from recycled aluminum.

⁶⁴ Steel Statistical Yearbook 2016, worldsteel.org

^{65, 66} Gulf Aluminum Council, gac.ae

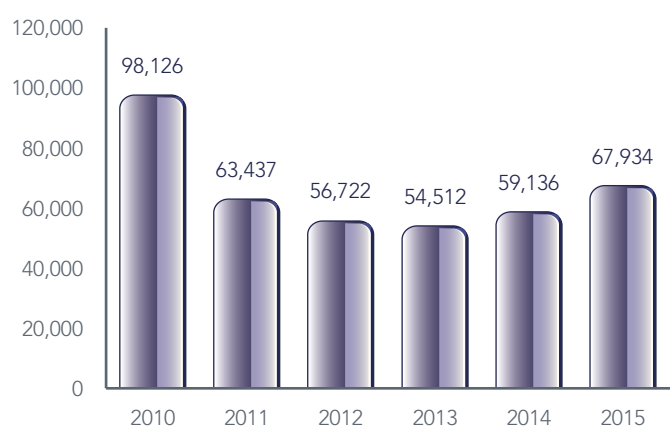
⁶⁷ Aluminum Circle Blog, blog.alcircle.com

⁶⁸ QATALUM Website, qatalum.com

QATALUM exports foundry aluminum to over 30 countries across the globe with almost 85% of the exports done to Asian countries (47.25%), Turkey (21.31%) and North America (16.07%).

Imports: Aluminum imports in Qatar (HS Code: 76 excluding 7602 i.e. waste of aluminum) decreased from 98,126 tons in 2010 to 67,934 tons in 2015 (Chart 53).

Chart 53: Qatar's Aluminum Import, 2010-2015 (Tons)



Source: Trademap

In 2015, approximately 74.1% (50,313 tons) of imports were done under 7604 (36.4%) (Bars, rods and profiles of aluminum), 7606 (17.4%) (Plates, sheets and strip, of aluminum) and 7610 (20.2%) (Structures and parts of structures).

Exports: Aluminum exports from Qatar (HS Code: 76 excluding 7602 i.e. waste of aluminum) increased from 179,379 tons in 2010 to 866,857 tons in 2015 (Chart 54).

Chart 54: Qatar's Aluminum Export, 2010-2015 (Million Tons)



Source: Trademap

Approximately 96.9% (839,315 tons) of the exports were done under HS Code 7601 (unwrought aluminum). UAE (19.2%), Turkey (15.9%), Korea (12.6%), USA (10.3%) and Saudi Arabia (7.6%) were the leading exporters for unwrought aluminum in 2015.

Replacement Opportunity for Recovered Aluminum

Qatar generates approximately 20,000 tons of aluminum waste through MSW and ELV which can be recovered by the domestic aluminum recovery facilities and can be sold to QATALUM that uses 150,000 tons of secondary foundry alloys in the production of aluminum.

ii. Copper

There are no primary copper production in Qatar and hence, the demand for raw material is fulfilled completely through imports. In addition, there are imports of finished copper products in the country.

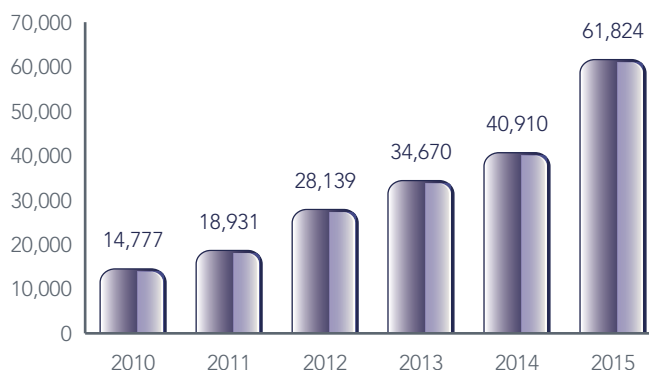
Local production: Imported refined copper as a raw material is used in Qatar mainly for the production of cables. These end products produced are consumed not only in domestic market but are also exported to other countries.

Doha cable⁶⁹ imports primary copper and processes them for the production of cables. They have an annual production capacity of 50,000 tons of copper products.

QICC⁷⁰ (Qatar International Cables Company) has a capacity to produce 25,000 tons of copper cables annually.

Import: As per Trademap statistics, imports of refined copper and its products (HS Code: 74 except for 7404 i.e. waste and scrap of copper) increased from 14,777 tons in 2010 to 61,824 tons in 2015 witnessing a CAGR of 33.1% (Chart 55).

Chart 55: Qatar's Copper Import, 2010-2015 (Tons)



Source: Trademap

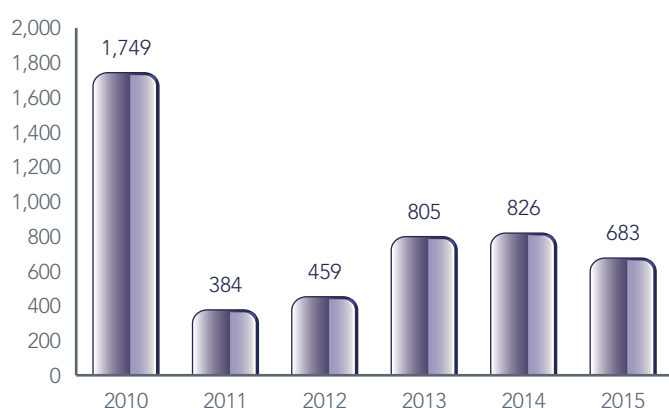
⁶⁹ Doha Cables: Company website

⁷⁰ "QICC to ramp production", Doha.biz

Almost 82.1% (50,735 tons) of the imports in 2015 were done under HS Code 7408 i.e. copper wire (excluding surgical sutures, stranded wire, cables, plaited bands etc.). UAE (65.5%), Russia (17.8%), India (9.6%), Turkey (4.2%) and Kuwait (2.6%) were the leading importers to Qatar for this product segment (HS Code: 7408) in 2015.

Exports: Qatar's export of copper and copper products (HS Code: 74 except for 7404 i.e. waste and scrap of copper) decreased from 1,749 tons in 2010 to 826 tons in 2014 (Chart 56).

Chart 56: Qatar's Copper Export, 2010-2015 (Tons)



Source: Trademap

In 2014, over 62% (519 tons) of the exports were done under the HS Code: 7413 i.e. stranded wire, cables and plaited bands etc. Of this 519 tons of exports from Qatar, 435 tons was the re-exported quantity.

Replacement opportunity for recovered copper:

As copper does not degrade or lose its chemical properties and cannot be distinguished from primary copper upon recycling, they can easily replace the demand for refined copper in the country that is presently being imported.

However, copper scrap is primarily found in CDW which is not segregated or recovered in Qatar currently and hence, recovery of substantial amount of copper in Qatar is a challenge. Moreover, if the copper scrap is not properly segregated and is contaminated, it can pose challenges for the facilities to alter the composition of recovered copper required to meet the government specifications.

2.6.5. Assessment of Supply Landscape

Within Qatar, metal recovery and recycling, especially steel, is governed through stringent regulations by the government and hence the number of facilities operating in the metal recovery sector are limited.

1. Venture Gulf Recycling^{71 72} is a member company of Al Nasr Holding that started operations in 1981. It has an employee base of 34 people including 22 labors. The plant is spread across 15,000sqm and has an annual installed capacity of 50,000 tons. However, the company operates at 48% of their capacity and recovers almost 24,000 tons of metal annually. The adverse summer temperatures make it challenging to operate during the day at desired capacity as the facility is an open yard.

The company mainly deals with ELV scrap along with other metal waste generated from industries and the construction sector. The metal scrap is sourced through government auctions and from customers who visit the facility to sell the scrap.

Of the ELV scrap recovered annually, steel accounts for almost 70% (16,800 tons) while copper and aluminum are recovered in small percentages (approximately 1% to 2%). The remaining ELV scrap is generated in the form of rubber and plastic and is dumped in the landfill.

The high quantity of plastic and rubber waste is generated as an output of shredding process because Venture Gulf do not separate tires and other plastic materials from the vehicles before feeding it to the shredder. Separation of tires and other plastic parts is labor-intensive and time-consuming and hence avoided.

The recovered steel is sold to QASCO while the recovered aluminum and copper are sold to domestic players as well as in the overseas market.

2. Lucky Star Alloys⁷³ is a subsidiary of Lucky Group, UAE, which started its operations in 1976, with their first plant in Dubai and expanded its footprints to Doha, Shanghai and Toronto over the years. The facility in Qatar was started in 2012 and is spread across 16,300sqm with 25 employees. The annual production capacity of the plant is 40,000 tons and its current capacity utilization is in the range of 40–50%, i.e., 16,000 to 20,000 tons. In Qatar, the company is involved in the recovery of non-ferrous scrap and manufacturing of copper granules. The company undertakes the process of cleaning and compacting for aluminum scrap while copper is recovered in the form of bare copper. These products are then sold in the overseas market. The scrap is sourced from SME industries through long-term contracts, from waste management companies and through government auctions.

3. Seashore Steel W.L.L⁷⁴: Seashore group started its operations in Qatar in 1989 and has recently ventured into manufacturing steel products such as mild steel billets, angles, flat bars and channels. The facility is spread across an area of 5,000sqm and has an annual production capacity of almost 100,000 tons.

⁷¹ Company website

⁷² Primary research

^{73, 74} Company website

The steel required for production is sourced either through QASCO or from its in-house waste management company (Seashore waste management). Steel scrap is recovered in the facility and then reused in production of steel products. Seashore steel sells the steel products both domestically and internationally, as it has permission from QASCO to export steel products.

Their international client base is spread across countries such as India, Austria, Jordan, the UAE, Saudi Arabia, the UK, Oman and Sri Lanka.

4. Rastec Scrap and Surplus⁷⁵, was established in 1995 to buy, sort and sell scrap to recovery and recycling companies. It sells ferrous scrap to QASCO while non-ferrous scrap is exported to other countries. Apart from Rastec, many other companies in Qatar are operating with the same business model.

2.6.6. Pricing Analysis

A. Ferrous Metals⁷⁶

As per the data derived from Trademap, the price of ferrous scrap (HS Code: 7204 excluding 72042100 i.e. stainless steel) witnessed the highest price in 2012 when average export price jumped to QAR2,136 per ton from QAR908 per ton in 2009. However, the average export price per ton has registered a continuous downfall since 2010 until 2015, except for the year 2012 when prices saw an increase by QAR251 per ton, as compared to that in 2011 (Chart 57).

Chart 57: Qatar's Steel Scrap Export Price, 2005-2015 (QAR/Ton)



Source: Trademap, Team analysis

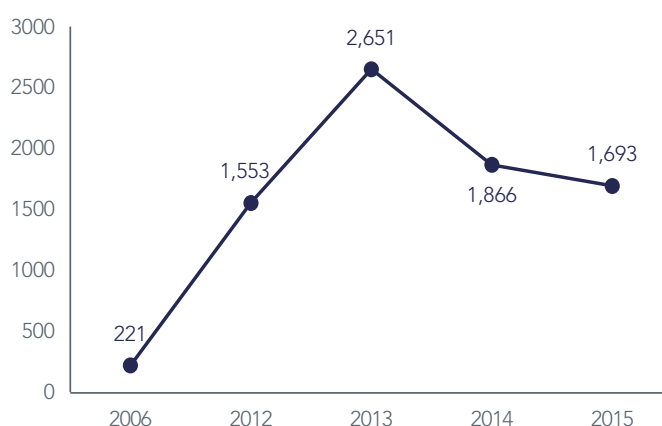
Remelted scrap ingots (HS Code 72045000), which accounted for more than 90% of the ferrous scrap exports annually during 2012 and 2015, declined in export prices. The prices for this segment fell from QAR2,113/ton in 2012 to QAR1,461/ton in 2015.

⁷⁵ Company website

^{76, 77} Trademap

For HS Code 72042100 i.e. stainless steel scrap, the export were done only in few years as represented in Chart 58. The prices increased from QAR1,553 per ton in 2012 to reach QAR2,651 per ton in 2013, an increase of QAR1,098 per ton over the year. However, prices have witnessed continuous downfall in the last two years and prices registered for 2015 was QAR1,693 per ton.

Chart 58: Qatar's Stainless Steel Scrap Export Price, 2006-2015 (QAR/Ton)



Source: Trademap, Team analysis

ELV were and metal scrap was bought by the recovery facilities in a price range of QAR250 to 300 per ton. As per the regulations in Qatar, no facility can export steel in any form without the permission from Qatar Steel (QASCO). Thus, the only buyer available for these steel recovery facilities is QASCO.

QASCO buys scrap from these recovery facilities at a discounted price compared to that of international steel prices and the price varies on a quarterly basis. Based on the primary interviews conducted with metal recovery facilities, Qatar Steel, in 2014, bought recovered steel at QAR700 per ton but the price per ton declined to QAR550 during 2015.

B. Non-Ferrous Metals:

i. Aluminum⁷⁷

Corresponding to the variation in aluminum scrap exports (as explained in section 4.6.4), the export price per ton also witnessed bi-annual fluctuations during 2005 and 2015.

In fact, after 2008, the prices of aluminum scrap per ton has been inversely proportional to the export quantity. This is evident from the fact that in 2011, the quantity of aluminum exports reached its peak with 21,112 tons and correspondingly, the export price per ton registered an all-time low value of QAR1,401 per ton (Chart 59).

Chart 59: Qatar's Aluminum Scrap Export Price, 2005-2015 (QAR/Ton)



Source: Trademap, Team analysis

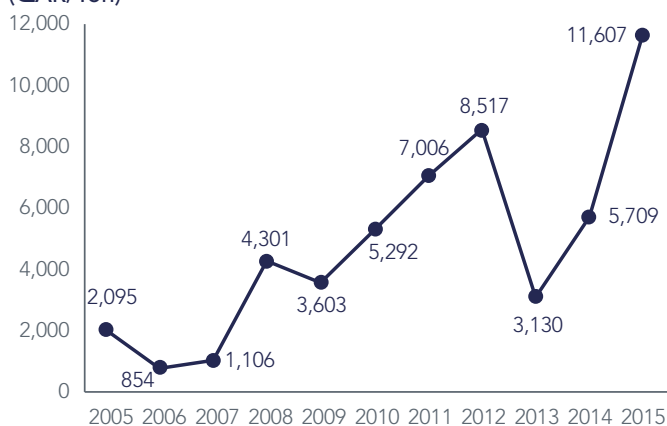
In domestic market, aluminum scrap in form of sheets was bought by recovery facilities in price range of QAR1,100 to QAR1,200 per ton while scrap cans were bought in bracket of QAR900 to QAR1,300 per ton⁷⁸.

ii. Copper⁷⁹

As per our discussion with the metal recovery facilities, there are no regulations that hinder the export of non-ferrous metals and thus, the recovered aluminum and copper is traded in the domestic and international markets.

Export prices per ton for copper scrap saw an abrupt downfall in 2006, with a reported price of QAR854. Hereafter, the export price per ton saw continuous increase from 2007 until 2012. There were minor fluctuations during this period owing to the disparity in international copper prices but in 2013, the export quantity declined by 43.2% and the corresponding price per ton fell by 63.3%. However, the market regained momentum post this drop in 2013 and thus, the export price per ton was reported to be QAR11,607 per ton in 2015 (Chart 60).

Chart 60: Qatar's Copper Scrap Export Price, 2005-2015 (QAR/Ton)



Source: Trademap, Team analysis

Copper scrap in domestic market was bought at different prices based on the specifications of the products⁸⁰

- Bare Bright Copper – QAR6,600 to QAR7,500 per ton
- Copper Pipe – QAR5,600 to QAR6,700 per ton
- Insulated Copper – QAR2,000 to QAR5,200 per ton

2.6.7. Analysis of Business Model and Presence/Absence of Key Synergies

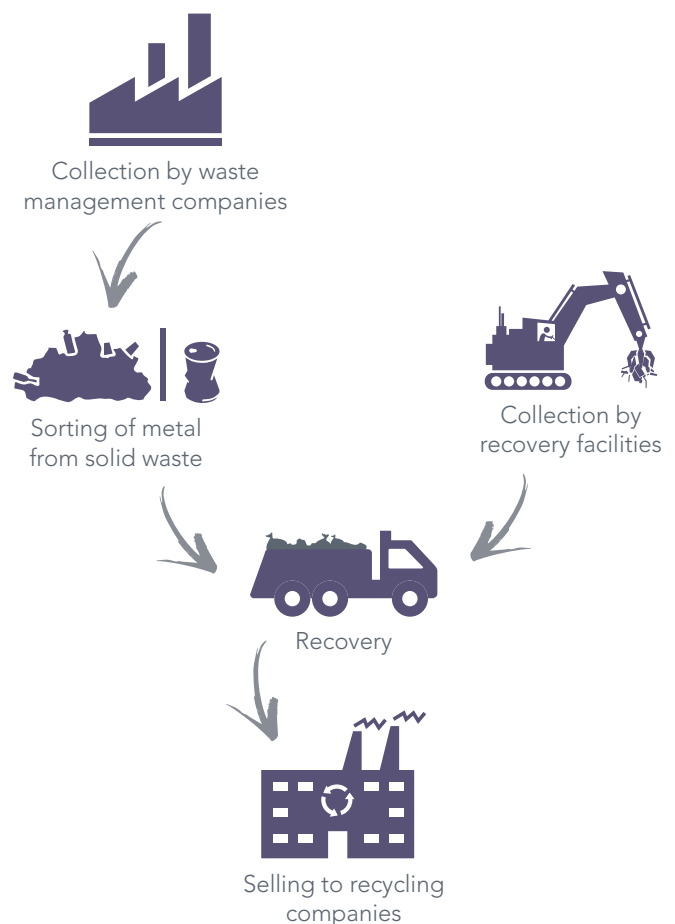
Based on our discussion with the key metal recovery facilities, we understand that companies in Qatar operate on either of the two models explained below:

Business Model 1: Recovery Of Scrap Metal – in this model, there are two ways to source metal scrap:

- By Waste Management Companies: Waste management companies collect scrap from households and industries and sort the scrap into organic, plastic, metal, paper, etc. This sorted waste is directed to the recovery facilities for extraction of steel, copper and aluminum.

Example: Seashore waste management company

Figure 4: Business Model 1: Recovery of Scrap Metal



^{78,80} Primary research

⁷⁹ Trademap

- By Recovery Facilities: Recovery facilities can directly source the scrap through government auctions, long-term contracts with industries and via ad-hoc collection through people who visit the facility to dispose the scrap. This scrap is pre-sorted and does not contain much of plastic or organic waste. It is directly fed into the shredder and follows the metal recovery process.

Example: Venture Gulf Recycling and Lucky Star Alloys

Business Model 2: Sorting and Trading of Non-Ferrous Metal Scrap – in this model, waste management companies collect the scrap from industries, households, etc. The metal scrap is sorted from other waste and sold to trading companies. These trading companies further sort the metals into steel, copper, aluminum, etc. Ferrous metals are sold only to domestic recovery facilities or QASCO while non-ferrous metals are usually exported, as they are not bound by regulations.

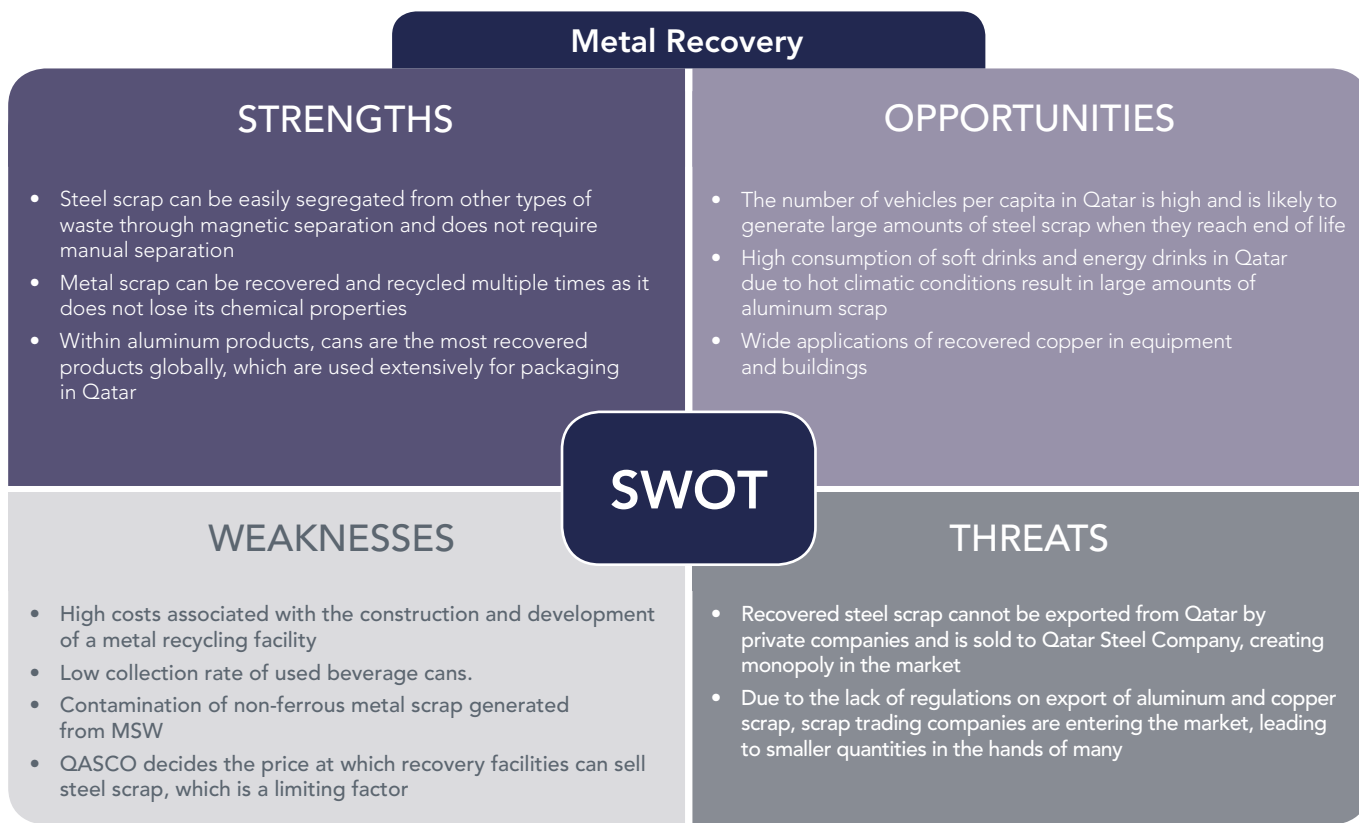
Example: Rastec Scrap and Surplus

Figure 5: Business Model 2: Sorting and Trading of Non-Ferrous Metal Scrap



2.6.8. SWOT Analysis

Figure 6: SWOT Analysis – Metal Recovery



Summary:

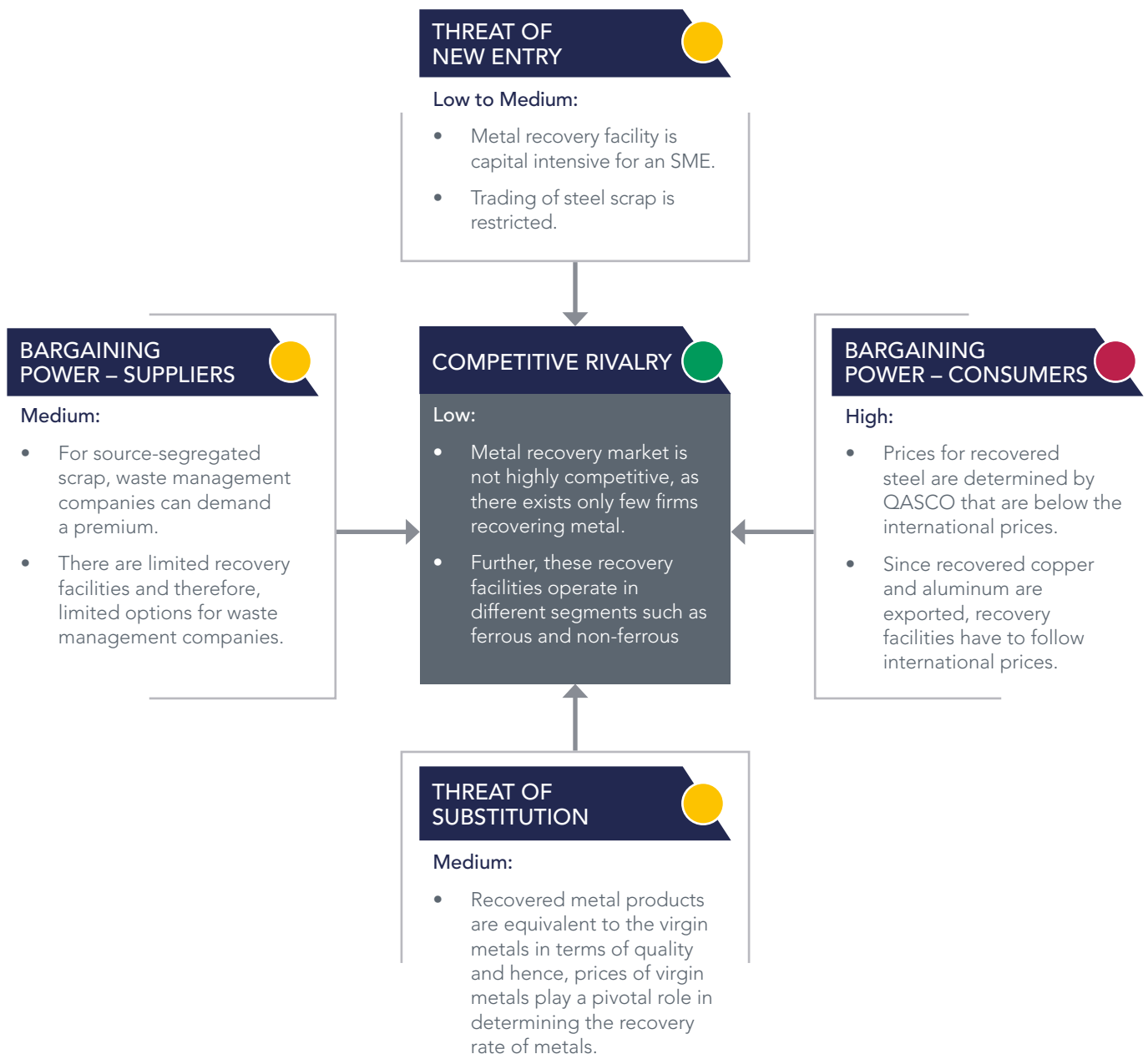
Our assessment indicates that metal scrap in Qatar is available through ELV and CDW and can be recovered and put to use in the downstream industry. The major challenges for recovery facilities will be non-segregation and contamination of waste. In addition, steel scrap recovery facilities will have to operate at lower margins as the prices for recovered steel is decided by QASCO.

2.6.9. Regulations

- Steel in any form, i.e., scrap or recovered cannot be exported without permission from Qatar Steel Company. However, Seashore steel has been granted special permission by QASCO to use the steel scrap recovered by the in-house recovery facility for the production of mild steel billets, angles, flat bars and channels
- For dumping of waste generated from the recovery process, the company has to seek permission from the municipality. This permission is provided to the recovery companies for a period of 2 days to 6 months and has to be renewed upon expiry.
- There are no regulations barring the export/import of aluminum and copper in Qatar.

2.6.10. Michael Porter's Five Forces Model

Figure 7: Michael Porter's Five Forces Model - Metal



2.6.11. Key Takeaways and Potential Opportunities

- Metal waste is 100% recoverable and can be reused infinite number of times.
- Metal waste in Qatar is generated through different sources such as MSW, ELV, CDW and bulky waste. In 2016, 805,540 tons of metal waste is estimated to be generated and is forecasted to reach 1,001,391 tons in 2025.
- Most of the metal waste in Qatar is generated through CDW that is currently not recovered in Qatar and is dumped in landfill in Rawdat Rasheed.
- Recovered steel or steel scrap exports by private companies can be done only after permission from QASCO. However, in case of aluminum and copper there is no such restrictions.
- Prices for scrap metals vary with the international metal prices. In 2015, prices of scrap metal in Qatar were:
 - Steel – QAR250 to QAR300 per ton
 - Aluminum Sheet – QAR1,100 to QAR1,200 per ton
 - Aluminum Cans – QAR900 to QAR1,300 per ton
 - Bare Bright Copper – QAR6,600 to QAR7,500 per ton
 - Copper Pipe – QAR5,600 to QAR6,700 per ton
 - Insulated Copper – QAR2,000 to QAR5,200 per ton
- Downstream industry in Qatar for steel and aluminum has opportunities for recovered materials due to presence of regional giants i.e. QASCO and QATALUM that uses recovered metal in their production process.
 - Thus, recovery facilities can be set up in Qatar and can supply the recovered metal to domestic players. However, steel scrap recovery facilities will have to take the price decided by QASCO.
- In case of copper, there are cable manufacturing companies that import raw materials and thus, present a potential opportunity for recovered copper. However, copper scrap is primarily found in CDW which is not segregated or recovered in Qatar currently and hence, recovery of substantial amount of copper in Qatar is a challenge.
- There is ample amount of metal waste generated in Qatar through MSW, ELV, CDW and bulky waste and majority of that waste is currently being dumped in landfills. This is due to absence of regulations on appropriate disposal and collection of metal waste and lack of awareness regarding the benefits of material recovery. If these issues are addressed, Qatar market can accommodate many new recovery facilities to handle the metal waste generated.



3. PLASTIC



3.1. Overview of Plastic Scrap

3.1.1. Description

Plastic is one of the most popular and useful materials of the present times. The popularity of plastic has soared rapidly in the recent times, leading to it being consumed 20 times more now than it was fifty years ago⁸¹. Recycled plastics (produced through mechanical or chemical processes) are substituting products otherwise produced from virgin materials. Plastics are composed of a variety of common polymers (e.g., PP, PET, PS, etc.) and their recycling potential, as well as resilience to contamination may differ significantly, depending upon the technical, economic and logistical factors.

The quality of the plastic scrap received for recycling governs the substitution ratio. The lower the quality of the recycled plastics, the lower will be the substitution ratio and the smaller the benefits from its recycling.

It is estimated that 5.25 trillion of plastic particles⁸² weighing a total of 268,940 tons are currently floating in the world's oceans. This debris results in an estimated annual loss of USD13 billion from damage to marine ecosystems, including financial losses to fisheries and tourism as well as time spent cleaning beaches⁸³.

Thus, as a valuable and finite resource, the optimum recovery route for most plastic items at the 'end of life' is to be recycled, preferably back into a product that can then be recycled repeatedly.



⁸¹ "PLASTICS: See how it is recycled", recyclenow.com






⁸² "Plastic Pollution in the World's Oceans", ncbi.nlm.nih.gov



⁸³ "Global recycled plastics market 2016-2020" technavio.com

3.1.2. Classification

Plastic is classified into seven categories on the basis of its chemical properties. Classification of plastic along with the applications are given below:

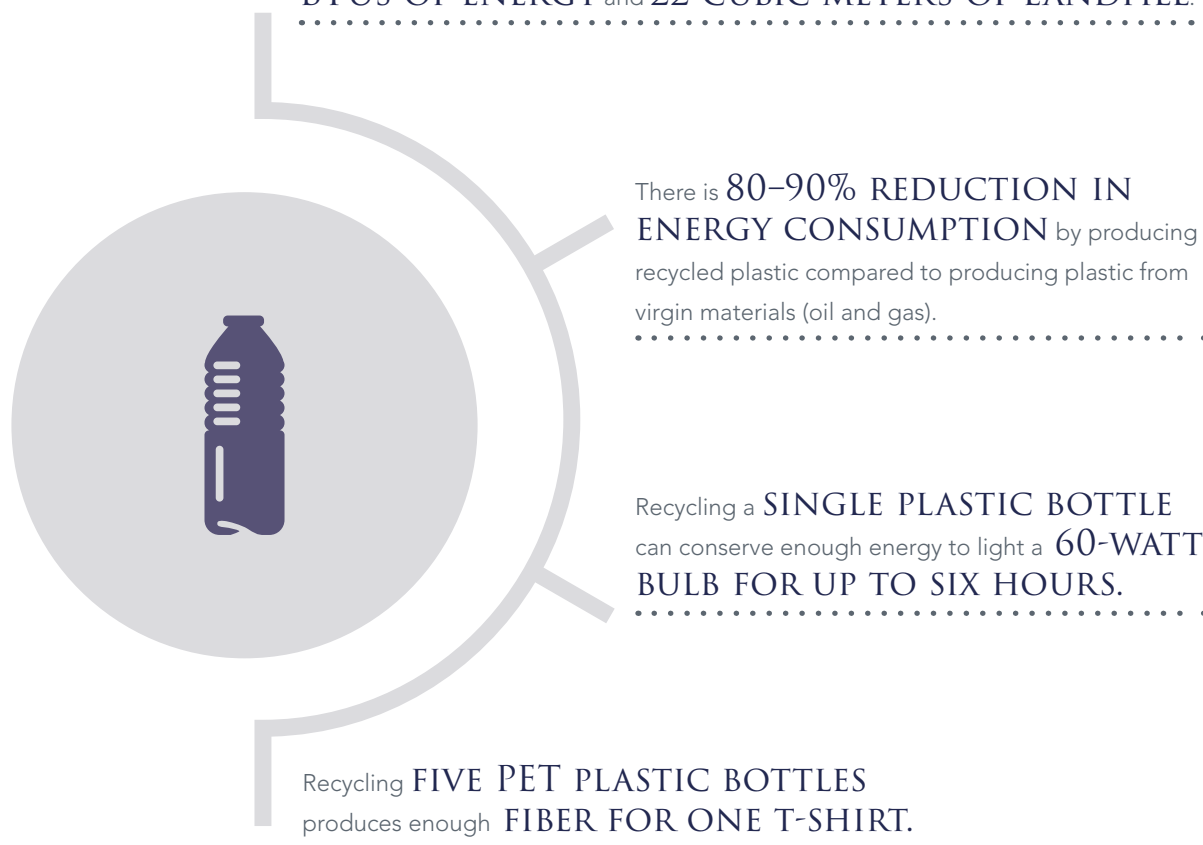
Table 11: Classification of Plastic

Polymer	Description	Applications
	Polyethylene terephthalate <ul style="list-style-type: none">• Effective gas and moisture barrier properties• High heat resistance• Clear, hard and durable• Transparent and solvent resistant	<ul style="list-style-type: none">• Polyester fibers• Soft drink bottles• Water bottles• Pre-prepared food trays• Fiber for clothing and carpets
	High-density polyethylene <ul style="list-style-type: none">• Excellent moisture barrier properties• Excellent chemical resistance• Soft waxy surface• Permeable to gas• Stress-resistant pigmented bottles	<ul style="list-style-type: none">• Plastic bottles• Plastic bags• Trash can• Snack food boxes• Milk and non-carbonated drinks bottles
	Polyvinyl chloride <ul style="list-style-type: none">• Hard, rigid (flexible when plasticized)• Good chemical resistance• Transparent• Good weathering ability• Stable electrical properties	<ul style="list-style-type: none">• Window frames• Bottles for chemicals• Flooring• Plumbing pipes• Wire and cable sheathing• Synthetic leather products
	Low-density polyethylene <ul style="list-style-type: none">• Waxy surface• Good transparency• Low melting point• Stable electrical properties• Effective moisture barrier properties	<ul style="list-style-type: none">• Bread bags• Buckets• Soap dispenser bottles• Irrigation pipes• Packaging films• Flexible bottles
	Polypropylene <ul style="list-style-type: none">• Excellent chemical resistance• High melting point• Hard, but flexible• Waxy surface• Translucent• Strong	<ul style="list-style-type: none">• Bumpers• Car interior trim• Industrial fibers• Carry-out beverage cups• Most bottle tops• Yoghurt and some margarine containers

Polymer	Description	Applications
	Polystyrene <ul style="list-style-type: none"> • Clear to opaque • Glassy surface • Rigid or foamed • Hard and brittle • High clarity • Affected by fats and solvents 	<ul style="list-style-type: none"> • Toys • Flower pots • Video cassettes • Ashtrays • Trunks • Beverage/food coolers • Beer and yoghurt cups
	Code 7 represents miscellaneous types of plastic, which are not defined by the other six codes. Polycarbonate and Polylactide are included in this category.	<ul style="list-style-type: none"> • Nylon (PA) • Acrylonitrile butadiene styrene (ABS) • Polycarbonate (PC)

3.1.3. Benefits of Plastic Recovery⁸⁴

ONE TON of recycled plastic saves approximately **5,774KWH OF ENERGY**, **16.3 BARRELS** (2,604 liters) of **OIL**, **98 MILLION BTUS OF ENERGY** and **22 CUBIC METERS OF LANDFILL**.



⁸⁴ Bureau of International Recycling, bir.org



3.2. Plastic Recovery Process

Plastic recycling is the process of recovering scrap or waste plastic and reprocessing the material into useful products, sometimes completely different in form from their original state.

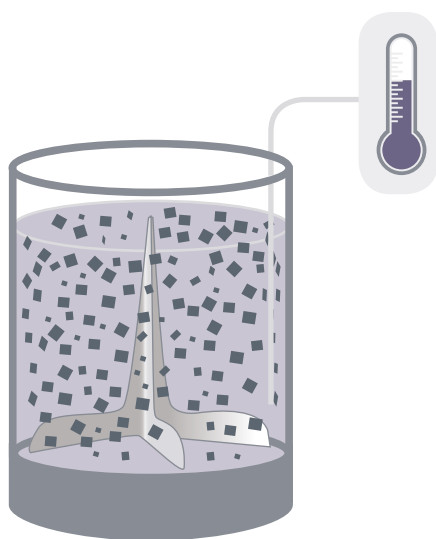
Plastic recycling involves the following steps:

Figure 8: Plastic Recovery Process



C. Chipping

Each sorted stream of plastic is then sent separately to a chipper. The plastic is sliced into flakes that go through a washing process.



D. Washing

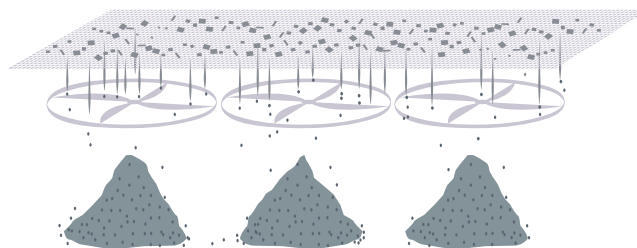
The chips are then washed to remove glue paper labels, dirt and any remnants of the product they contain. All streams of plastic except HDPE are washed at about 90°C for at least twelve minutes, while HDPE (which has a much lower melting point) must be washed below 40°C to prevent discoloration.

During washing, the agitator in the wash tank acts as an abrasive, grinding off the glue from the labels and reducing any paper labels to fibers.

The plastics are then separated from the glue, paper, dirt, etc. in a spinning tower in which this very fine material is forced out through small holes, while the plastic itself remains inside.

E. Pelletizing

This is done by melting the chips and extruding them out first through a fine grill to remove any solid dirt or metal particles that have made it through the treatment thus far and then through a die of small holes. It is sprayed with water as it comes out (to prevent the plastic from sticking together) and cut off after recycling by rotating knives to give small, oval pellets.



3.3. Recovered Plastic Applications

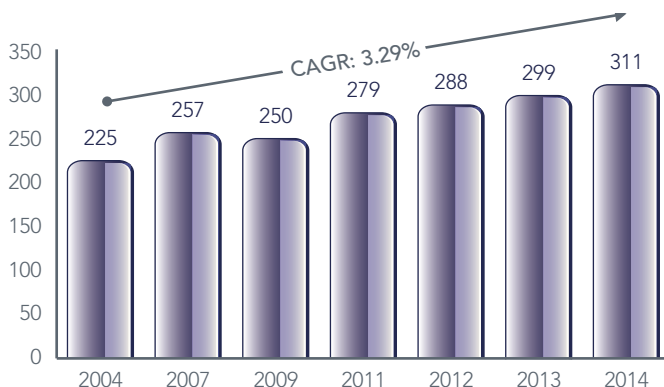
Recycled plastic can be used in almost as many ways and products as prime plastic, for example, packaging, construction and automotive products. Some of the key applications⁸⁵ include:

- **Packaging:** Recycled PET and HDPE is used in primary packaging by retailers and branded manufacturers for bottles and trays.
- **Construction:** Recycled plastic is widely used in mainstream construction products such as damp proof membrane, drainage pipes, ducting and flooring. It is also used in innovative products such as scaffolding boards or curbstones, where its durability and weight has significant health and safety benefits.
- **Landscaping:** Walkways, jetties, pontoons, bridges, fences and signs can also be made from recycled plastic.
- **Textile fiber/Clothing:** Polyester fleece clothing and polyester filling for duvets, coats, etc. are made from recycled PET bottles (e.g., soft drink and water bottles).
- **Street furniture:** Street furniture, seating, bins, street signs and planters are made from plastic. They are cost competitive in comparison with virgin materials.
- **Bin liners/Refuse sacks:** Plastic film from sources such as pallet wrap, carrier bags and agricultural films are made into new film products such as bin liners, carrier bags and refuse sacks on a large scale.
- **Other uses:** Traffic management products, automotive products, stationary, industrial strapping and many more.

3.4. Global Plastic Recovery Market Overview

For more than 50 years, global production of plastic has been on the rise. About 311 million tons of plastics was produced in 2014, representing a CAGR of 3.29% during 2004 and 2014⁸⁶ (Chart 61).

Chart 61: Global Plastic Production, 2004-2014 (Million Tons)



Source: Plastic Europe-2015

⁸⁵ "Uses for recycled plastic", wrap.org

⁸⁶ "Plastics – the Facts 2015", Page 8, corepla.it

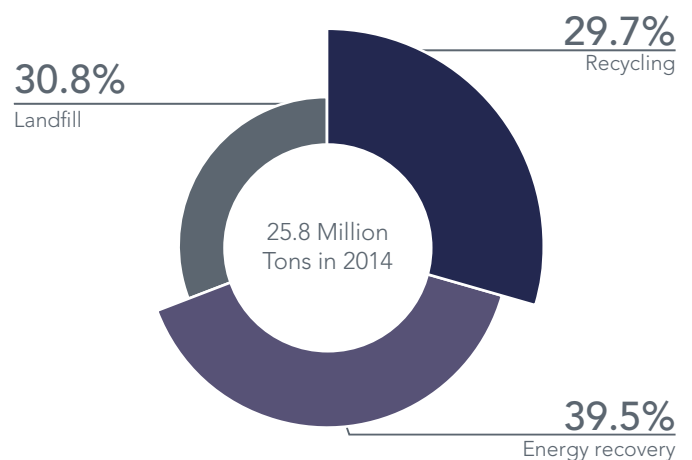
⁸⁷ "Plastics – the Facts 2015", Page 17, corepla.it

With the explosive growth in the manufacturing of plastics, there is an increased need to recycle material in an environmentally responsible manner once they reach the end of their useful lives.

Despite the ubiquity of plastics, plastic recycling is still a young industry and the technology to sort and recycle plastics in a cost-efficient manner has been developed only over the past 25 years. Recovery and recycling thus remain insufficient, and millions of tons of plastic end up in landfills and oceans each year.

In Europe⁸⁷, 29.7% (7.7 million tons) of the post-consumer plastic produced in 2014 was recycled, while 40 percent was incinerated for energy generation. The remaining 30.8% of post-consumer plastic in Europe made its way to the landfills. Europe (EU-27) collectively exports almost half of the plastics collected for recycling (i.e., 4 million tons), at least 87% of which goes to China and Hong Kong (Chart 62).

Chart 62: Treatment of Plastic Waste in the EU (2014)



Source: Plastic Europe-2015



Within Europe, Norway had the highest recycling rate in 2014 (40%) followed by Germany and Sweden with 38% each. Bulgaria, Cyprus and Malta registered the lowest recycling rates of less than 20% in 2014⁸⁸ (Table 12).

Table 12: Plastic Recycling Rate in EU (2014)

Country	Plastic recycling rate in the EU (2014)
Norway	40%
Germany	38%
Sweden	38%
Ireland	37%
Czech Republic	37%
Denmark	34%
Estonia	34%
Slovenia	34%
Spain	34%
Portugal	33%
Belgium	32%
Netherlands	31%
Slovakia	31%
Luxembourg	29%
UK	29%
Austria	28%
Italy	28%
Latvia	28%
Romania	26%
Switzerland	25%
Lithuania	25%
Poland	25%
Croatia	24%
France	22%
Hungary	21%
Finland	20%
Greece	20%
Bulgaria	19%
Cyprus	18%
Malta	14%

⁸⁸ Plastics – the Facts 2015, Page 21, corepla.it

⁸⁹ Advancing Sustainable Materials Management, epa.gov, Page 8

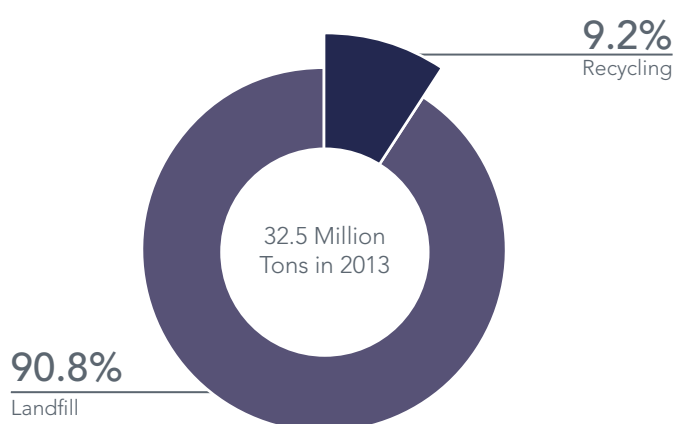
⁹⁰ Valuing plastic, Page 17, unep.gov

⁹¹ Global Waste Management Outlook 2015, Page 84, unep.gov

⁹² Trademap

In the US⁸⁹, only 9.2% of the post-consumer plastic (3 million tons) was recycled in 2013 while the remaining 29.5 million tons was disposed in landfills. The US exported 2.1 million tons of plastic waste with over 50% of the export to China (Chart 63).

Chart 63: Treatment of Plastic Waste in the US (2013)



Source: EPA-2014

According to UNEP, an estimated 22–43% of the plastic used worldwide is disposed in landfills⁹⁰. Recovering plastic from the waste stream for recycling or combustion for energy generation has the potential to minimize these problems. However, much of the plastic collected for recycling in Europe, the US, Japan and other industrialized countries is shipped to countries with lower recycling standards.

The annual volume of globally traded plastic scrap (raw plastic scrap as well as flakes) was 16.4 million tons in 2014, less than 5% of the new plastics production in 2014⁹¹. Such a small percentage suggests that to-date, international trade is a minor means to extract the resource value of plastic.

The aggregate trade of plastic scrap (HS Code-3915) saw a marginal decline in 2014 compared to 2010 when the global trade was 16.5 million tons. However, in 2014 global trade of plastic scrap saw an increase of 8.3% compared to that in 2013⁹² (Chart 64).

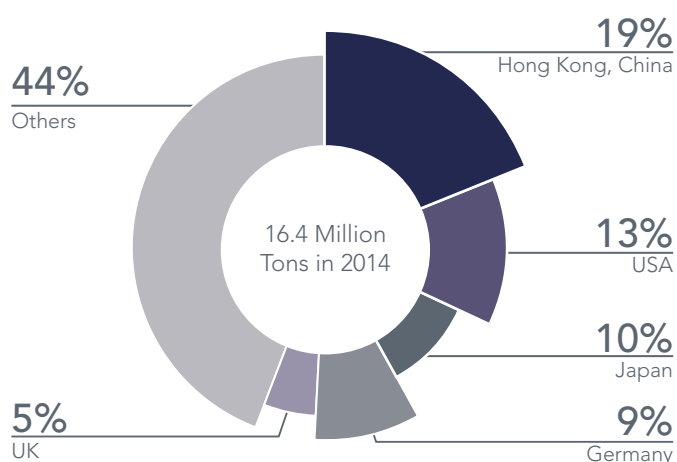
Chart 64: Global Plastic Scrap Trade, 2010-2014 (Million Tons)



Source: Trademap

In 2014, exports from Hong Kong saw an increase of 104% and was 3.1 million tons (19% of global exports) compared to 2013 when it exported 1.5 million tons of plastic scrap. Other major countries included the US and Japan, which exported 13% and 10% of the total global plastic scrap, respectively (Chart 65).

Chart 65: Leading Plastic Scrap Exporters (2014)

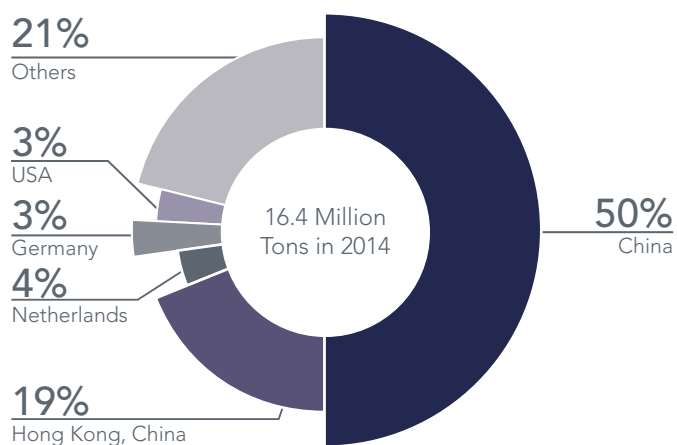


Source: Trademap

China has been the largest importer of plastic scrap across the world since 2001. Over the years, China's imports have seen a substantial increase but it was for the first time during 2012 and 2013 that China's plastic scrap imports saw a decline from 8.8 million tons to 7.8 million tons, witnessing a dip of 11.2%.

This was due to the initiation of Operation Green Fence⁹³ – an operation launched by the Chinese government to improve the quality of imported recyclables. However, China's import saw a recovery in 2014 when imports accounted for 8.3 million tons (50% of the global imports), with a 7% year-on-year increase compared to that in 2013 (Chart 66).

Chart 66: Leading Plastic Scrap Importers (2014)



Source: Trademap

⁹³ Global recycling markets: plastic waste, Page 46, technavio.com

⁹⁴ "GCC plastics industry to grow by over 3% annually till 2020", gpca.org.ae

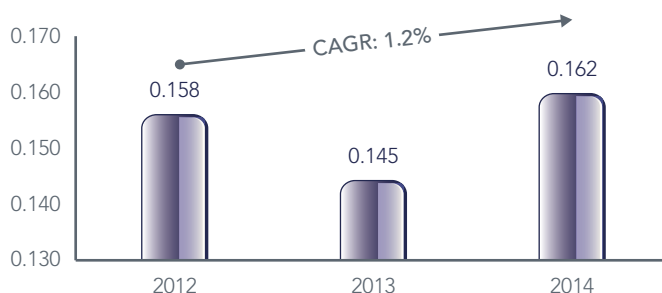
3.5. GCC Plastic Recovery Market Overview

3.5.1. Market Overview

As per the recent study by GPCA, plastic industry in the GCC region is expected to grow at a rate of 3.2% annually until the end of 2020⁹⁴, spurred by a sustained roll-out of strategic projects. However, plastic recycling industry in the GCC region is in a nascent phase and currently, 10% of the plastic scrap across the region is recycled⁹⁵. The remaining plastic scrap that is collected and sorted is exported to other countries. Majority of the plastic scrap is not collected and is disposed in the landfills. These landfills are also running out of space, as the per capita waste generation in the region is high.

Exports⁹⁶ of plastic scrap increased from 0.158 million tons in 2012 to 0.162 million tons in 2014 at a CAGR of 1.2%. Saudi Arabia accounted for 42.76% share in the GCC exports followed by Qatar and the UAE with 26.08% and 20.40% shares, respectively (Chart 67).

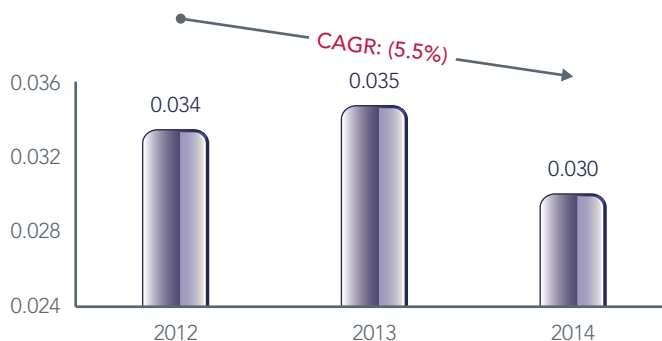
Chart 67: GCC Plastic Scrap Export, 2012-2014 (Million Tons)



Source: Trademap

Imports⁹⁷ of plastic scrap to the GCC member countries was very low and accounted for 30,432 tons in 2014. The import quantity saw a negative CAGR of 5.5% during 2012 and 2014. During 2014, the UAE imported 52.2% of the total GCC imports of plastic scrap while Saudi Arabia accounted for 27.2% of the imports (Chart 68).

Chart 68: GCC Plastic Scrap Import, 2012-2014 (Million Tons)



Source: Trademap

⁹⁵ About 10% of Plastic is Recycled in GCC Countries, ptonline.com

^{96, 97} Trademap

The higher proportion of imports of plastic scrap and flakes in UAE can be attributed to the presence of established recycling industry. In 2014, the UAE imported majorly from Japan and China, which together accounted for 55%, while Italy accounted for 55.7% of Saudi Arabia's imports.

3.5.2. Leading Companies in the GCC Market

Some of the leading metal recycling companies operating in the GCC region include:

Table 13: Plastic Recovery Companies in the GCC Market

Company	Year of Establishment	Country	Activity	Annual Capacity (tons)
Alpha Emirates	1985	UAE	<ul style="list-style-type: none"> Collection Recovery Recycling 	6,000
Bee'ah*	2007	UAE	<ul style="list-style-type: none"> Collection Recovery 	NA
Al-Owais Recycling	2007	UAE	<ul style="list-style-type: none"> Collection Recovery 	NA
Zone Waste Management & Recycling	1999	UAE	<ul style="list-style-type: none"> Collection Recovery Recycling 	NA
Baa Plastics	2010	UAE	<ul style="list-style-type: none"> Collection Recovery 	3,000
NESMA Recycling	1988	Saudi Arabia	<ul style="list-style-type: none"> Recovery Recycling 	NA
Middle east plastic industries	1998	Saudi Arabia	<ul style="list-style-type: none"> Collection Recovery 	NA
Arabian Ladina for Industries	2000	Saudi Arabia	<ul style="list-style-type: none"> Collection Recovery 	NA
Muscat Industrial Development & Services LLC	2009	Oman	<ul style="list-style-type: none"> Collection Recovery 	NA
Al Majid Plastic and Metal Recycling Factory	2013	Bahrain	<ul style="list-style-type: none"> Collection Recovery 	NA
Kuwait Waste Collection & Recycling Company**	1980	Kuwait	<ul style="list-style-type: none"> Collection Recovery 	48,000

*Bee'ah collects 500,000 tons of MSW annually and recovers 67% of the waste. This is mix of paper, plastic and aluminum cans

** Capacity of Kuwait Waste includes other products such as paper, glass, metal and waste oil.

3.6. Qatar Plastic Recovery Market Overview

3.6.1. Historical and Current Waste Generation

Plastic scrap in Qatar is generated through MSW and from lead-acid batteries (covered in Chapter 6: e-waste and battery recovery). Plastic scrap generated from MSW is collected from households and businesses. Plastic scrap collected from businesses and industries have a high recycling rate as these are segregated at source and is not contaminated. Plastic recovery facilities also sign long-term contracts with commercial establishments to source the plastic scrap. Plastic scrap accounts for approximately 13% of the MSW generated⁹⁸.

During 2010 and 2015, the amount of plastic scrap generated in the country increased from 110,062 tons to 151,613 tons, witnessing a CAGR of 6.7%. In 2016, the plastic scrap generation is estimated to be 162,749 tons (Chart 69).

Chart 69: Plastic Scrap Generated from MSW in Qatar, 2010-2016E (Tons)



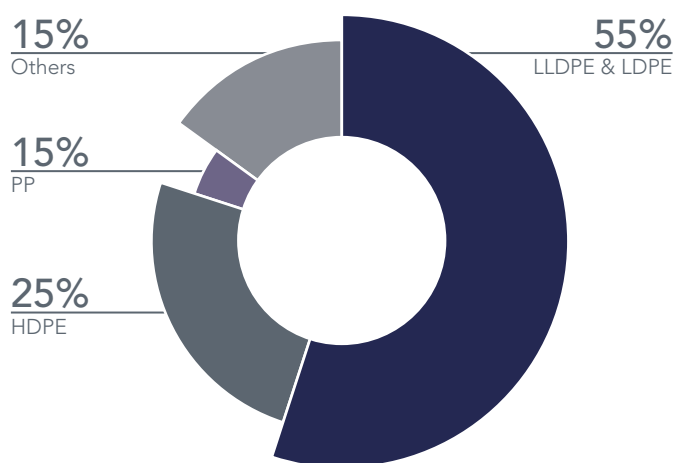
Source: MDPS Environment Statistics 2014, Primary Research

The increase in quantity of plastic scrap is attributable to the rising population and changing consumption patterns. In addition, lack of awareness amongst the people regarding benefits of plastic recycling and adverse impacts caused by usage of plastic has resulted in increased generation of plastic scrap.

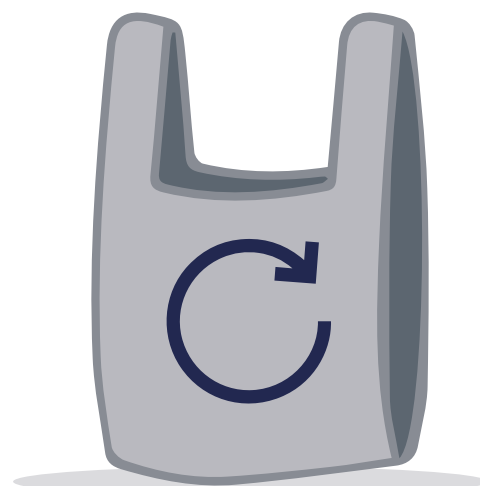
3.6.2. Market Size Segmentation by Product Segments

The most common categories that are recycled in Qatar⁹⁹ are LDPE & LLDPE (50–55%), HDPE (25–30%) and PP (5–10%). In Qatar, PVC is usually crushed, cleaned and exported while PET is not currently recycled. However, based on the primary interviews, Twyla Recycling is expected to start operations for recovering PET bottles in the form of PET sheets (Chart 70).

Chart 70: Plastic Products Recovery in Qatar, By Segment (2015)



Source: Primary research



⁹⁸ MDPS Environment Statistics 2014, Team analysis

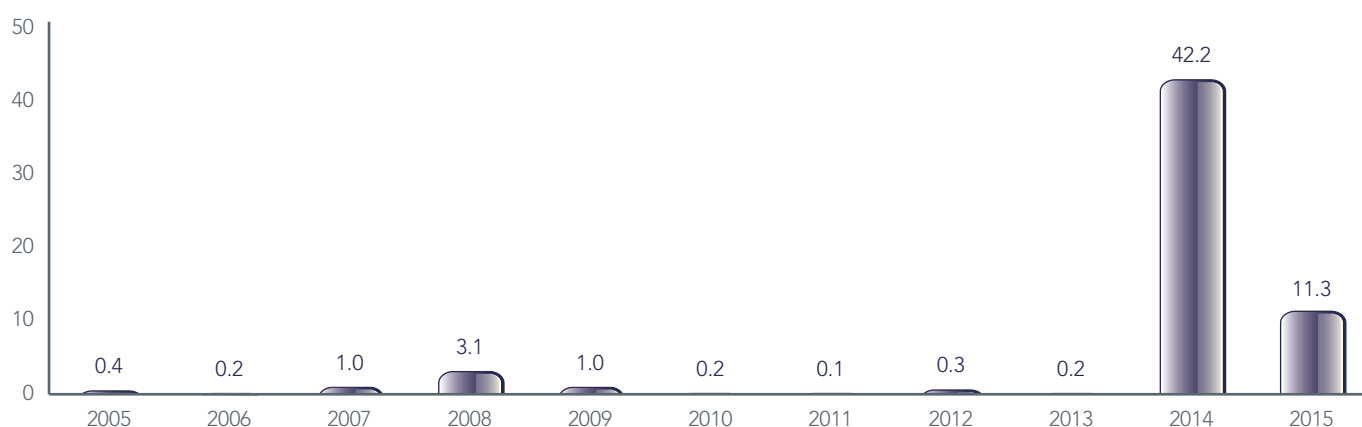
⁹⁹ Primary research, Team analysis

3.6.3. Analysis of Exports and Imports

This section talks about the import and export of plastic scrap as done under HS Code: 3915. The analysis presented below is at 4-digit HS Code.

Exports¹⁰⁰: Scenario for plastic scrap exports (HS Code: 3915) have changed drastically post 2013. This is primarily due to the rising environmental concerns over plastic scrap, government's focus on increased collection and recycling of waste, and establishment of new facilities for recovery and recycling of plastic in Qatar (Chart 71).

Chart 71: Qatar's Plastic Scrap Export, 2005-2015 ('000 Tons)



Source: Trademap

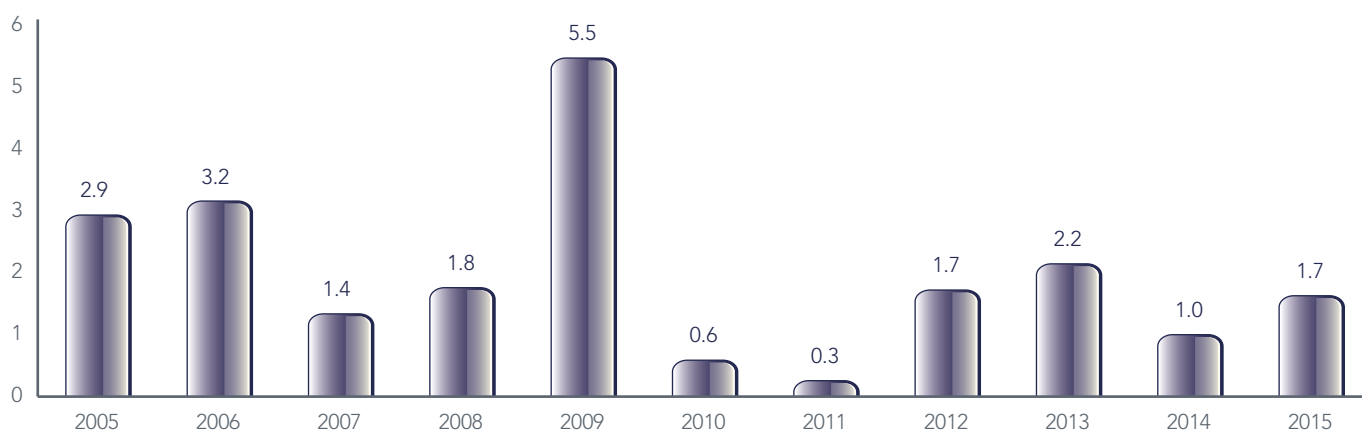
Qatar's export of plastic scrap increased from 150 tons in 2006 to 343 tons in 2012, with spikes observed between 2007 and 2009. However, export of plastic scrap increased from 184 tons in 2013 to 42,161 tons in 2014, but declined to 11,266 tons in 2015.

In 2014, PVC scrap (HS Code: 39153000) had the major share (98.7%) in the exports. The exports of PVC saw an eight-fold downfall in 2015 which could be linked to the decrease in international oil prices that affected price of primary resin. In 2015, PET scrap accounted for 22.2% (2,500 tons) of the exports while PVC scrap accounted for 76.3% (8,600 tons).

India was the leading exporting destination for plastic scrap from Qatar in 2014 and 2015. In 2015, India imported 76.3% (8,600 tons) of the Qatar's exports, while UAE imported 22.18% (2,552 tons).

Imports¹⁰¹: Until 2013, Qatar witnessed a negative trade balance for plastic scrap, as the import quantity was greater in comparison to the export quantity (Chart 72).

Chart 72: Qatar's Plastic Scrap Import, 2005-2015 ('000 Tons)



Source: Trademap

^{100, 101} Trademap

Imports of plastic scrap has seen cycles of fluctuations during 2005 and 2015.

The reduction in the import volumes can be associated with improved collection rates i.e. availability of plastic scrap for recycling. Improvement in collection rates has been achieved by recovery facilities through long term contracts with the commercial units that provide them source segregated plastic scrap.

During 2005 and 2009, the imports increased from 2,940 tons to 5,513 tons, thus witnessing a CAGR of 17.02%. The only drop during this period was in 2007 when the import recorded was 1,359 tons – a decline of 57.37% compared to that in 2006.

The second phase of decline was witnessed in 2010 and 2011, with 609 tons and 278 tons of plastic scrap reportedly being imported in these years, respectively.

Post 2011, the import quantity saw an exponential increase with 2,172 tons of plastic scrap being imported in 2013.

In 2014, the imports witnessed a downfall compared to that in 2013 with 1,023 tons of plastic scrap being imported. However, there was a revival in 2015 with 1,653 tons of plastic scrap being imported, registering an annual growth of 61.51% over 2014.

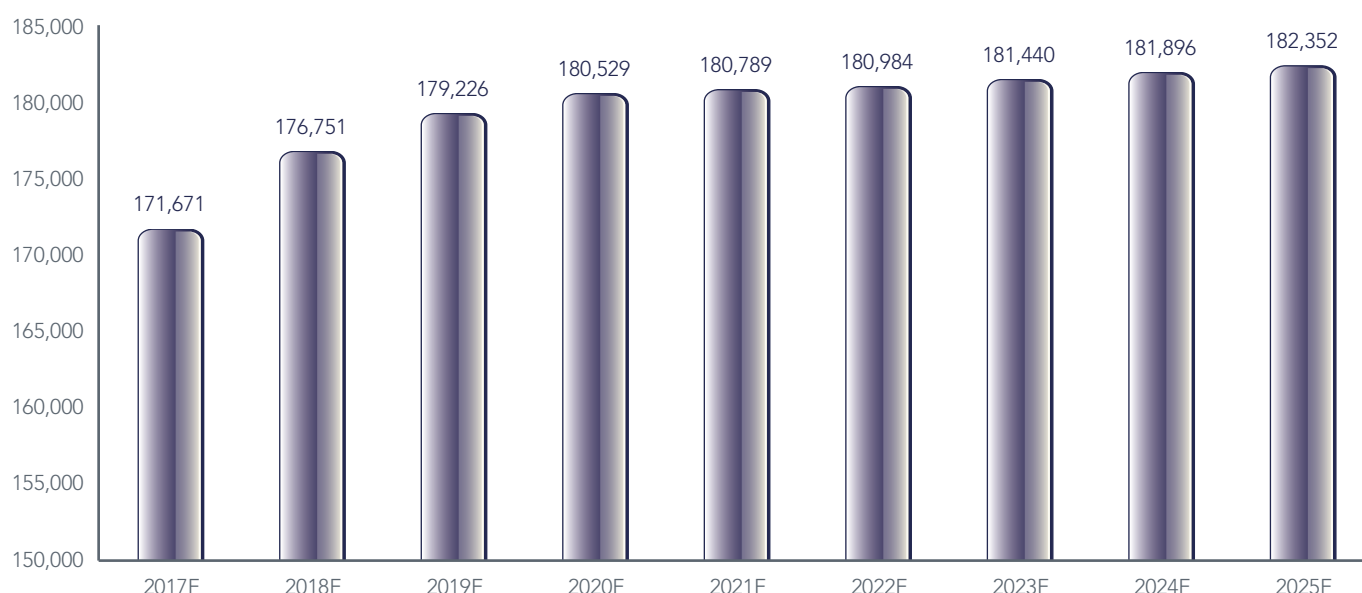
More than 75% of the annual imports during 2005 and 2015 was under HS Code: 39159000 (plastic scrap except for PVC, PET and Polystyrene). During 2015, the UAE, Saudi Arabia and Oman held a combined share of 49.2% (814 tons) along with China that exported 365 tons (22.1%) of plastic scrap to Qatar.

3.6.4. Waste Generation Forecast

The amount of MSW generated over the next few years is estimated based on the average per capita MSW generated during 2008–14 and is equal to 1.37kg¹⁰² per person per day. Plastic accounts for approximately 13% of the MSW generated.

Current plastic scrap generation as illustrated in section 5.6.1 is estimated to be 162,749 tons. Pegged with the increase in population, the plastic scrap generation is also expected to increase during 2017 and 2025 from 171,671 tons to 181,896 tons, witnessing a CAGR of 0.8% (Chart 73).

Chart 73: Plastic Scrap Generation from MSW in Qatar, 2017F-2025F (Tons)



Source: MDPS Environment Statistics 2014, Team analysis

This slowdown in the growth rate of plastic scrap is primarily attributed to the reduction in the consumption of plastic, as a result of the awareness programs initiated by the government and local bodies such as Clean Qatar¹⁰³, Go Green, Say no to plastic bags¹⁰⁴ mission along with easy availability of eco-friendly substitutes in the market.

¹⁰² MDPS Environment Statistics 2014, Primary research

¹⁰³ "Plastics recycling comes to Qatar", Mideastplast.com

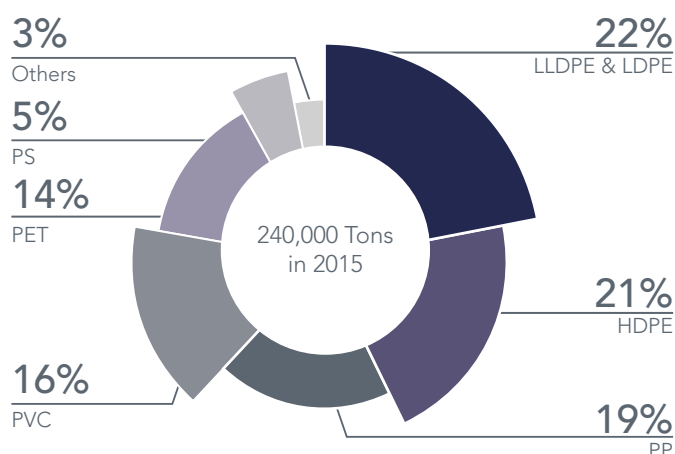
¹⁰⁴ "Environmental group to launch 'Say no to plastic bags' campaign in Qatar", Dohanews.co

3.6.5. Demand for Recovered Material

The consumption of plastic polymers in Qatar i.e. the demand arising from plastic processors in the country was 260,000 tons in 2016, increasing from 152,000 tons in 2013.

Among different polymers of plastic, LDPE and LLDPE together accounts for 22% of the plastic consumption followed by HDPE and PP with a share of 21% and 19% respectively, and PVC with a share of 16%¹⁰⁵ (Chart 74).

Chart 74: Plastic Products Consumption in Qatar, By Segment (2015)



Source: GPCA

Polymers such as HDPE, LDPE and PET can be easily recovered. However, polymers such as PVC, PP and PS find it difficult to be recovered and hence, recovery centers usually avoid these polymers due to the low rate of recyclability. Polymers which are made from combination of various plastic or from unique plastic formulations that are classified under category 7 of polymer are extremely difficult to recover.

Countries which have close to 100% collection rate for plastic scrap have a recovery rate of approximately 40%. Hence, the potential for replacing virgin plastic with recovered pellets is also 40%. The demand for recovered plastic i.e. plastic pellets from the plastic processors is estimated to be 103,680 tons in 2016 compared to 60,861 tons in 2013.

The recovery of plastic scrap in Qatar is estimated to be approximately 30,000 to 35,000 tons per annum in 2016. However, approximately, 40% to 50% of the recovered pellets are exported.

3.6.6. Assessment of Supply Landscape

Qatar intends to increase recycling rates and reduce dumping of plastic scrap in the landfills due to rising environmental concerns. This has led to an increase in recovery facilities in the last few years. Some of the key recovery companies operating in Qatar include:

1. Doha Plastic Recycle¹⁰⁶ is a subsidiary of Doha Plastic Company. The parent company is involved in manufacturing plastic products such as HDPE pipes, LDPE pipes and landscape irrigation system.

Doha plastic recycling facility is spread across 15,000 sqm with an employee base of 70 people. The subsidiary has an installed capacity of 9,000 tons and recycles LDPE, HDPE and Polypropylene (PP) plastic scrap through dedicated pelletizing lines for each polymer.

They collect plastic scrap through contract with companies such as Qatar Airways, RasGas, QChem, Qatar Petroleum and through waste management companies such as Averda and Seashore. The recovered plastic in the form of pellets is either used for in-house production or is sold in domestic and overseas market.

2. Twyla recycling was formed in 2012 but the operations started in the year 2014. The company has a total land area of 12,000 sqm with a built-up facility of 5,000sqm. The company employs 48 people and has an annual capacity of approximately 4,800 tons. Almost 92% to 95% of the plastic scrap collected is recovered.

The waste is collected from industries through company owned trailers (30 tons), through waste management companies (70 tons) and remaining through long-term contracts with Qatar Fuel, QChem etc. The company recovers LDPE, HDPE and PP scrap in form of pellets while for PET they only convert scrap into compressed bales.

The company sells the product in domestic market to companies such as Petrofoam and National plastic while internationally the recovered plastic is exported to the KSA, Bahrain, India, Pakistan and Egypt.

3. Asima Plastic Factory¹⁰⁷ was formed in the year 1993 and is involved in the production of plastic vest carriers, patch handle, polythene sacks, refuse sacks, polythene sheets, counter bags and bin liners. They collect the scrap from waste management companies, recover the plastic in form of pellets and uses them for in-house production. They also sell the recovered plastic pellets in the domestic and international markets.

The facility has area of 15,000 sqm and staffs over 100 employees. The facility produces 9,000 tons of plastic bags (through recovered plastic pellets) and exports over 20 containers, each having a storage capacity of 40 feet.

Other companies such as Qatar Plastics Products Company¹⁰⁸ recover and recycle the plastic scrap generated in their production process while Seashore Waste Management Company collects, sorts and sells almost 2,000 tons annually.

There are small companies such as Scrap Center LLC¹⁰⁹, which collect scrap and export them overseas. Some trading companies sort the waste on basis of polymer while some just pack and export without any value addition.

¹⁰⁵ GCC Plastic Industry Indicators 2015, gpc.org.ae

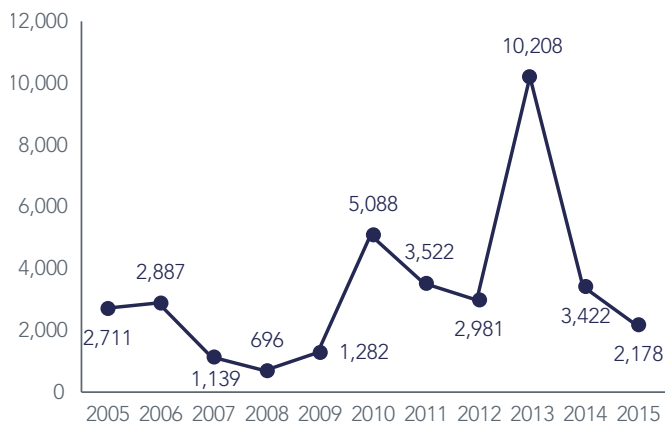
^{106, 107, 108} Company website

¹⁰⁹ Primary research

3.6.7. Pricing Analysis

It has been observed that the average export price per ton and export quantity has maintained an inverse relationship during 2005 and 2014, i.e., with the rise in export quantity, price per ton has decreased. The average price¹¹⁰ was QAR10,208 per ton in 2013 – the highest in 10 years. However, the reason behind this abrupt increase is unknown (Chart 75).

Chart 75: Qatar's Plastic Scrap Export Price, 2005-2015 (QAR/Ton)



Source: Trademap, Team analysis

After a surge in price during 2013, the export prices witnessed a decline for two consecutive years, i.e., in 2014 and 2015. This decline was due to the fluctuations in oil prices. In 2015, export price and quantity both declined heavily. The average export price per ton in 2015 declined to QAR2,178 from QAR3,422 in 2014.

Within the HS Code: 3915 at eight digit, prices for different polymers varied significantly. Export price per ton for PET and PVC scrap was QAR803 and QAR2,525 respectively while plastic scrap except for PVC, PET and Polystyrene (HS Code: 39159000) was exported at QAR4,782 per ton during 2015. Polystyrene (HS Code: 39152000) was last exported in 2011 at QAR2,207 per ton.

Based on primary interviews, the recovery companies buy scrap in a price range of QAR1,200 to QAR3,400 per ton, depending on the quality of scrap. Further, depending on the color of the recovered plastic granules and polymer, the selling price per ton varies between QAR2,900 and QAR3,900. The price for both domestic and overseas customers are the same and excludes transportation costs, which are borne by the customer.

3.6.8. Analysis of Business Model and Presence/Absence of Key Synergies

Based on our discussion with the plastic recovery facilities in Qatar, we understand that companies in Qatar follow a model similar to that of metal recovery.

Business Model 1: Recovery of Plastic Pellets: In this model, there are two ways to source plastic scrap.

- **By Waste Management Companies:** Waste management companies collect scrap from households and industries and sort the scrap into organic, plastic, metal, paper, etc. Plastic is sorted out from other waste and sent to plastic recovery facilities.

Example: Seashore waste management company

- **By Recovery Facilities:** Recovery facilities can directly source the scrap through long-term contract with industries. This scrap is pre-sorted but may still contain some other waste and hence manual sorting may be required.
- After sorting, the plastic scrap follow the recovery process and are then sold to recycling companies or can be used in-house for production.

Figure 9: Business Model 1: Recovery of Plastic Granules



¹¹⁰ Trademap

Example: Doha plastic uses some of the recovered plastic for internal production while Twyla sells the recovered plastic granules to domestic and international recyclers.

Business model 2: Sorting and Trading of Plastic Scrap: In this model, waste management companies collect the scrap from industries, households, etc. The plastic scrap is sorted from the collected waste and is sold to trading companies. Trading companies either sort the waste as per the polymer type or can pack and export it internationally.

In case, they want to sell it to the local recovery facilities, the plastic has to be sorted as per the polymer type. Otherwise, local companies will not prefer buying from traders as recovery facilities can directly collect unsorted plastic waste from waste management companies.

Example: Scrap center LLC

Figure 10: Business model 2: Sorting and Trading of Plastic Scrap



3.6.9. SWOT Analysis

Figure 11: SWOT Analysis – Plastic Recovery



Summary:

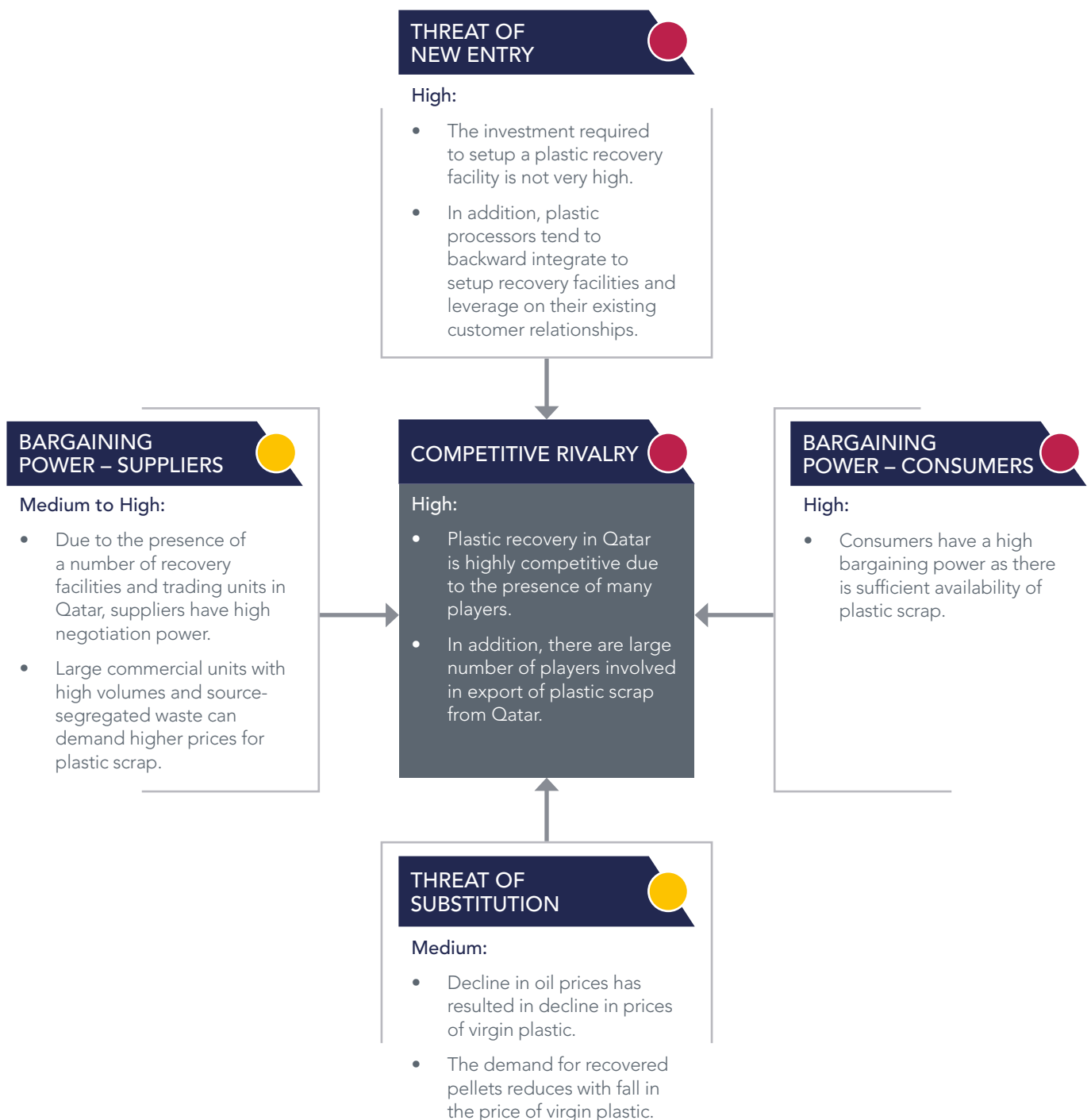
Plastic scrap is available in Qatar but is still not accessible due to lack of source segregation. Recovery facilities need to get into long term contracts with commercial units for collection of segregated waste. The demand from plastic processors in the country presents ample opportunity for recovered pellets to be sold domestically. The recovery facilities can also export recovered plastic pellets.

3.6.10. Regulations

- Importing hazardous plastic scrap is not permitted in Qatar. However, there are no regulations on import of treated plastic waste.
- There are no regulations pertaining to the collection of plastic waste in Qatar.

3.6.11. Michael Porter's Five Forces Model

Figure 12: Michael Porter's Five Forces Model - Plastic



3.6.12. Key Takeaways and Potential Opportunities

- Plastic scrap in Qatar is generated as a part of MSW and is sourced by the recovery facilities either through waste management companies or through direct contracts with commercial units in the country.
- Qatar's plastic scrap generation in 2016 is estimated to be 162,749 tons and will reach 182,352 tons in 2025.
- There is lack of sorting and segregation of plastic scrap in Qatar that results in reduced recovery of plastic scrap.
- Price of waste plastic depends on the quality of waste and varies between QAR1,200 to QAR3,400 per ton.
- Depending on the color of the recovered plastic granules and polymer, the selling price per ton varies between QAR2,900 and QAR3,900.
- There are 4 major recovery facilities operating in Qatar while there are several small companies involved in the export of plastic scrap.
- Demand for recovered plastic by plastic processors in Qatar is estimated to be 103,680 tons in 2016. However, the recovery of plastic scrap in Qatar is estimated to be approximately 30,000 to 35,000 tons per annum in 2016. This presents an opportunity for new plastic recovery facilities to be set up in Qatar.
- The capital required to setup a plastic recovery facility is not very high. In addition, plastic processors tend to backward integrate to setup recovery facilities and leverage on their existing customer relationships.



4. PAPER

4.1. Overview of Paper Scrap

4.1.1. Description

Paper is used in applications such as newspapers, magazines, catalogs, office paper, packaging and tissue products. As per the estimate by BIR, paper and pulp, which is produced through the use of fiber obtained from trees and agricultural residues is expected to account for over half of the world's industrial wood demand by 2050¹¹¹.

Not all paper products can be recycled due to the additives included in them. Some paper items, which are not typically recoverable include brown and Kraft envelopes, carbon paper, paper towels, tissues, candy wrappers, coffee cups and pizza boxes while some of the most repeatedly recycled paper items include cardboard, newsprint and magazines, manuals and booklets and assorted office papers.

Paper cannot be recovered indefinitely as the fibers become too weak and lose their mechanical properties. Thus, after few alterations, recycling of paper require mixing of recycled fibers and virgin fibers for the papermaking process. Estimates suggest that printing and writing paper can be recovered seven to twelve times while newspapers can be recovered three to four times.

4.1.2. Classification

Recovered paper can be grouped into several main categories such as:

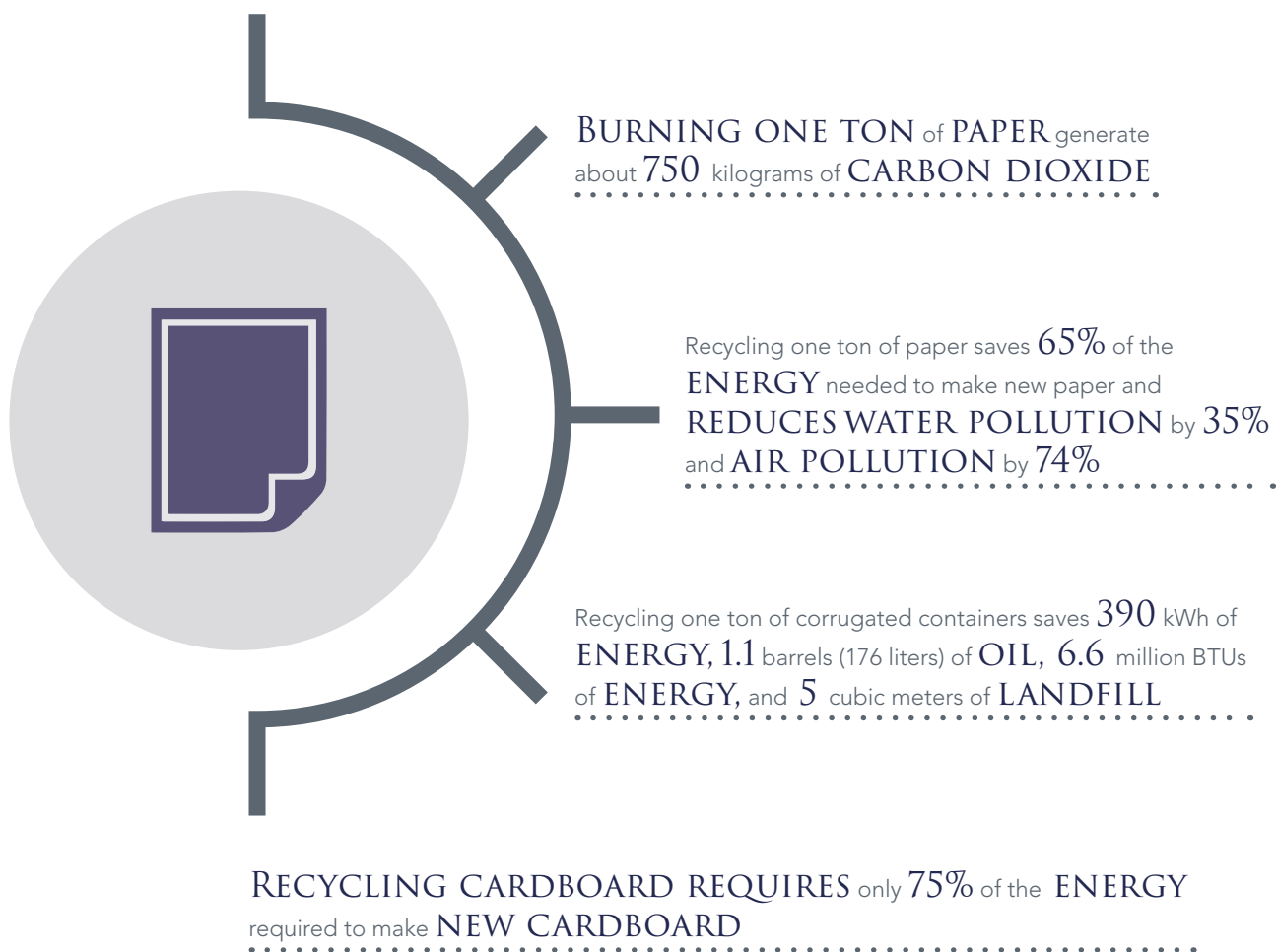
Table 14: Classification of Paper Waste

Type of paper scrap	Description
Old corrugated containers (OCC)	OCC contains a rippled middle layer that is sandwiched between two layers of linerboard. Mills use old corrugated containers to make new recycled-content shipping boxes, as well as they use recycled paperboard for product packaging.
Old newspaper (ONP)	After the newspapers are distributed to customers and once it is used after reading, they become ONP. Mills primarily use ONP to make new newsprint and in the making of recycled paperboard.
Mixed paper	Mixed paper is a broad category that includes items such as discarded mail, telephone books, paperboard, magazines, and catalogues.
High-grade deinked paper	This includes items such as letterhead, copier paper, envelopes, and printer and converter scrap that has gone through the printing process. These need to be de-inked before it can be reprocessed into high-grade paper products such as printing and writing papers.
Pulp substitutes	These are discarded materials such as shavings and clippings obtained from converting operations at paper mills and print shops. Mills can use these pulp substitutes in place of virgin materials to make high-grade paper products.

¹¹¹ "The State of the Paper Industry", greenpressinitiative.org

4.1.3. Benefits of Paper Recovery¹¹²

Recycling one ton of paper saves up to **31 TREES**, **4,000 kWh** of **ENERGY**, **1.7** barrels (270 liters) of **OIL**, **10.2** million BTUs of **ENERGY**, **26,000** liters of **WATER** and **3.5** cubic meters of **LANDFILL SPACE**



¹¹² Bureau of International Recycling, bir.org

4.2. Paper Recovery Process

Paper recovery refers to collection of used paper and paper board that undergoes recovery process and produces paper rolls that are sent to the recycling facilities. The collection of used paper and board is the first step in the recovery process.

Figure 13: Paper Recovery Process

A. Paper Scrap Collection

There are two major sources of paper waste for a recycling facility:

- Pre-Consumer Waste: This includes paper scraps and trimmings left over from the paper manufacturing process. These paper scraps and trimmings are easy to recycle, as they do not require collection, separation, de-inking, etc.
- Post-Consumer Waste: This includes paper that has been used by the end consumer and is then collected for recycling from various recycling programs.



B. Sorting of Paper

Paper is separated from other waste materials through combination of built-in sensors technology. In this, the pre-sorted waste is passed through a rolling drum, which contain paddles. Since paper is lighter than the other recyclable waste, it gets pushed forward while the rest of the waste falls behind.

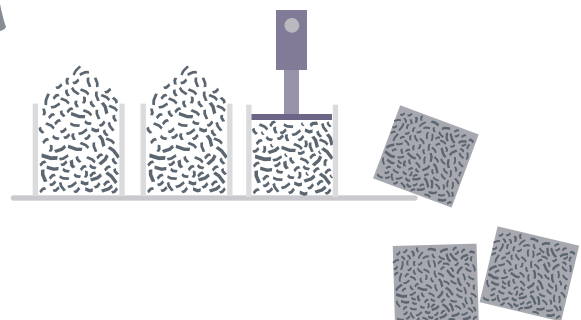
Once the paper is separated from the other waste, it is mechanically sorted to separate paper scrap classified into grades according to its fiber length. This is followed by manual sorting performed in order to remove residual unwanted materials.

For example, the very thin lightweight paper materials such as newspapers are put separately from thick paper materials such as paper folders, letterheads and cardboards. This is done because different grades of paper are required to be treated and processed differently.

C. Bailing

Hydraulic machines are used for the process of bailing. These machines exert colossal pressure on the collected paper waste and bundle them into blocks.

The final end product of the recovery process is in form of paper bails that is stored in the warehouse and is sold to the recycling facilities. These recycling facilities follow the recycling process and produce paper rolls to be sold to the end consumers.



4.3. Recovered Paper Applications

Recovered paper can be used to make new products composed entirely of recovered fiber or a blend of recovered and virgin fibers. Some products usually manufactured products using recycled materials are:

Packaging: Recycled paper is used in packaging products such as cardboard boxes, egg cartons, shoeboxes and grocery bags.

Printing and Writing Paper: Weekly magazines, notebook paper, copier paper, newspapers have a wide application for recycled paper, as it requires very low-grade paper.

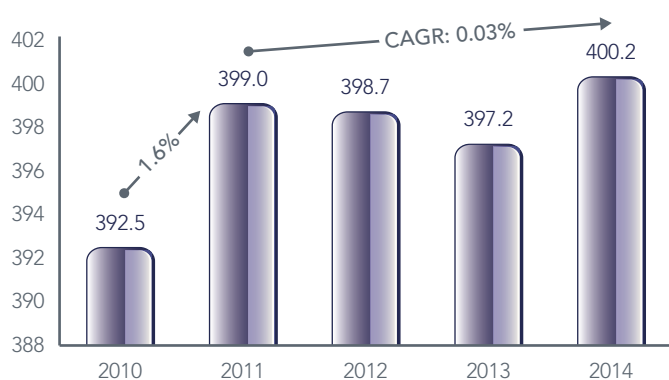
Household Products such as toilet paper, facial tissues, paper towels and napkins use a good amount of recycled paper.

4.4. Global Paper Recovery Market Overview

Paper can only be recycled for finite number of times owing to its chemical properties. In addition, paper production using virgin wood fiber is not sustainable, as it has limited availability. Thus, scarcity of raw material coupled with economic factors such as high costs of virgin wood fibers has encouraged paper recycling. In addition to the above-mentioned factors, there has been increased focus on environmental sustainability during the last decade that has also encouraged paper recycling across the globe.

As per data from FAOSTAT, global production of paper and paperboard increased sharply during 2010 and 2011, witnessing a growth rate of 1.6%. However, from 2011 onward, global production witnessed a marginal increase from 399 million tons in 2011 to 400.2 million tons in 2014, witnessing a CAGR of 0.03% during the period¹¹³ (Chart 76).

Chart 76: Global Paper and Paperboard Production, 2010-2014 (Million Tons)



Source: FAOSTAT

¹¹³ FAOSTAT, Faostat3.fao.org

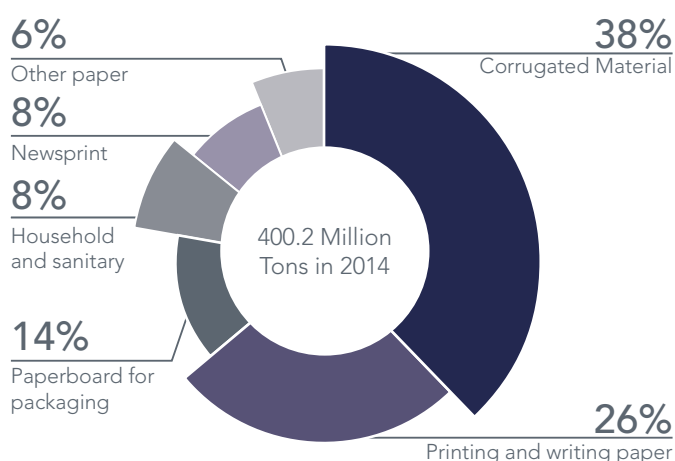
¹¹⁴ "Recovered paper market in 2013", Page 2, bir.org

^{115, 116} FAOSTAT, Faostat3.fao.org

In 2014, Asia was the leading producer of paper and paperboard with 45.9% share followed by Europe and America (North and South America) with 26.2% and 26.1% respectively¹¹⁴.

In 2014, corrugated materials used 152.1 million tons (38%) of paper while printing and writing segment consumed 104.1 million tons (26%). Other segments such as packaging consumed 56 million tons (14%) while household and sanitary and newspaper segments consumed 32 million tons (8%) each¹¹⁵ (Chart 77).

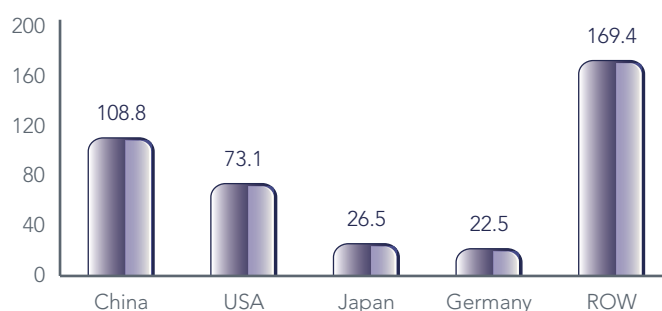
Chart 77: Paper Consumption, By Product Segment (2014)



Source: FAOSTAT

In 2014, cumulative production of China, the US, Japan and Germany accounted for 57.6% share of the total paper and paperboard production. China was the market leader with 108.8 million tons production of paper and paperboard in 2014. The US followed it with 73.1 million tons and Japan was ranked third with 26.5 million tons of paper production¹¹⁶ (Chart 78).

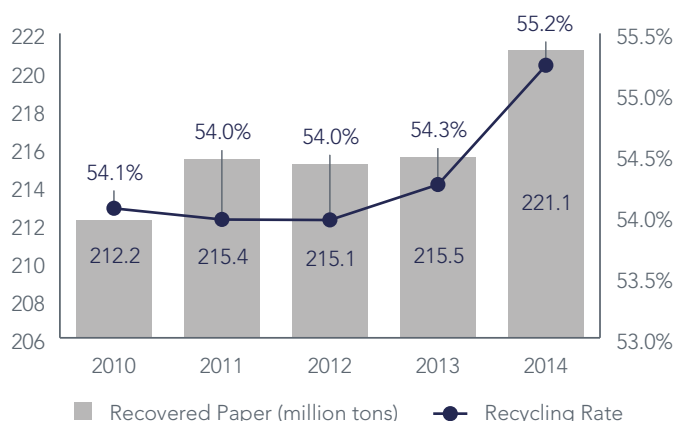
Chart 78: Leading Paper and Paperboard Producers (2014) (Million Tons)



Source: FAOSTAT

During 2010 and 2014, production of recovered paper increased from 212.2 million tons to reach 221.1 million tons¹¹⁷, witnessing a CAGR of 0.41%. In addition, recovery rate of paper also increased marginally from 54.1% in 2010 to reach 55.2% in 2014 (Chart 79).

Chart 79: Global Recovered Paper Production, 2010-2014 (Million Tons)

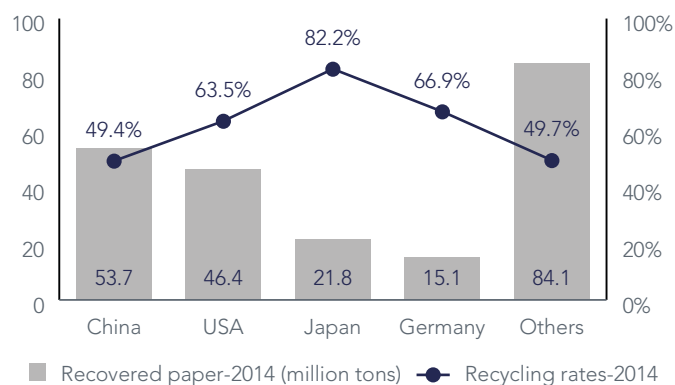


Source: FAOSTAT

During 2014, 61.9% of the total recovered paper was from China, the US, Japan and Germany. In 2013, the recovered paper from these countries had accounted for 61.1% of the total global recovery¹¹⁸.

Quantity of recovered paper from China during 2013 and 2014 increased from 49 million tons to 53.7 million tons, recording the highest growth rate of 9.7%. The US grew by 2.1% and recovered 46.4 million tons of paper in 2014 while Japan and Germany saw a marginal dip of 0.5% and 1.6% in their paper recovery and recovered 21.8 and 15.1 million tons of paper, respectively (Chart 80). In 2014, recovered paper accounted for 49.4% of the paper production in China while it accounted for 63.5% in the US.¹¹⁹

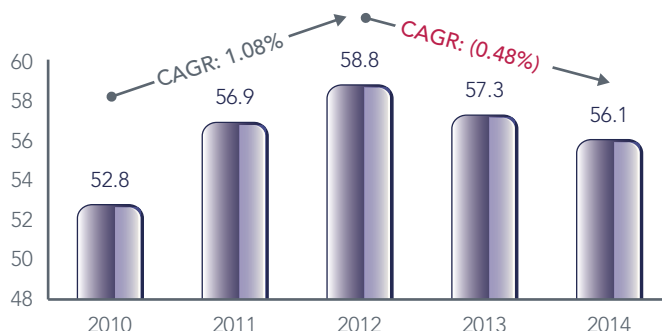
Chart 80: Leading Recovered Paper Producers (2014, Million Tons)



Source: FAOSTAT

During 2010 and 2012, global trade¹²⁰ of paper and paperboard scrap (HS Code-4707) witnessed a CAGR of 1.08% to reach 58.8 million tons. From 2012 to 2014, the trade of paper scrap saw a marginal decrease of 0.48% and thus quantity of paper traded globally in 2014 amounted to 56.1 million tons (Chart 81).

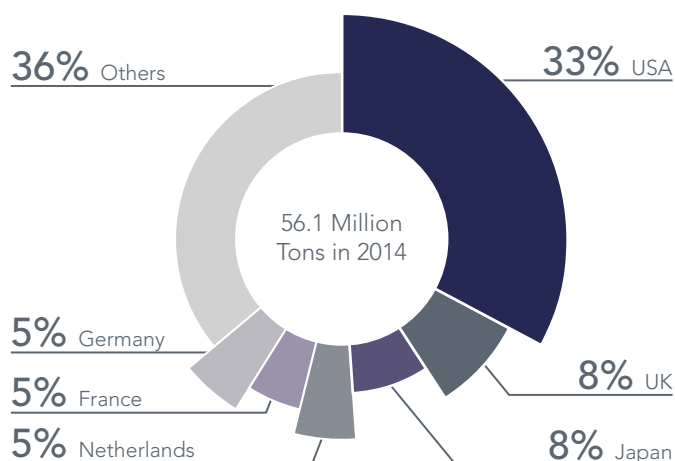
Chart 81: Global Recovered Paper Trade, 2010-2014 (Million Tons)



Source: Trademap

Compared with 2013, in 2014, the UK had a 4.99% growth rate in the export quantities and was the only country among top five global exporters to witness a growth. All the other leading exporting countries saw a decrease in their exports. Germany had the highest reduction of 11.8% followed by Netherlands and Japan, which witnessed shrinkage by 7.3% and 5.4%, respectively¹²¹ (Chart 82).

Chart 82: Leading Recovered Paper Exporters (2014)



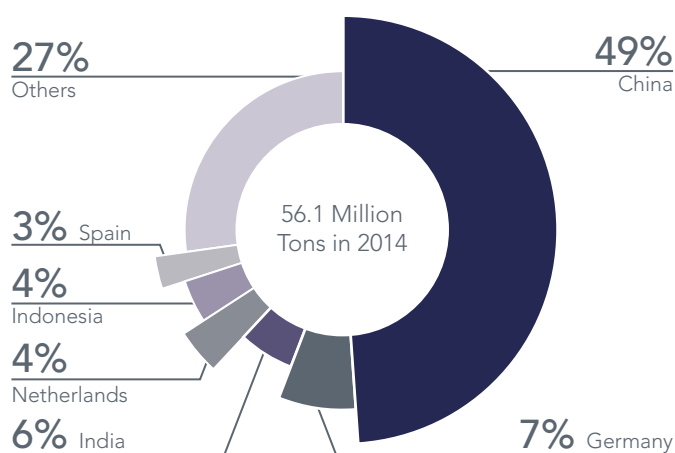
Source: Trademap

^{117, 118, 119} FAOSTAT, faostat3.fao.org

^{120, 121} Trademap

Despite the decrease in global imports of China by 5.75%, it was ranked first with import of 27.5 million tons (49%) of paper scrap. All the other countries such as Germany, India, the Netherlands, and Indonesia combined had 24% share in the global imports¹²² (Chart 83).

Chart 83: Leading Recovered Paper Importers (2014)



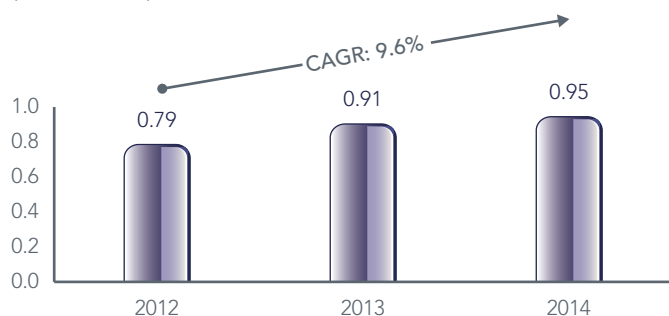
Source: Trademap

4.5. GCC Paper Recovery Market Overview

4.5.1. Market Overview

During 2012 and 2014, exports¹²³ of paper scrap from GCC increased from 0.79 million tons to reach 0.95 million tons, witnessing a CAGR of 9.6% (Chart 84).

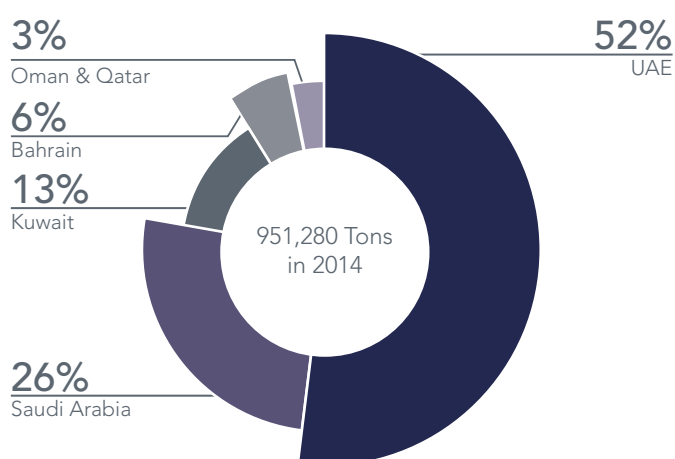
Chart 84: GCC Recovered Paper Export, 2012-2014 (Million Tons)



Source: Trademap

Among the member countries, the UAE held 51.8% share in the GCC exports for paper and paperboard scrap while Saudi Arabia and Kuwait constituted 25.7% and 13.7% shares, respectively (Chart 85).

Chart 85: GCC Recovered Paper Export (2014)



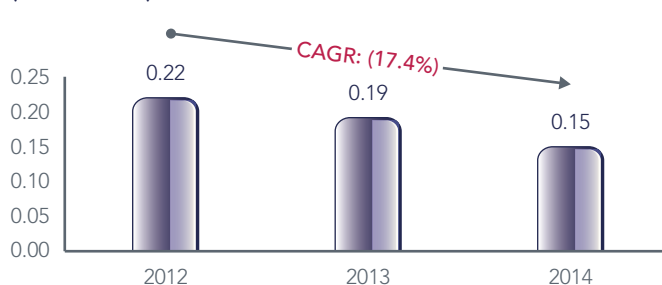
Source: Trademap

In 2014, India was the leading consumer of paper and paperboard scrap exported from Kuwait, the UAE and Saudi Arabia. Kuwait exported 83.6% of their paper scrap to India, while the UAE and Saudi Arabia exported 68.7% and 47.5%, respectively.

Imports¹²⁴ of paper scrap saw a substantial decrease from 0.22 million tons in 2012 to reach 0.15 million tons in 2014, recording a negative CAGR of 17.3%.

Of the total imports (0.22 million tons) among GCC members in 2014, the UAE accounted for 70.37% while Saudi Arabia's share was 26.58% (Chart 86).

Chart 86: GCC Recovered Paper Import, 2012-2014 (Million Tons)



Source: Trademap

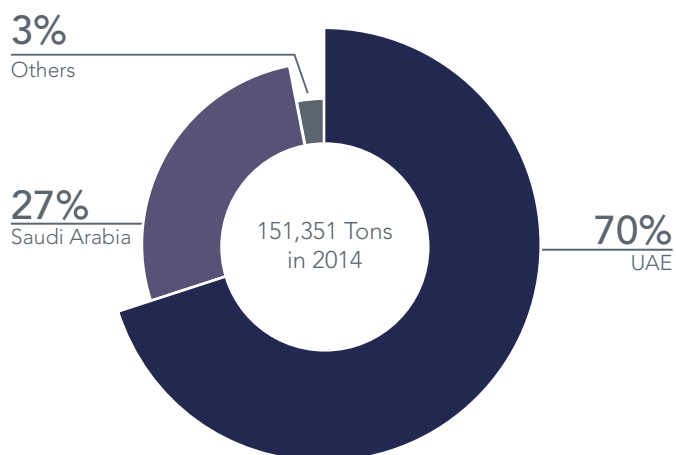
However, majority of the imports in paper and paperboard scrap was inter-GCC imports.

Oman and Saudi Arabia accounted for 53.3% and 40.9% share respectively of the United Arab Emirates imports (106,511 tons) for paper and paperboard scrap during 2014.

Saudi Arabia imported 40,023 tons in the year 2014 with 77.9% of the imports coming majorly from Jordan, China, the UK and Algeria.

The decrease in import of paper scrap and recovered paper in GCC can be attributed to better collection rates and subsequent recovery. Expansion of capacities of paper recovery and recycling facilities in UAE and Saudi Arabia has led to increase in exports of recovered paper from the region (Chart 87).

Chart 87: GCC Recovered Paper Import



Source: Trademap



4.5.2. Leading Companies in the GCC Market

Some of the leading paper scrap recovery companies in the GCC region include:

Table 15: Paper Recovery Companies in the GCC Market

Company	Year of Establishment	Country	Activity	Annual Capacity (tons)
Alpha Emirates	1985	UAE	<ul style="list-style-type: none"> Collection Recovery Recycling 	84,000
Bee'ah*	2007	UAE	<ul style="list-style-type: none"> Collection Recovery 	NA
Zone Waste Management and Recycling	1999	UAE	<ul style="list-style-type: none"> Collection Recovery Recycling 	NA
Union Paper Mill	1988	UAE	<ul style="list-style-type: none"> Collection Recovery Recycling 	146,000
WASCO (Waste collection and recycling)	2004	Saudi Arabia	<ul style="list-style-type: none"> Collection Recovery Recycling 	480,000
NESMA Recycling	1988	Saudi Arabia	<ul style="list-style-type: none"> Collection Recovery 	NA
Saudi Paper Manufacturing	2005	Saudi Arabia	<ul style="list-style-type: none"> Collection Recovery Recycling 	NA
Waraq Arab Paper Manufacturing Company	1994	Saudi Arabia	<ul style="list-style-type: none"> Collection Recovery Recycling 	200,000
Hadaba Recycling	1988	Saudi Arabia	<ul style="list-style-type: none"> Collection Recovery 	NA
Kuwait Waste Collection and Recycling Company*	1980	Kuwait	<ul style="list-style-type: none"> Collection Recovery 	48,000
Falcon Factory Waste Paper Recycling Unit	2008	Bahrain	<ul style="list-style-type: none"> Collection Recovery 	NA
Bani Adam Carton Recycling Services	2012	Oman	<ul style="list-style-type: none"> Collection Recovery 	109,500

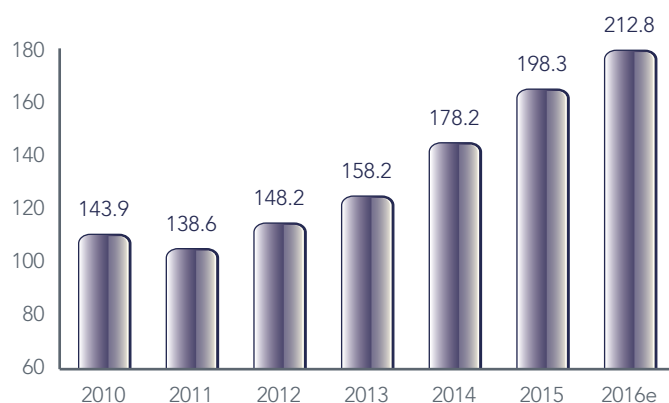
4.6. Qatar Paper Recovery Market Overview

4.6.1. Historical and Current Waste Generation

Major source of paper scrap in Qatar is MSW that is collected from both households and commercial units. Most of the paper scrap generated in Qatar is contaminated due to the lack of source segregation and hence is unfit for recovery. Moreover, sanitary paper cannot be recovered. Thus, most of the paper is dumped in the landfills. Paper recovery companies in Qatar collect waste directly from commercial units through long-term contracts. This paper is easily recoverable as it is source segregated. In MSW, paper scrap comprises approximately 17%¹²⁵.

Due to the increase in population over the years, the amount of paper scrap generated in the country has also increased from 143,927 tons in 2010 to 198,263 tons in 2015, witnessing a CAGR of 6.7%. In 2016, the paper scrap generation is estimated to be 212,826 tons, growing by 7.3% over 2015 (Chart 88).

Chart 88: Paper Scrap Generated from MSW in Qatar, 2010-2016E ('000 tons)

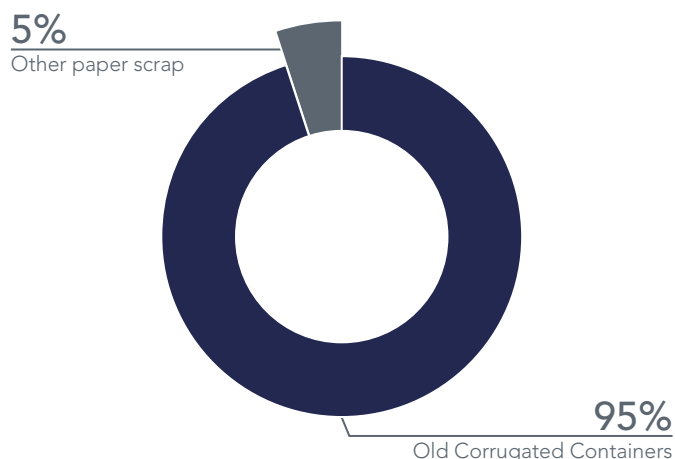


Source: MDPS Environment Statistics 2014, Primary research

4.6.2. Market Size Segmentation by Product Segments

Based on the primary interviews, old corrugated paper accounted for almost 95% of the recovered paper in Qatar while other paper scrap i.e., old newspapers, magazines, telephone books, paperboard, letter pads, and catalogues, accounted for the remaining 5% of recovered paper¹²⁶ (Chart 89).

Chart 89: Paper Products Recovery in Qatar, By Segment (2015)



Source: Primary research

The reason for the low percentage share of newspaper and magazines in recovered paper is that they are generated by households and are contaminated due to lack of source segregation. Moreover, the increased usage of internet/web-based reading has reduced the consumption of newspaper and magazines, thus reducing the share in paper scrap. As stated in above sections tissue paper and facial paper are contaminated, and therefore not recovered and reused.

4.6.3. Analysis of Exports and Imports

This section represents the trade of recovered paper waste and scrap done under HS Code: 4707. The graphs represent data at four-digit level.

Exports¹²⁷: Qatar exported a total of 33,369 tons of recovered paper waste and scrap between 2005 and 2015. The major proportion of this export was done during 2007 and 2011 when the country exported a total of 31,655 tons of paper scrap.



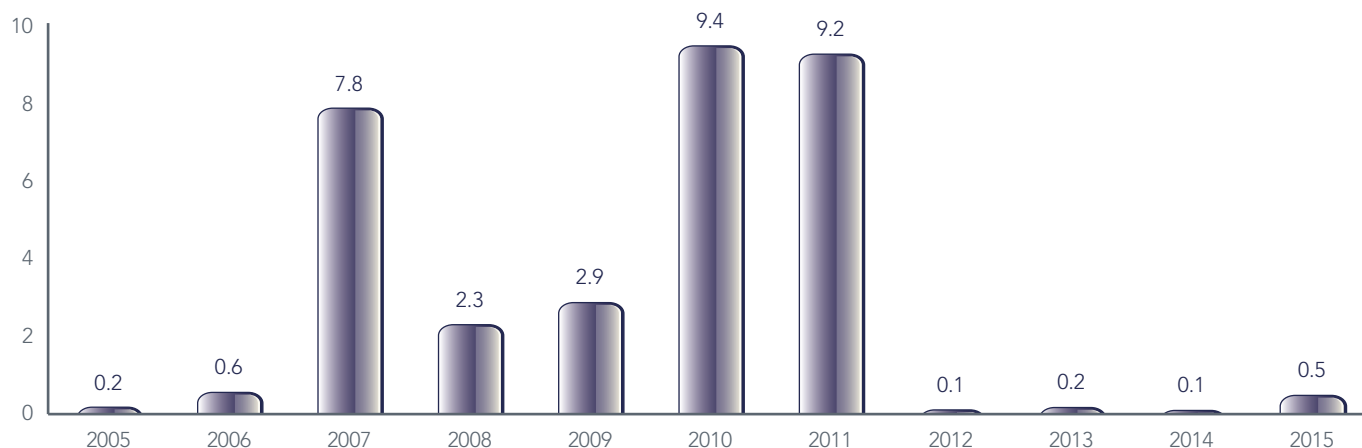
¹²⁵ MDPS Environment Statistics 2014, Analysis

¹²⁶ Primary research, Analysis

¹²⁷ Trademap

In 2010 and 2011, the exports were registered at 9,419 tons and 9,242 tons, respectively. Post this, the market witnessed a steep downfall during 2012 and only 144 tons of paper scrap was exported. This decline was attributed to restriction on export of scrap paper bails from the country post 2011 (Chart 90).

Chart 90: Qatar's Recovered Paper Export, 2005-2015 ('000 Tons)



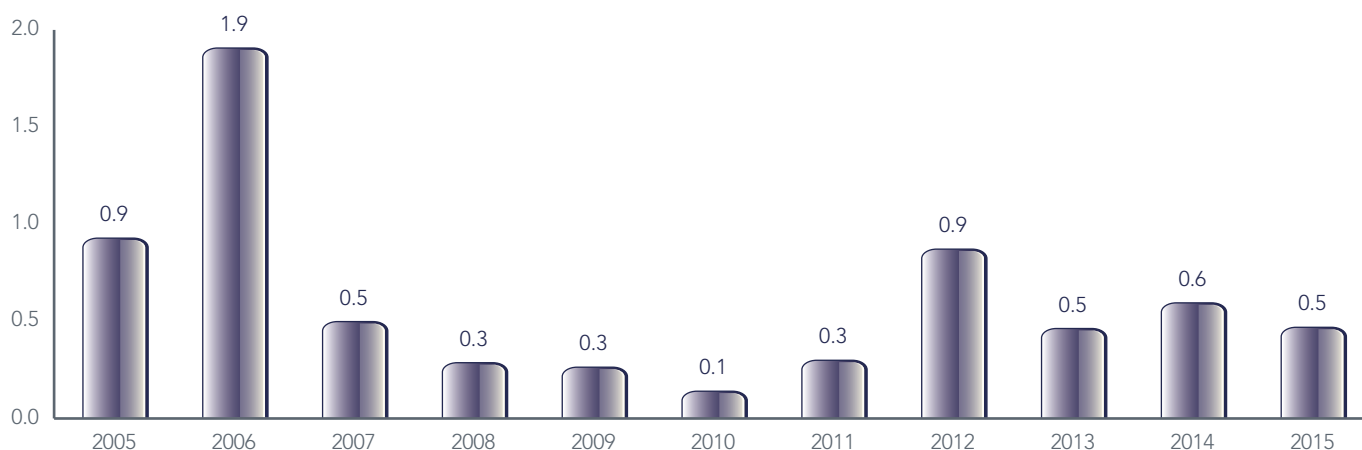
Source: Trademap

At eight-digit HS code level during 2015, paper scrap was exported under three sub-categories: 47072000 (bleached paper), 47073000 (paper made of mechanical pulp, such as newspapers, journals and similar printed matter) and 47079010 (unsorted waste and scrap, such as old newspapers). These segments accounted for 23.5% (120 tons), 58.5% (299 tons) and 18% (92 tons) of exports, respectively.

Imports¹²⁸: Compared to the exports of recovered paper and scrap, the imports are considerably low. This is due to the absence of paper recovery and recycling facilities in the country. The requirements of the two recycling facilities can be met by the current paper scrap generated within the country. However, the import of paper scrap is expected to rise as recycling facilities plan for expansion.

The country imported a total of 6,662 tons between 2005 and 2015. The import volume saw fluctuations in phases. During 2005, imports accounted for 918 tons, while in 2006 it increased to 1,888 tons. Hereafter, the import volumes decreased until 2010 and registered a volume of 138 tons. Between 2011 and 2015, imports witnessed an annual aberration i.e., increase in imports in one year and decrease in the following year. Thus, in 2015 the import volume was registered at 465 tons, an increase from 296 tons in 2011 (Chart 91).

Chart 91: Qatar's Recovered Paper Import, 2005-2015 ('000 Tons)



Source: Trademap

¹²⁸ Trademap

Over the period of 10 years i.e., between 2005 and 2015, paper scrap imports were done mainly under HS Code 47071000 (unbleached kraft and corrugated paper), 47072000 (bleached paper), 47073000 (paper made of mechanical pulp, such as newspapers, journals, etc.) that accounted for a combined volume of 4,819 tons (72.3%).

In 2015, HS Code 47073000 accounted for 40.8% (190 tons) of imports while the HS Code 47071000 and 47072000 accounted for 30.9% (143 tons) and 28.2% (131 tons), respectively.

Imports under HS Code 47071000 and 47072000 is used as raw material for manufacturing of packaging products by recycling facilities such as Al-Suwaidi and Elite recycling.

4.6.4. Waste Generation Forecast

The amount of MSW to be generated from 2017 to 2025 is estimated based on the average per capita MSW generated during the period between 2008 and 2014, which is equal to 1.37kg per person per day. In this, paper accounts for approximately 17% of the MSW generated.

Presently, Qatar generates about 212,826 tons of paper scrap and the quantity is expected to reach 224,493 tons in 2017 and 238,460 tons in 2025, witnessing a CAGR of 0.76% between 2017 and 2025 (Chart 92).

Chart 92: Paper Scrap Generation from MSW in Qatar, 2017F-2025F ('000 Tons)



Source: MDPS Environment Statistics 2014, Team analysis

As per the estimated paper scrap generated in 2016, approximately 47,000 tons cannot be recovered as it comprises of food contaminated paper products and tissue paper and napkins. Of the remaining paper scrap generated, approximately 85,000 tons can be recovered, however, currently it is not recovered in Qatar. This is because it comprises of printing paper, newsprint, magazines, writing paper etc. which is difficult to recycle due to the de-inking process. Due to absence of demand from downstream industry, these categories of paper scrap are not recovered in Qatar.

Hence, corrugated containers (OCC) forms the majority of the paper scrap recovered in Qatar. The OCC scrap generated is estimated to be 81,000 tons in 2016 of which approximately 46,000 tons is recovered in Qatar.

4.6.5. Demand for Recovered Material

Qatar's demand for paper is currently fulfilled through imports that is done in form of paper rolls and finished products. This is due to the absence of paper mills in the country.

As there are regulations on the export of scrap paper bails, the recovered paper has to be recycled domestically. Moreover, majority of the paper scrap generated is contaminated in nature and hence is dumped in the landfills. OCC accounts for 95% of the recovered paper in Qatar (described in market segmentation)

Thus, demand for recovered paper is primarily with the companies recycling old corrugated containers. In Qatar, there are two recycling facilities using OCC, namely Al-Suwaidi and Elite paper recycling company.

1. Al-Suwaidi Paper¹²⁹ Factory was established in 2001 and is a division of Al Suwaidi Group of Companies. They have an annual installed capacity of 15,000 tons with 250 employees.

There final products include kraft paper and board made from waste paper that is collected from within the country. About 300 tons of recycled paper is sold in the domestic market while the remaining is exported to Bahrain, UAE and Saudi Arabia.

Domestically, there recycled product is sold to carton producing companies such as Doha modern, Galaxy Carton etc.

The company is expanding its operations with the second facility that would have an installed capacity of 80,000 tons. This facility was expected to be operational in the second half of 2016 and would produce kraft liner, fluting and white top testliner of varying dimensions. The company plans to source paper scrap from the UAE to meet its production requirements.

2. Elite Paper Recycling¹³⁰ was established in the year 2012 and have an installed annual capacity of 54,750 tons. There products include: Floating paper and Test liner.

The company is currently operating at 56% efficiency (31,000 tons) and sells 15% of their products in domestic market while the remaining is exported.

Taher and Taleb supplies paper scrap to them while their major domestic consumers of their products include Doha modern, Galaxy Carton and Qatar Carton.

Replacement Opportunity for Recovered Paper:

As mentioned above, Al-Suwaidi post expansion is planning to import paper scrap from UAE and thus opens a potential opportunity for recovery companies in Qatar.

For other grades of paper, there is ample amount of scrap generation in Qatar but due to the absence of any recycling facility and ban on exports of paper bails, these grades are not recovered in Qatar (as described in the earlier section).

In the absence of recycling facilities that cater to grades of paper such as printing paper, newsprint, magazines, writing paper etc. and the current ban on paper scrap exports, the opportunity for recovery facility is limited and will face intense competition from existing facilities.

Establishment of a recycling facility for these grades of paper in Qatar will boost up the paper recovery industry and can thus replace some amount of paper roll imports by manufacturing facilities involved in production of tissues, sanitary rolls etc.

4.6.6. Assessment of Supply Landscape

Based on the primary interviews, operations in waste management companies include sorting, compressing and bailing of paper waste. However, these companies do not undertake the process of de-inking and papermaking as explained in the recovery process.

1. Taher and Taleb Paper-Pressing Company¹³¹ is the only paper scrap exporting company in Qatar, sourcing directly from the market through long-term contracts and from waste management companies. They also sell the paper scrap to Al-Suwaidi and Elite paper recovery facility in Qatar.
2. Seashore Waste Management Company collects MSW and commercial waste in Qatar and sorts paper scrap. They recovers 3,600 tons of paper annually in form of paper bails. These paper bails are sold either to Al-Suwaidi and Elite recycling or to Taher and Taleb that export it to other countries.

4.6.7. Pricing Analysis

Since paper recovery firms sell recovered paper to the domestic entities or export it overseas, we have taken export prices of recovered paper and scrap as an indicator for the purpose of analysis.

Between 2005 and 2015, the average export price¹³² (HS Code: 4707) of recovered paper and scrap varied between QAR255 per ton and QAR484 per ton (Chart 93).

Chart 93: Qatar's Recovered and Scrap Paper Export Price, 2005-2015 (QAR/Ton)



Source: Trademap, Team analysis

¹²⁹ "Al Suwaidi Paper to establish its new factory in 2nd half of 2016", printweekmea.com

¹³⁰ Company website

¹³¹ Primary research

¹³² Trademap

As per the primary interviews with the waste management companies in Qatar, paper scrap (in form of bails) was sold to the recovery facilities at a rate of QAR200 per ton in 2016.

In 2015, as briefed in the import-export section, paper scrap was exported under three HS Code sub-categories: 47072000, 47073000 and 47079010. Prices per ton for these segments were reported to be QAR151, QAR584 and QAR593, respectively.

4.6.8. Analysis of Business Model And Presence/Absence of Key Synergies

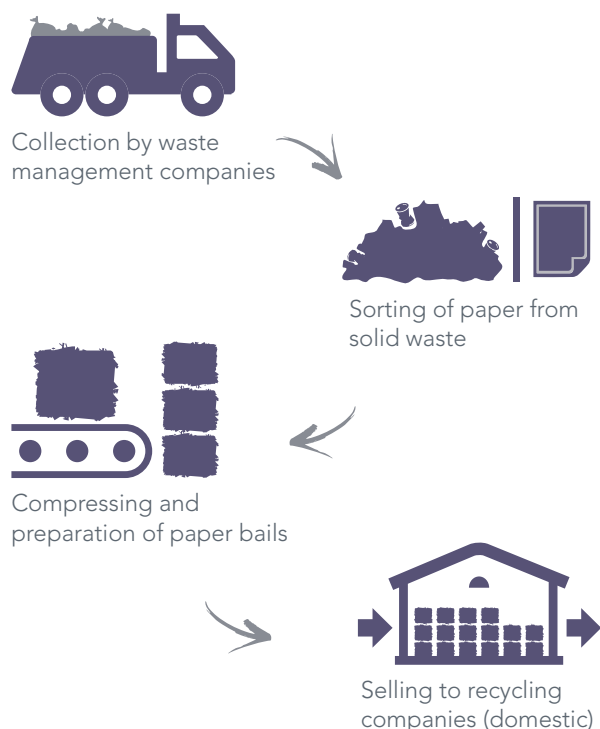
There are two models under which the paper scrap recovery is been done in Qatar. These are:

Business model 1: Recovery of Scrap Paper: There are two ways to source paper scrap:

- By Waste Management Companies: Waste management companies collect scrap from households, industries and MSW and sort the scrap into organic, plastic, metal, paper, etc. The sorted paper scrap is then compressed and bailed before it is sold to the paper recycling facilities.

Example: Seashore waste management company

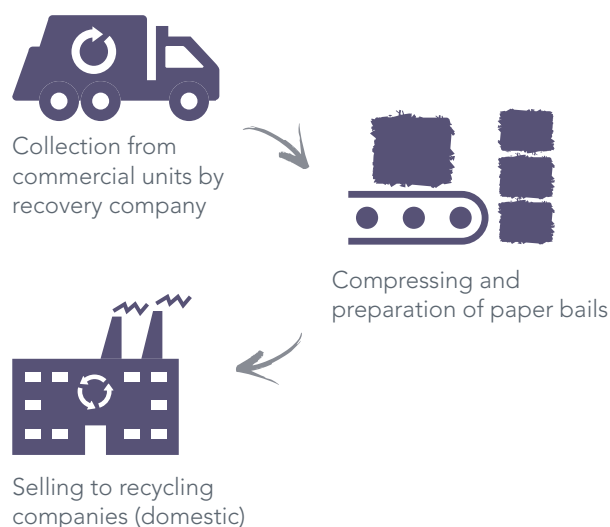
Figure 14: Business model 1 (a): Recovery of Scrap Paper by Waste Management Company



- By Recovery Facilities: Paper recovery facilities collect waste directly through long-term contracts with the commercial facilities and follow the recovery process. The bailed paper is then sold to the recycling facilities for papermaking.

Example: Taher and Taleb

Figure 15: Business Model 1(b): Recovery of Scrap Paper by Recovery Facility



Business model 2: Export of Paper Bails – In this model, trading is done via:

- Through Taher and Taleb: In this, paper recovery companies or waste management companies can collect paper scrap from households and industries. This scrap paper once sorted and bailed can be sold to Taher and Taleb and thus can be exported from Qatar.

Example: Seashore Waste Management Company

Figure 16: Business Model 2: Export of Paper Bails



The exports can be done only through Taher and Taleb as government has imposed regulations and are not providing any company with the license to export paper bails. Taher and Taleb exports paper bails as they got the license before this regulation was implemented.

However, in case the regulations are amended the recovery companies and waste management companies can directly export paper bails to other countries.

4.6.9. SWOT Analysis

Figure 17: SWOT Analysis – Paper Recovery



Summary:

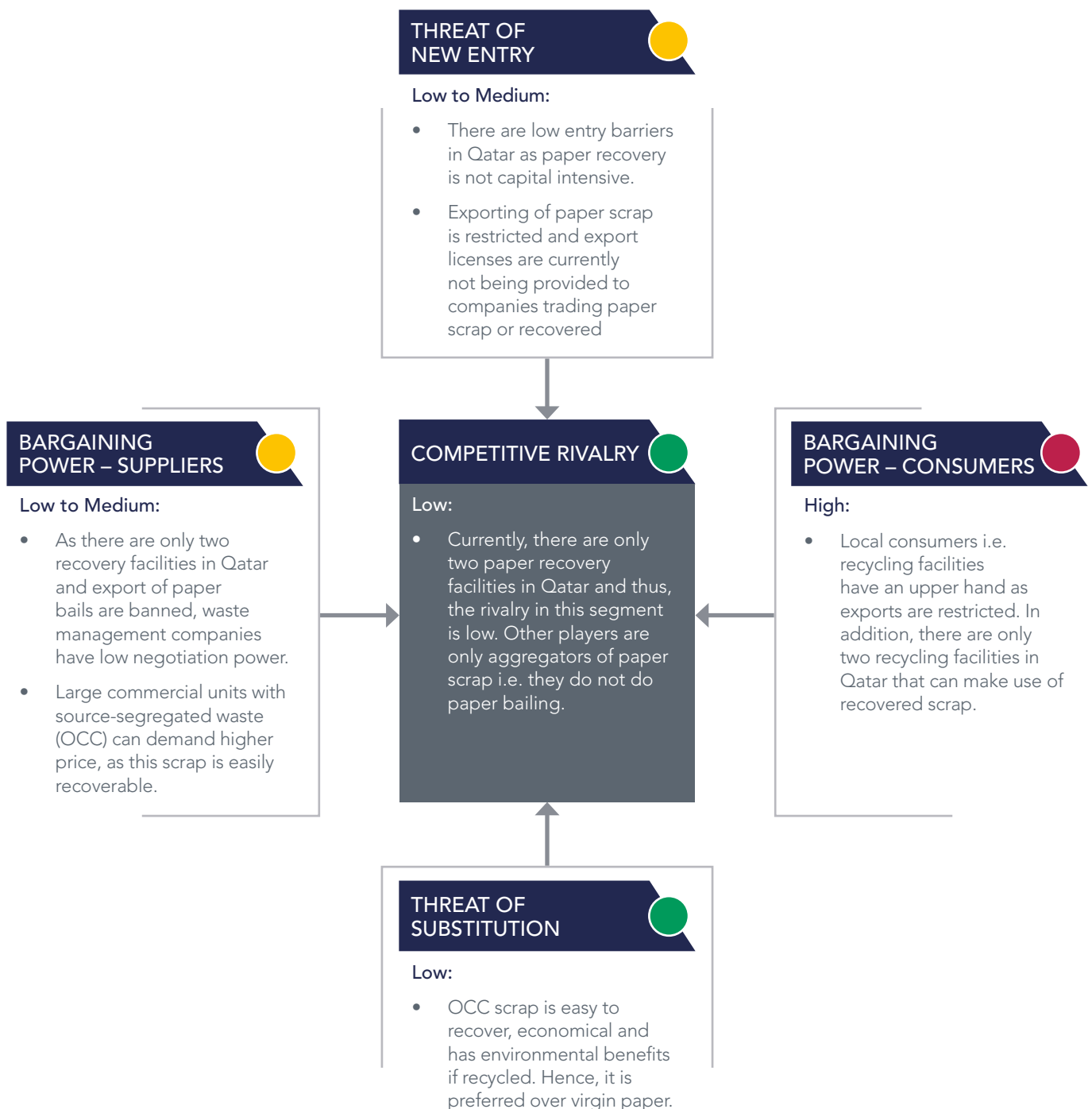
As per our assessment, majority of the paper recovered in Qatar is in form of OCC. Other grades of paper are not recovered because of the absence of paper mills in the country. In case paper recycling firms are established in Qatar for recycling printing paper, newsprint, magazines, writing paper, then these grades of paper can be recovered and put to use in the tissue making industry

4.6.10. Regulations

- The export of scrap paper bails is not allowed and the facility can export recycled paper only except for Taher and Taleb.
- The Ministry of Environment has specified the collection of paper in specified bins that ease the process of sorting by segment.

4.6.11. Michael Porter's Five Forces Model

Figure 18: Michael Porter's Five Forces Model Paper



4.6.12. Key Takeaways and Potential Opportunities

- Qatar generates paper scrap primarily through households and commercial units. Due to lack of segregation, this waste gets contaminated and is dumped in the landfills.
- As per estimates, Qatar is expected to generate 212,800 tons of paper scrap in 2016 and this will increase to 238,500 by 2025.
- Food contaminated paper products and tissue paper and napkins cannot be recovered and are dumped in the landfills. In 2016, the estimated quantity in this segment was 47,000 tons.
- Printing paper, newsprint, magazines, writing paper etc. accounts for approximately 85,000 tons and are currently not recovered in Qatar.
- 95% of the paper scrap recovered in Qatar is in form of OCC while the remainder is a mix of all other sources of paper scrap. OCC is estimated to account for 81,000 tons of paper scrap generated in 2016.
- OCC is collected by the recovery facilities directly through grocery stores, hotels, offices and small businesses to avoid contamination.
- Al-Suwaiddi and Elite recycling are the two recycling facilities in Qatar and will have a combined processing capacity of 149,750 tons by 2017. This presents an opportunity for paper recovery facilities to sell recovered bails to these recycling facilities.
- For other grades of paper, the demand for recovered paper will depend on the establishment of recycling facility also catering to printing paper, newsprint, magazines, writing paper etc.
 - Recycling facility, if established in Qatar can supply recycled paper rolls to tissue making facilities like NAPICO that are currently importing paper rolls from other countries. This will further boost the paper recovery industry in Qatar.



5. RUBBER

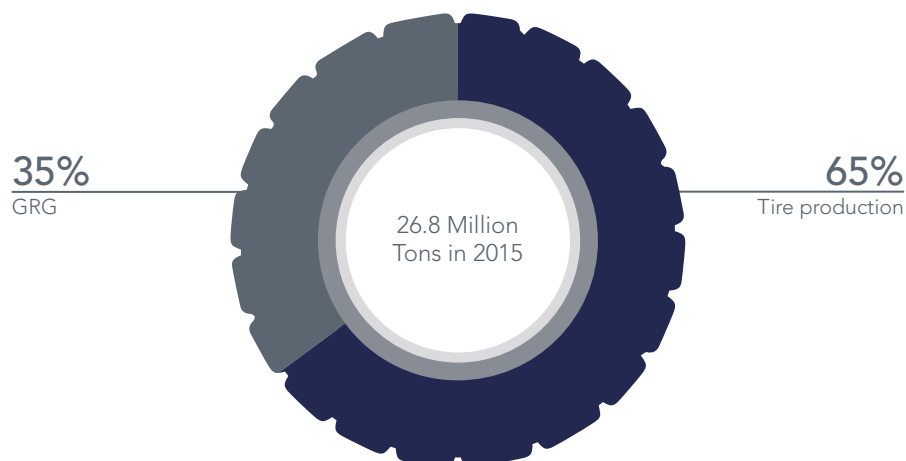
5.1. Overview of Rubber Scrap

5.1.1. Description

The consumption of rubber products is classified in two sub-industries: the automotive industry for the use in tire and tube, and in GRG applications, such as hose and belting, gaskets, weather-stripping, glass encapsulation, air dams and deflectors, door, window and closure seals.

The global automotive industry consumes approximately 65% of the total rubber produced, while GRG consumes the remaining 35%. The proportion of rubber for automotive production varies across countries e.g., China in 2015 consumed 81% of its rubber for tire production¹³³ (Chart 94).

Chart 94: Rubber Consumption, By End Use (2015)



Source: Tirebusiness.com

The growth in the automotive industry around the globe has resulted in increased demand for tires. In addition to this, the replacement of ELTs has caused an increase in the rubber scrap that is dumped in the landfills. There has been increased awareness on recovery of rubber scrap for reuse in different industries and applications because of:

- As rubber scrap can be completely recycled without loss of any physical or chemical properties (100% recyclability)
- There are environmental concerns with regards to dumping of ELTs in the landfill and can lead to spread of diseases

Recovered rubber known as crumb rubber is defined as material derived by reducing scrap tires or other rubber into uniform granules with the inherent reinforcing materials, such as steel and fiber, removed along with any other type of inert contaminants, such as dust, glass and rock. Overall, a scrap tire contains the following products in the mentioned proportion¹³⁴

¹³³ "World rubber demand seen rising 4% per year", tirebusiness.com

¹³⁴ "Scrap Tire Recycling", entire-engineering.de



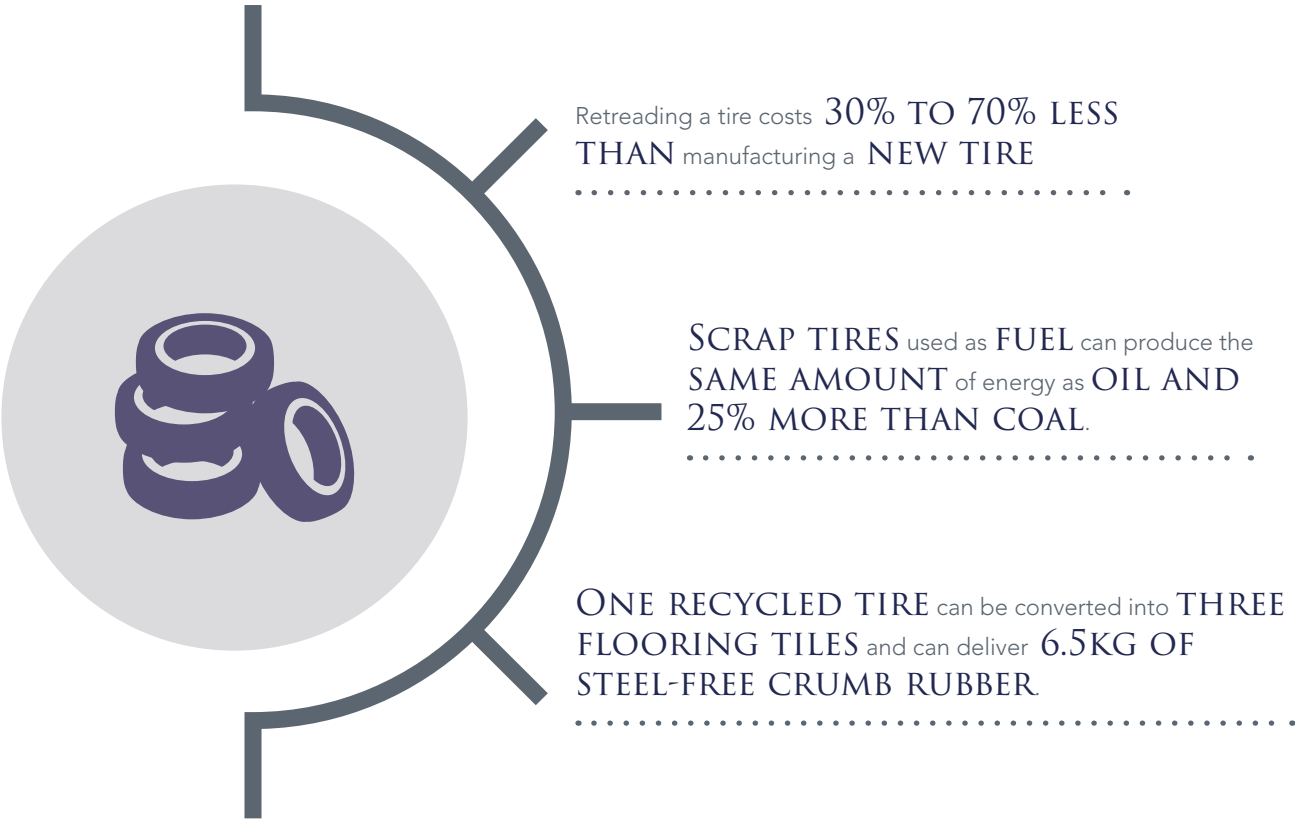
Table 16: Percentage Mix of Rubber and Steel in Different Types of Tires

Product	Truck Tires	Earth Moving Tires	Car Tires
Crumb rubber	70%	78%	70%
Steel	27%	15%	15%
Fiber and other scrap	3%	7%	15%

5.1.2. Benefits of Rubber Recovery¹³⁵

The oil required to rethread a tire is **20 LITER**, less than the oil needed to manufacture a new tire. With commercial vehicle tires, the **SAVINGS** are even greater, **ESTIMATED** to be about **68 LITERS PER TIRE**.

.....



One ton of **CRUMB RUBBER** (about 145 tires) produces approximately **500 TILES**, covering an area of **23SQM**.

.....

¹³⁵ Bureau of International Recycling, bir.org

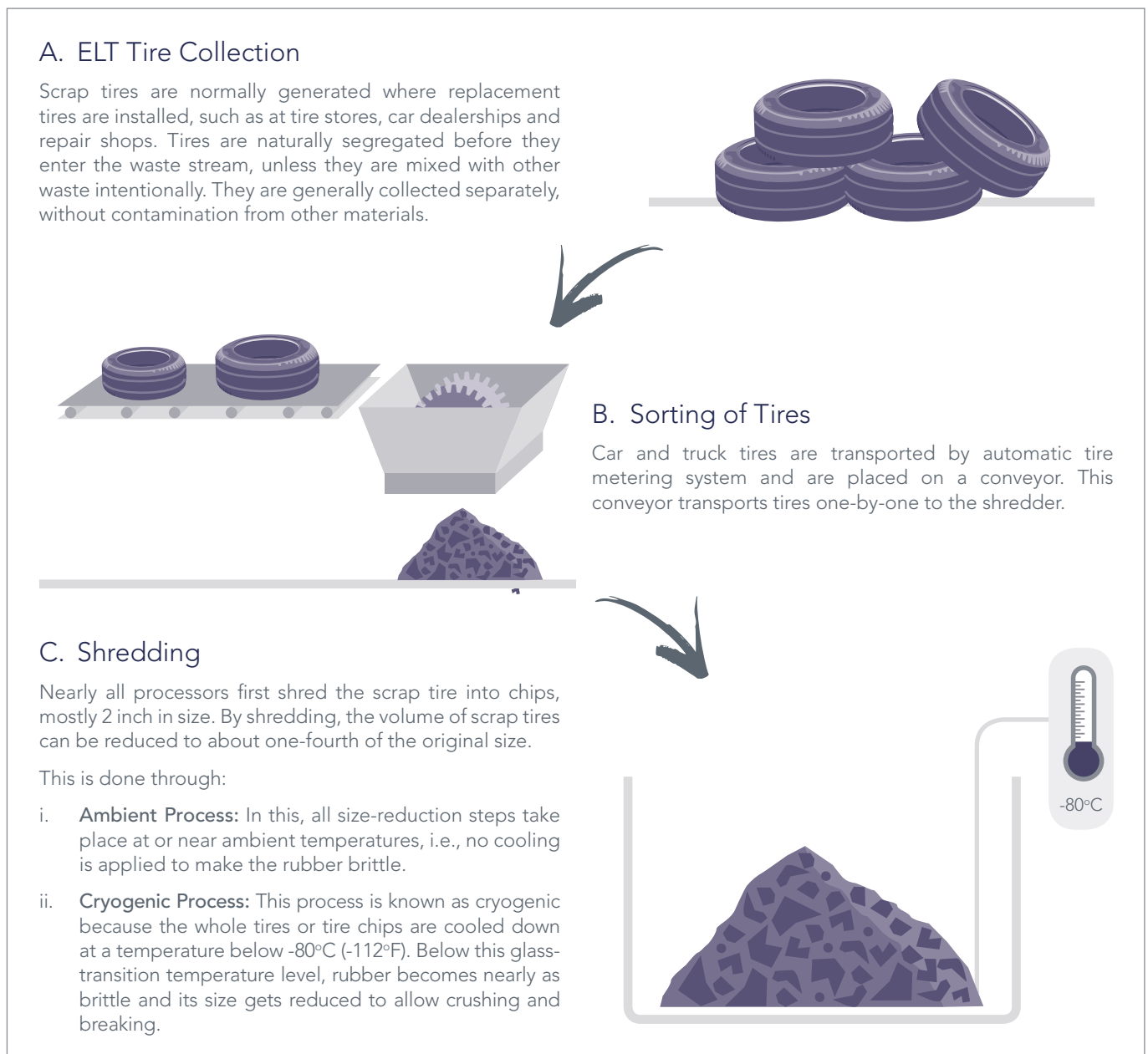
5.2. Rubber Recovery Process

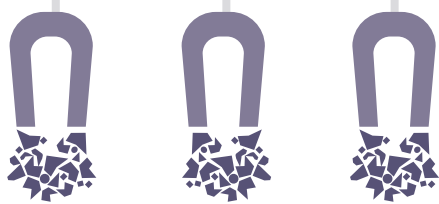
Rubber recovery is defined as grinding the scrap tires into crumb rubber while removing the steel, fiber and other contaminants. The collection of used tires and rubber is the first step in the recovery process.

The possible ways of treating used tires are as follows:

- i. **Rethreading and Reusing of Tires:** In this process, the remaining thread is ground away from a tire to be remolded and a new thread rubber strip is fused to the old body by vulcanization.
- ii. **Recovery of Rubber in the Form of Crumb Rubber:** This can be done by using ambient or cryogenic processes (cooling of rubber to a temperature ranging between -60°C and -100°C) at the milling stage of ground rubber to produce tires of various sizes.

Figure 19: Rubber Recovery Process

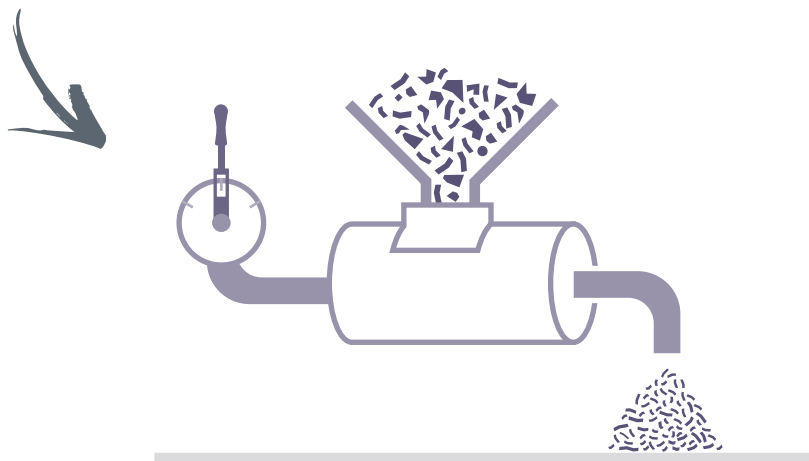




D. Separation of steel and fiber

After exiting the shredder, steel is removed magnetically and the fiber fraction is removed by a combination of aspiration and screening. Post this, shredded rubber is exposed to grinding.

After every step of recycling, the granules are passed through the screening process, and in case the size of granules is big, they are separated and returned to the shredding phase.



E. Grinding

The process is automated and the size of rubber granules can be controlled. The rubber is ground to a final raw product of varying sizes (0.5mm to 4mm) depending upon the requirement.

5.3. Recovered Rubber Applications

Recovered tires have wide applications especially in parks, sporting turfs and in civil construction works. Some of the applications areas of crumb rubber are:

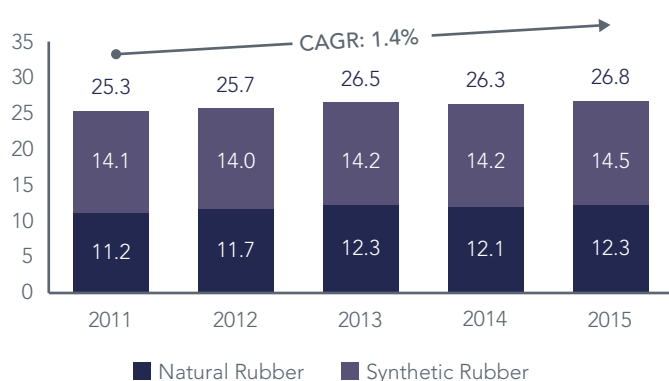
- Sport surfaces: Crumb rubber is mixed with polyurethane and are used to produce running surfaces, horse riding tracks and paving paths.
- Brake pads: Crumb rubber is used to produce asbestos-free brake pads.
- Building insulation: Crumb rubber is mixed with polyurethane to produce rubber matting insulation. This is especially used in flooring in apartments as well as between walls
- In road construction: Crumb rubber mixed with asphalt is used to produce rubberized asphalt that is applied to new roads.

5.4. Global Rubber Recovery Market Overview

Natural rubber and synthetic rubber are substitutes and are complementary to each other. Both materials are used to produce the desired properties needed in rubber products and tires.

Global rubber production increased from 25.3 million tons in 2011 to 26.8 million¹³⁶ in 2015, witnessing a CAGR of 1.4% (Chart 95).

Chart 95: Global Rubber Production, 2011-2015 (Million Tons)



Source: Malaysian Rubber Board

The global production of natural rubber increased from 11.2 million tons in 2011 to reach 12.3 million tons in 2015, marking a CAGR of 2.3%.

In 2015, Thailand emerged as the world's largest rubber-producing country with 4.5 million tons of output (35.7% of total production), followed by Indonesia, China, India and Malaysia with the share of 26%, 7%, 6% and 5.5%, respectively¹³⁷.

¹³⁶ "Natural Rubber Statistics 2016", Page 1, lgm.gov.my

^{137, 138} "THAILAND industry outlook 2016-18 rubber industry", krungsri.com

Worldwide, natural rubber production has exceeded consumption for more than three years due to the expansion of plantation area in many Asian countries as well as due to slow pace of the economic expansion in China. Production in 2015 was 12.3 million tons, leading to a record high global natural rubber stockpile of 3.4 million tons at the end of 2015¹³⁸.

Demand for natural rubber is related to demand for tires, as manufacturers use 60% to 70% of all natural rubber produced. However, synthetic rubber is used as a substitute for natural rubber in many applications.

Currently, synthetic rubber production accounts for 54% of the worldwide rubber production. Between 2011 and 2015, synthetic rubber production grew from 14 million tons to reach 14.6 million tons¹³⁹, registering a CAGR of 0.6%. Synthetic rubber is equally recyclable as primary rubber and is widely used in applications such as¹⁴⁰:

- SBR rubber pads (Mining equipment)
- Synthetic Rubber Seals
- Rubber gaskets
- SBR Panel grommets (HVAC market)
- Custom molded rubber components for plumbing applications

Currently, the management of ELTs is posing a serious challenge. The governments in the European countries and in the US and Japan have taken major steps in the direction of recovery of ELT tires.

ELT recovery has gained momentum in Europe. This is evident from the fact that the average recycling rate has increased from 50% in 1999 to 96% in 2013¹⁴¹. Presently, there are three different models operating within the EU for the management of tire waste. These are:

- Extended Producer Responsibility (EPR):** A manufacturer of tires is assigned the duty of ensuring the waste generated through the consumption is disposed responsibly, in an eco-friendly manner, thus making the producer responsible for the waste that the consumer generates.
- Liberal System (Free market):** Under this system, the legislation sets the objectives, but does not designate any manufacturer. Thus, all the members of the recovery chain operate under free market conditions and act in compliance with the legislation. Austria, Switzerland, Germany and the UK operate under this system.
- Tax System (Government Responsibility and Financed through Tax):** This model of tax system is applied in Denmark and Croatia. Under this tax system, each country is responsible for the management of ELTs. It is financed by the tax levied on tire producers, which is subsequently passed on to consumers.

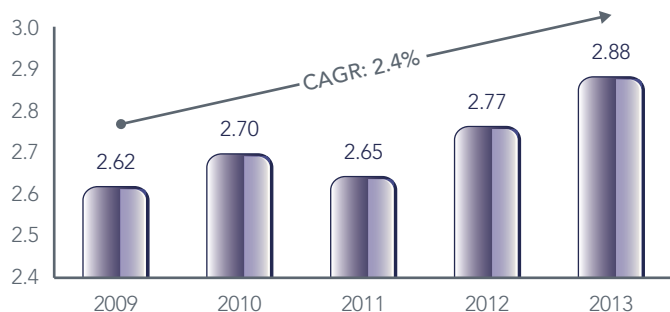
¹³⁹ Natural Rubber Statistics 2016, Page 1, lgm.gov.my

¹⁴⁰ Synthetic Rubber (SBR) Applications, Timcorubber.com

¹⁴¹ End-of-life Tire Report 2015, Page 12, etrma.org

In 2013, used tires arising in Europe accounted for 3.59 million tons of which ELT arising was 2.88 million tons. Almost 0.7 million tons of used tires were reused, retreaded and exported. The ELT arising within Europe has increased from 2.62 million tons in 2009¹⁴² to 2.88 million tons in 2013, registering a CAGR of 2.4% (Chart 96).

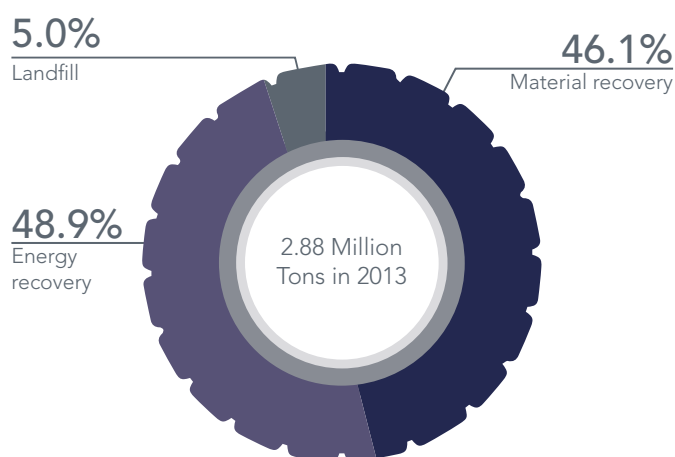
Chart 96: ELT Arising in Europe, 2009-2013 (Million Tons)



Source: ERTMA

In Europe, ELT waste was recovered in two forms: material recovery and energy recovery. In 2013, 46.1% (1.3 million tons) of ELT was used for material recovery, while 48.9% (1.4 million tons) was used for energy recovery. The remaining 5% (0.18 million tons) of ELT was dumped in the landfills¹⁴³ (Chart 97).

Chart 97: End-use of ELT Arising in Europe (2013)



Source: ERTMA

Within Europe, 20 out of 26 countries that reported ELT data had 100% recovery rate, while both the UK and Greece had a recycling rate of 95%. Turkey had the lowest recycling rate, but as per ERTMA, the country has set a national obligation for 100% ELT recovery for the coming years.

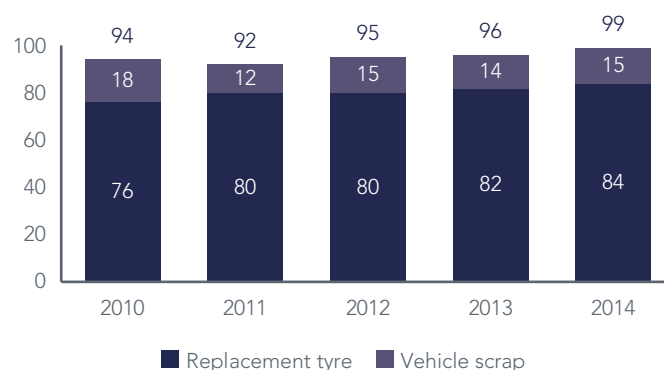
In 2014, Japan consumed 1.37 million tons of rubber as raw material. About 80.5% of this was in the production of tires, while 19.5% was consumed for the GRG segment¹⁴⁴.

^{142,143} End-of-life Tire Report 2015, etrma.org

¹⁴⁴ "Tire industry of Japan-2015", jatma.or.jp

The total used scrap tire collection in Japan increased from 94 million units in 2010 to 99 million units in 2014. The volume of tire scrap generated because of replacement was 84 million, while 15 million tires were generated through vehicle scrapping. In terms of volume, replacement tire scrap in 2014 accounted for 924,000 tons, while vehicle scrap tires had a share of 128,000 tons¹⁴⁵ (Chart 98).

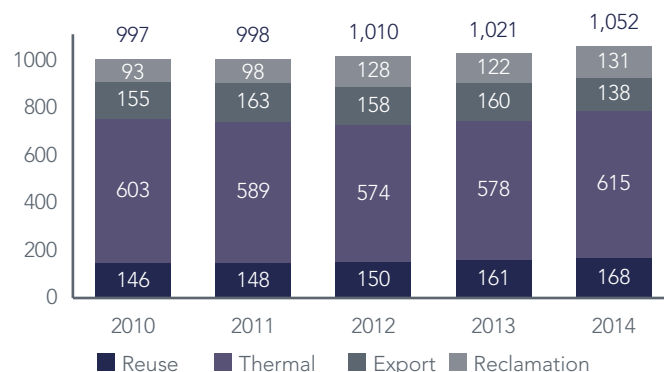
Chart 98: ELT Arising in Japan, 2010-2014 (Million Units)



Source: Malaysian Rubber Board

Thus, the total tire scrap generated in Japan was 1,052,000 tons and had a recycling rate of 87.5% in 2014. Tire scrap that was reused, retreaded and exported accounted for 306,000 tons (29.1%), while 615,000 tons of waste (58.4%) was recycled. The remaining 131,000 tons (12.5%) of waste was diverted to the landfill¹⁴⁶ (Chart 99).

Chart 99: End-use of ELT in Japan, 2010-2014 ('000 tons)

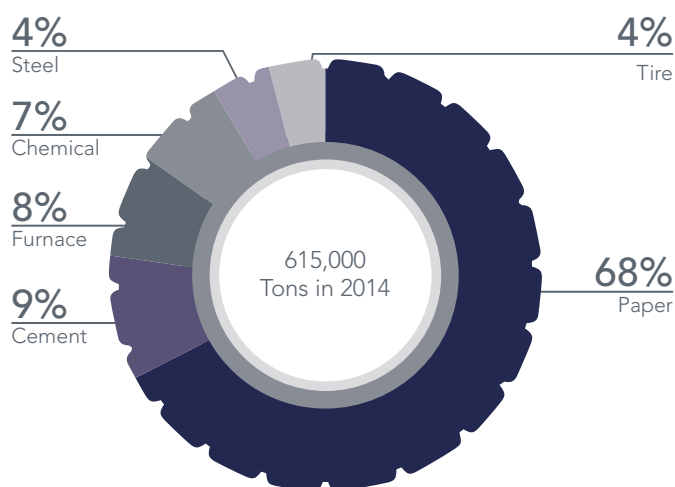


Source: JATMA

^{145, 146} Tire industry of Japan-2015, jatma.or.jp

In 2014, the recycled tire waste was used for various purposes, such as paper manufacturing (67%), chemical factories (7%), cement calcination (9%), steel manufacturing (4%), gasification of furnace (8%) and tire manufacturing (4%)¹⁴⁷ (Chart 100).

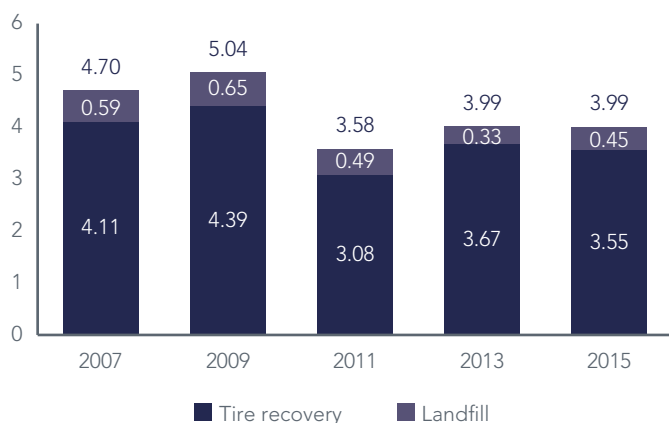
Chart 100: End-use of Thermally Recycled Rubber in Japan (2014)



Source: JATMA

In 2015, the US reported 3.99 million tons of tire waste arising from 246 million tires¹⁴⁸. The ELT scrap generated in 2014 registered a decline of 1.6% compared with that of 2007, when the US generated 4.7 million tons of ELT scrap (Chart 101).

Chart 101: ELT Arising in the US, 2007-2015 (Million Tons)



Source: RMA

Of the total ELT scrap, the US recovered 87.9% (3.55 million tons) of waste in 2015. However, the recycling rate in the US decreased from 2013 when the recycling rate was 95.9% (Chart 102).

Chart 102: Tire Recycling Rate in the US, 2007-2015

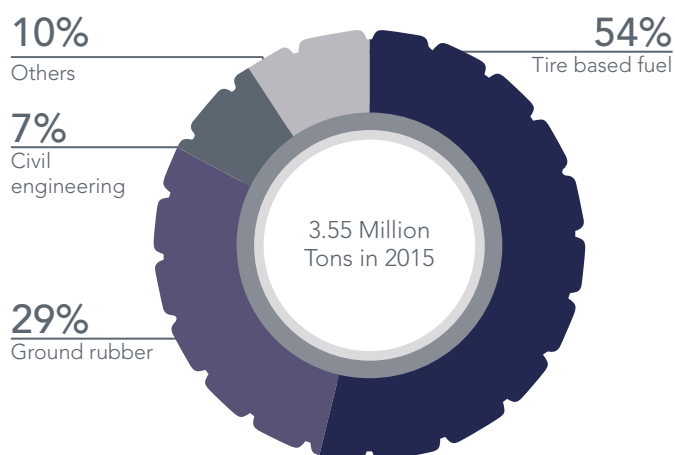


Source: RMA

Of the 246 million tires, light duty tires¹⁴⁹ i.e., passenger tire replacement, light truck tire replacement and vehicle scrap amounted for 89% of the total tire waste generated while commercial tires generated through medium – and heavy-truck replacement and scrap had a share of 11%.

In 2015, the recycled tire waste was used for various purposes¹⁵⁰. This included tire derived fuel (54%), ground rubber (29%), civil engineering (7%), and for other usage (10%) that included reclamation projects, furnace, agricultural uses, bailed tires, etc. (Chart 103).

Chart 103: End-use of ELT Arising in the US (2015)



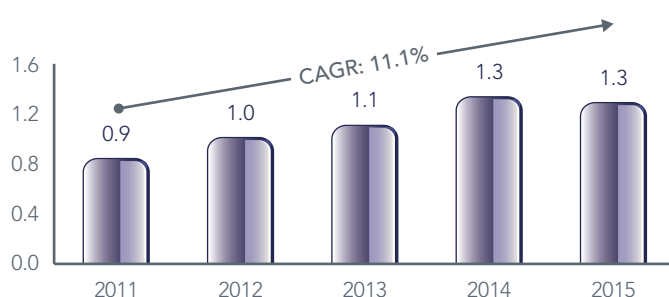
Source: RMA

¹⁴⁷ "Tire industry of Japan-2015", jatma.or.jp

^{148, 149, 150} 2015 U.S. Scrap Tire Management Summary, rma.org

The global trade of rubber scrap is done under HS Code 4004 and 4012. Trade under 4004 witnessed a double-digit CAGR of 11.1% and the trade increased from 0.9 million tons in 2011 to reach 1.3 million tons in 2015¹⁵¹ (Chart 104). Global trade for HS Code 4012 is not being represented because of inconsistent data.

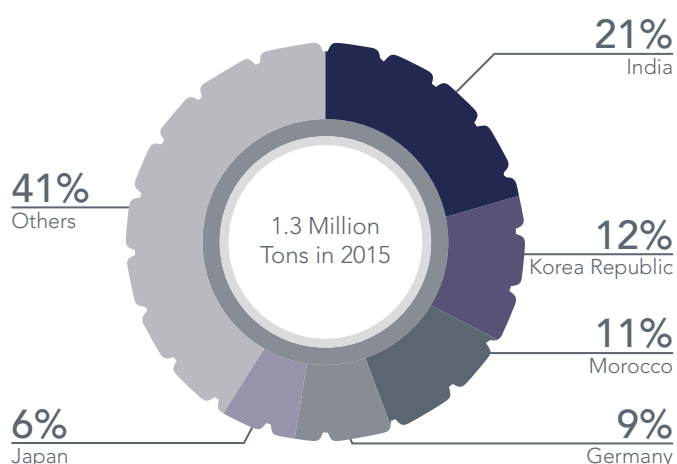
Chart 104: Global Rubber Scrap Trade, 2011-2015 (Million Tons)



Source: Trademap

India was the leading importer of rubber scrap with 0.30 million tons (21%) of the total imports in 2015. It witnessed an increase in the imports by 43.1% compared with that of 2014, when the imports were 0.19 million tons. The UK was the largest exporter and accounted for 54% of India's imports. Korea, Morocco, Germany and Japan also had significant imports in 2015 that accounted for 12%, 11%, 9% and 6%, respectively¹⁵², of the global import of rubber scrap (Chart 105).

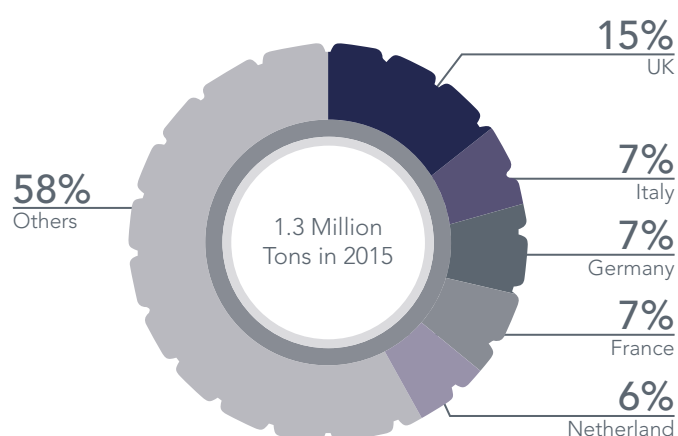
Chart 105: Leading Rubber Scrap Importers (2015)



Source: Trademap

Most of the exports¹⁵³ were from the European countries. For example, the UK was ranked first with 15% exports followed by Italy, Germany and France with 7% each. In 2015, the UK witnessed a growth of 40.7% compared with that in 2014 when it had exported 0.14 million tons. All the other leading countries saw a dip in the exports in 2015. France had the largest decline of 32.8%, while Italy witnessed a decline of 20.6% in its export quantity (Chart 106).

Chart 106: Leading Rubber Scrap Exporters (2015)



Source: Trademap

5.5. GCC Rubber Recovery Market Overview

5.5.1. Market Overview

On an average, vehicle tires in the GCC region have a lifetime of two years after which they need to be replaced. This is mainly due to cars running at high speed and because of hot climatic conditions that result in wear and tear of tires. In addition, ELV also generate a significant amount of ELTs in the region. The replacement tires and vehicle scrap generate millions of ELTs that are dumped in the landfills and remain untreated. This traditional method of waste tires management has resulted in stockpiling or illegal dumping, thus posing significant environmental challenges.

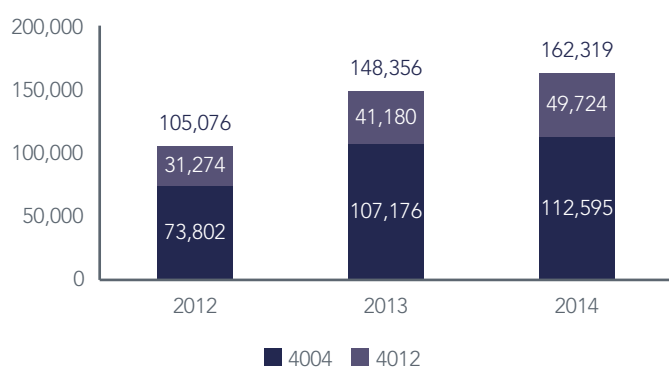
Tire recycling in the GCC region has gained momentum in the past decade with the initiation of large number of environmental programs sponsored by the government. In addition, the landfills allocated for dumping ELT have reached their capacity and have been closed from further dumping. In Kuwait, of the 16 landfill locations, only three are active for dumping while the remaining 13 have reached their capacity. In 2015¹⁵⁴, Ministry of Commerce and Industry Kuwait had made a plan to relocate the six recycling plants operating in Kuwait near the new tire collection location in Naayem and have allocated them two-million square meters site.

Oman presents a perfect example of this initiative; it is going to set up its first tire recycling plant in 2017, in partnership with Be'ah, which is the country's leading waste management company. As per estimates, the ELT stockpile in Oman is 110,000 tons with an annual ELT generation of 40,000 tons. The recycling facility is estimated to have a capacity to process 30,000 to-40,000 tons per year¹⁵⁵.

In the UAE, Bee'ah is one of the leading waste management companies and recycles about 9,000 tires on a daily basis. Other recycling companies are also being set-up in Sharjah and Abu Dhabi to recycle ELT waste.

Rubber scrap trade was done under HS Code: 4004 and 4012. Under 4004, the export¹⁵⁶ increased from 73,802 tons in 2012 to 112,595 tons in 2014, registering a CAGR of 23.5% (Chart 107).

Chart 107: GCC Rubber Scrap Export, 2012-2014 (Tons)



Source: Trademap

¹⁵⁴ "Municipality approves new tire recycling site", Kuwaittimes.net

The UAE was the leading exporter among the GCC member countries and accounted for 60.38% (67,993 tons) of exports. It exported 74.7% (50,803 tons) of rubber scrap under HS code 4004 to Pakistan and 17.7% (12,058 tons) to India (Chart 108).

Under HS Code 4012, exports increased from 31,274 tons in 2012 to 39,950 tons in 2014. In all the years, UAE was the major exporter in this category. However, 96% of the exports made by UAE in these years were the re-exports (Chart 108).

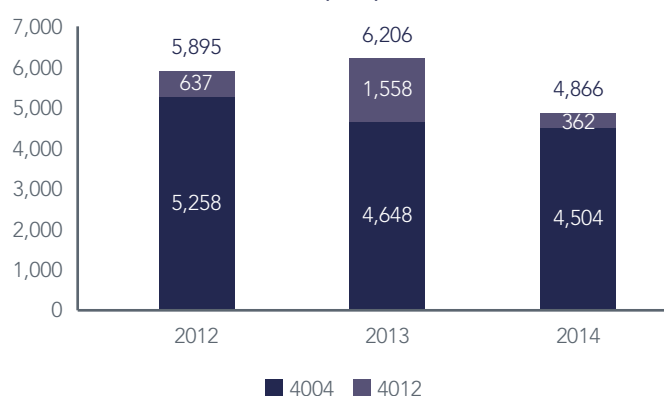
Chart 108: UAE Rubber Scrap Export under HS Code 4012, 2012-2015 (tons)



Source: Trademap

Imports¹⁵⁷ under HS Code 4004 were miniscule and witnessed a decline of 7.4% during 2012 and 2014. In 2014, 4,504 tons of rubber scrap was imported by the UAE accounting for 47.4% (2,137 tons) of the total imports in the GCC region. Saudi Arabia was ranked second with 29.2% (1,315 tons) of the GCC imports (Chart 109).

Chart 109: GCC Rubber Scrap Import, 2012-2014 (Tons)



Source: Trademap

Under HS Code 4012, imports decreased from 637 tons in 2012 to 362 tons in 2014. UAE accounted for over majority of the imports across all years followed by Qatar.

¹⁵⁵ Legal framework for massive tire recycling industry likely, omanobserver.com

^{156, 157} Trademap

5.5.2. Leading Companies in the GCC Market

Some of the leading companies operating in the tire recycling market in GCC region include:

Table 17: Rubber Recovery Companies in the GCC Market

Company	Year of Establishment	Country	Activity	Annual Capacity
Bee'ah	2007	UAE	• Recovery	3,285,000 Tires
Gulf Rubber Factory	2011	UAE	• Recovery • Recycling	43,800 Tons
Ceres Associates	2007	UAE	• Recovery	NA
Sharjah National Crumb Rubber Industries	2004	UAE	• Recovery	15,000 Tons
Tire Recycling Company	NA	Saudi Arabia	• Recovery	NA
Nabaa Al Wessal	2014	Saudi Arabia	• Recovery	25,000 Tons
Seder Environment Tyre Recycling Division	2011	Saudi Arabia	• Recovery	NA
Kuwait National Tire Recycling Company	2012	Kuwait	• Recovery	12,000 Tons
Green Rubber Tire Recycling Plant	2013	Kuwait	• Recovery • Recycling	6,000 Tons

Please note that Oman is setting up its first tire recovery facility and it will be operational in 2017. The installed capacity of the plant is 30,000 to 40,000 tons annually (described in GCC market overview section)

5.6. Qatar Rubber Recovery Market Overview

5.6.1. Historical and Current Waste Generation

The recovery of rubber is done primarily through the shredding of ELTs, major consumer of rubber (globally 65%). During 2010, 1.03 million tires were replaced and the quantity increased to 1.45 million tires in 2015¹⁵⁸. In 2016, 1.55 million tires are estimated to be replaced. The average weight of the ELT is estimated to be 18.82kg (Chart 110).

Chart 110: Number of Tire Scrap Generated In Qatar, 2010-2016E (Million Tires)



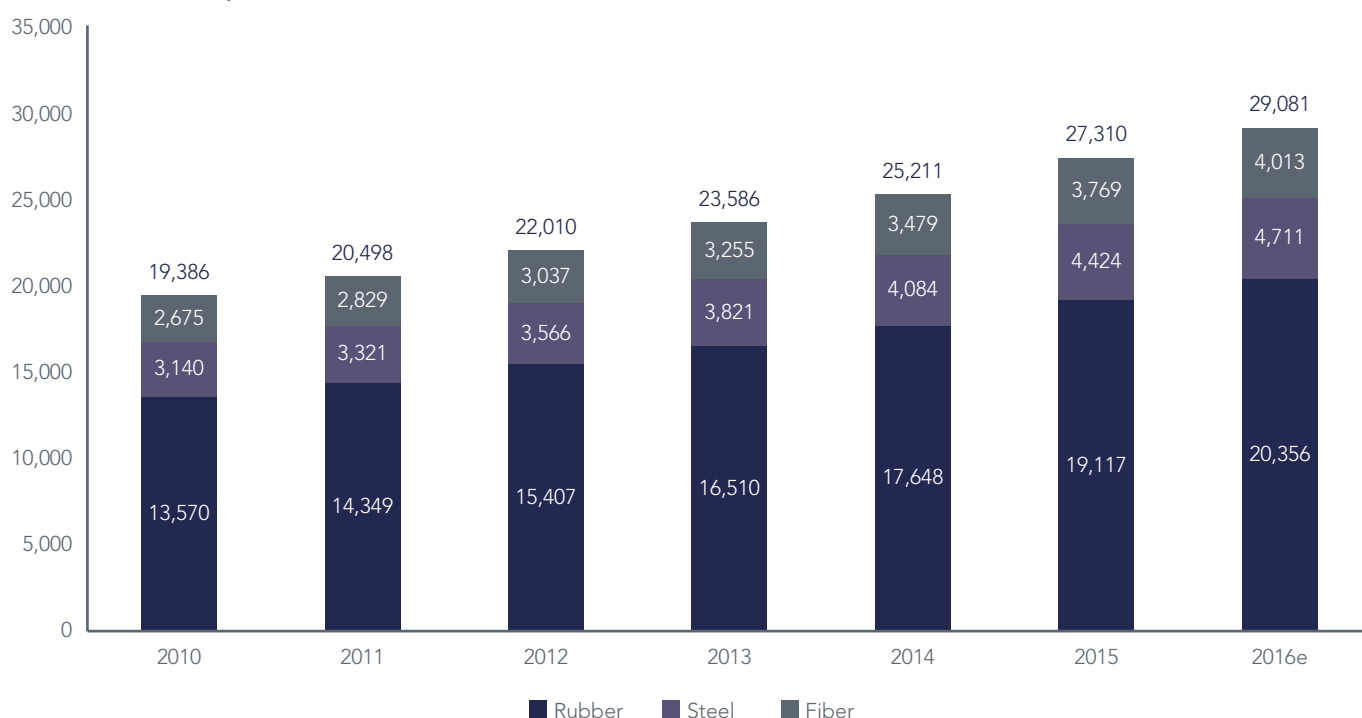
Source: MDPS Environment Statistics 2014, Team analysis

¹⁵⁸ MDPS Environment Statistics 2014, Team analysis

Based on the primary interviews, it is estimated that seven million tires are stockpiled in Umm-Al-Afai landfill which has now been closed. Tires are now being dumped in Rawdat Rasheed landfill.

Tire shredding generates on an average 70% rubber, 16.2% steel and 13.8% fiber¹⁵⁹. During 2010, approximately 19,386 tons of tire scrap was generated and increased to 27,310 tons in 2015, witnessing a CAGR of 7.1%. In 2016, based on the estimates, approximately 29,081 tons of scrap tires would be generated (Chart 111).

Chart 111: Tire Scrap Generated in Qatar by Material, 2010-2016E (Tons)



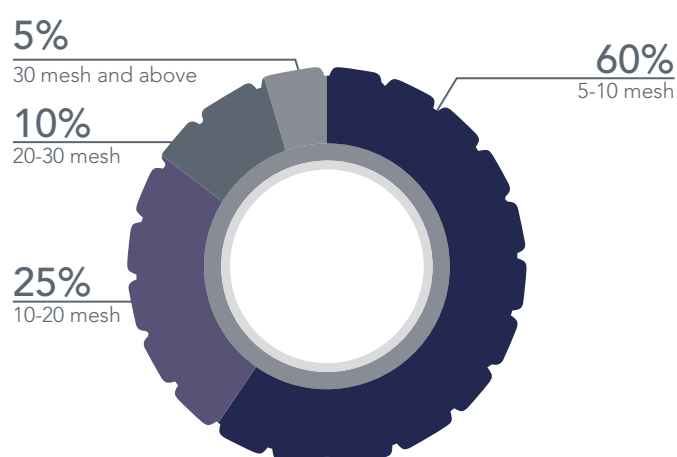
Source: MDPS Environment Statistics 2014, Team analysis

5.6.2. Market Size Segmentation by Product Segments

In Qatar, rubber is recovered only through ELT while other types of rubber scrap are landfilled.

Based on primary interviews with leading tire recovery facilities, it is estimated that rubber is recovered in different sizes. The size of 5 to 10 mesh crumb rubber accounts for 60%, while 10 to 20 mesh account for 25%. Crumb rubber of sizes over 20 mesh account for a cumulative market of 15% (Chart 112).

Chart 112: Crumb Rubber Segmentation in Qatar, By Size (2015)



Source: Primary research

¹⁵⁹ Primary Research Team analysis

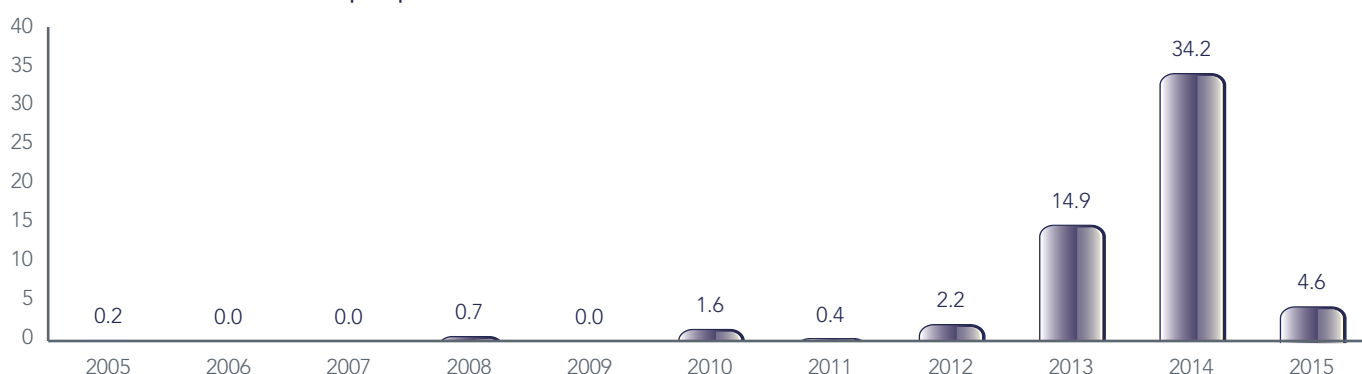
5.6.3. Analysis of Exports and Imports

HS Code 4004 and 401220 represent the trade of cut tires and crumb rubber. The export and import for these HS codes are illustrated below:

Exports¹⁶⁰: The exports of cut rubber tires and crumb rubber under 4004 were miniscule until 2011. The country exported a total of 2,831 tons between 2005 and 2011, with the maximum quantity exported in 2010 (1,595 tons). During this phase, ELTs were disposed off in Umm Al-Afai landfill. However, due to scarcity of space, this landfill was closed and tires are now disposed in Rawdat Rashid landfill and in DSWMC.

With initiatives from the government to resolve the challenge of improper tire disposal, licenses were provided to rubber-recycling companies, post 2011 and thus, the country saw an increased recovery and management of rubber scrap. Between 2012 and 2014, cut rubber tires and crumb rubber exports witnessed an exponential increase from 2,192 tons to 34,177 tons. However, with the weakening of the international oil market and slowdown in the GCC market, the rubber scrap exports dropped to 4,649 tons in 2015 (Chart 113).

Chart 113: Qatar's Rubber Scrap Export (HS Code 4004), 2005-2015 ('000 tons)



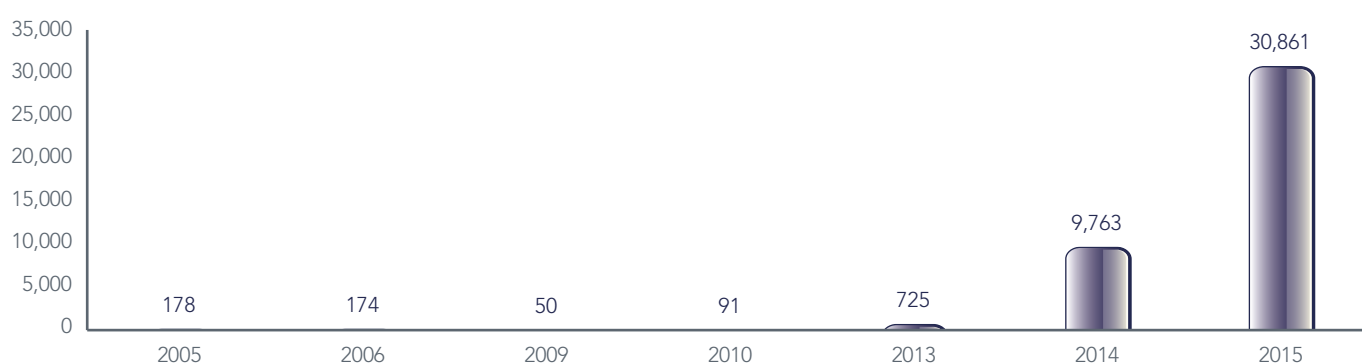
Source: Trademap

At the eight-digit level, trade during 2005–15 was done only under 40040000 (waste, parings, scrap of rubber and powders and granules obtained) except for 2014, when HS Code 40049999 (defined as confidential) registered 76.7% (26,238 tons) of exports.

Pakistan, India and the UAE were the leading importers of rubber from Qatar. In 2014 and 2015, Qatar exported 33,408 tons (97.7%) and 3,892 tons (83.7%) of rubber scrap, respectively, to these countries.

Prior to 2014, the trade of used tires (cut into pieces) (HS Code: 401220) from Qatar was miniscule due to lack of recovery facilities in Qatar. In 2014, 9,763 tons of tires were exported while in 2015, the quantity witnessed an exponential increase to 30,861 tons (Chart 114).

Chart 114: Qatar's Used Tires Export (HS Code 401220), 2005-2015 (Tons)



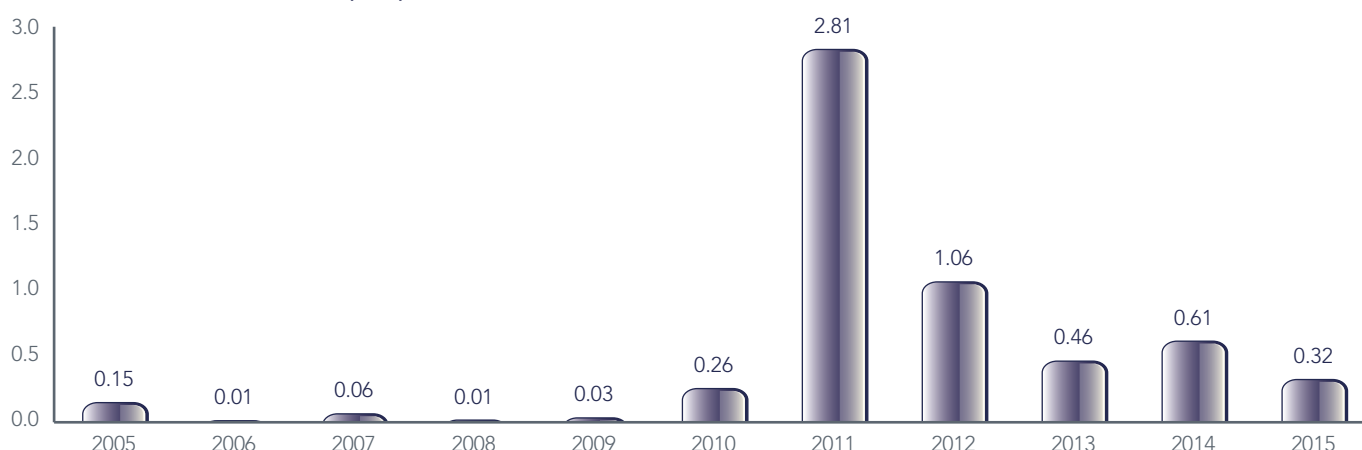
Source: Trademap

¹⁶⁰ Trademap

In 2015, Pakistan (18,326 tons), UAE (7,088 tons) and India (5,274 tons) were the leading importers of pneumatic tires from Qatar.

Imports¹⁶¹: Under HS Code; 4004; Qatar imported a total of 5,805 tons of rubber scrap and granules in a duration of 10 years i.e., between 2005 and 2015. In 2011 and 2012, import volumes registered were 2,814 tons and 1,063 tons, respectively, thus both the years, combined accounting for of 66.7% (3,877 tons) of the total imports (Chart 115).

Chart 115: Qatar's Rubber Scrap Import (HS Code 4004), 2005-2015 ('000 tons)



Source: Trademap

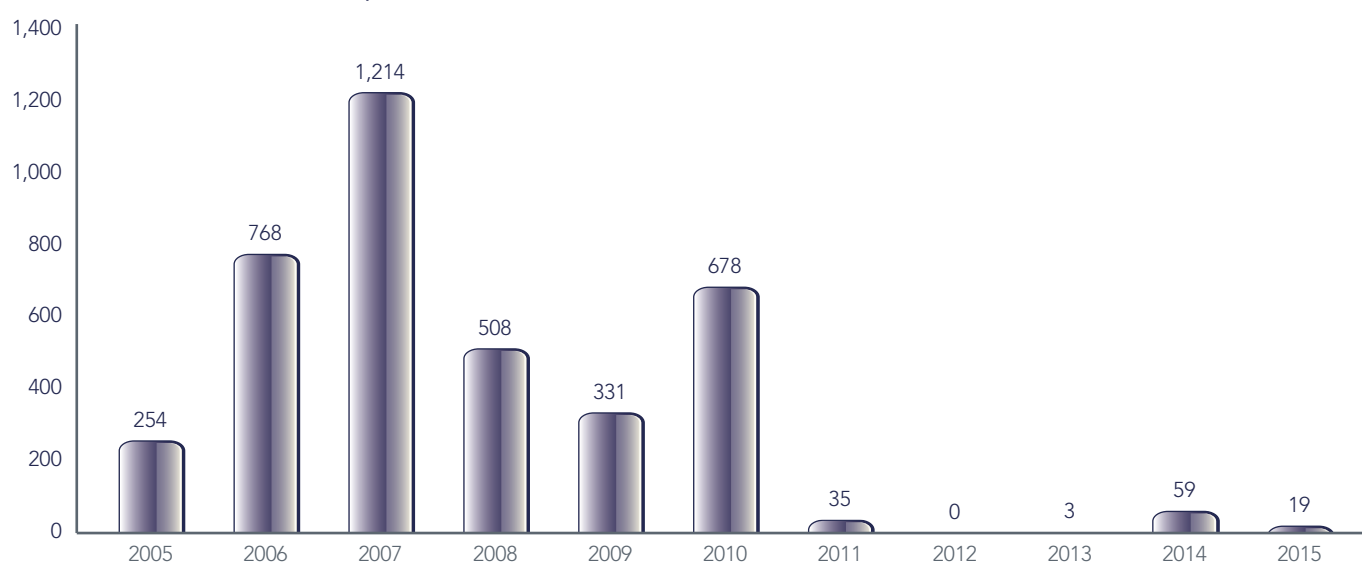
For the interval between 2005 and 2010, imports were miniscule and summed up to 528 tons. In the preceding three years i.e., 2013–15, the imports witnessed annual fluctuations. Imports in 2013 were 463 tons that increased to 615 tons in 2014, and later witnessed a decline in 2015 with 323 tons.

The Netherlands and Germany have almost 100% recovery rate for tires and were the leading exporters of rubber scrap and granules to Qatar in 2015.

Used tires (HS Code: 401220) were imported to Qatar until 2010. Post 2010, the imports have been miniscule.

Imports between 2005 and 2010 were primarily from China, Japan, India and Turkey (Chart 116).

Chart 116: Qatar's Used Tires Import (HS Code 401220), 2005-2015 (Tons)



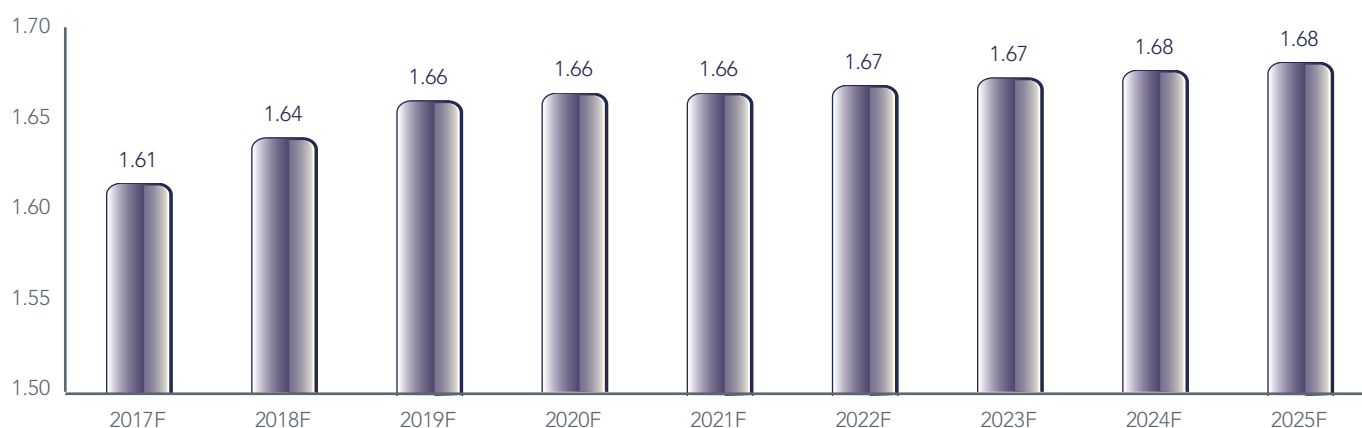
Source: Trademap

¹⁶¹ Trademap

5.6.4. Waste Generation Forecast

The amount of scrap tires expected to be generated during 2017–25 is estimated based on the tire replacement and number of vehicle registered. It is assumed that tires are replaced after every three years and average weight of a scrap tire is assumed to be 18.82kg. It is estimated that number of scrap tires generated annually would increase from 1.55 million in 2016 to reach 1.61 million in 2017 and 1.68 million in 2025 (Chart 117).

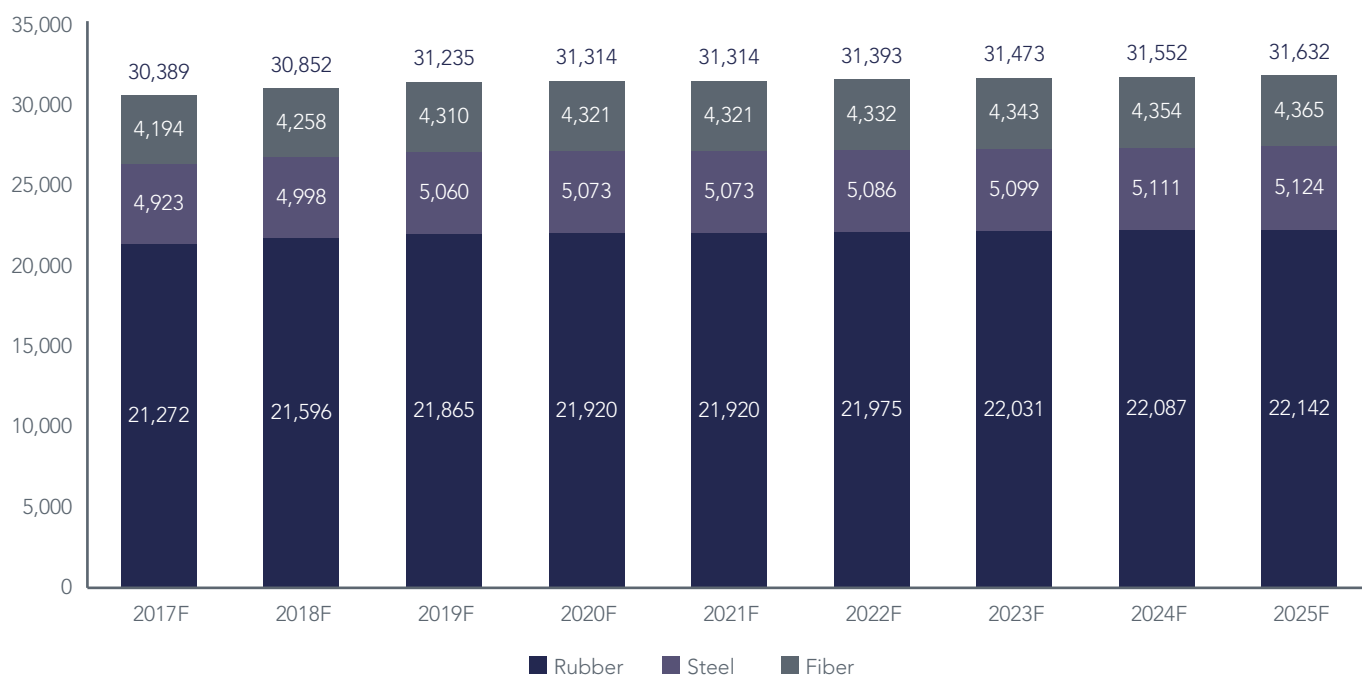
Chart 117: Number of Scrap Tire Generation in Qatar, 2017F-2025F (Million Tires)



Source: MDPS Environment Statistics 2014, Team analysis

Based on the assumptions, it is estimated that the volume of scrap tires would increase from 29,081 tons in 2016 to reach 30,389 tons in 2017 and 31,632 tons in 2025, witnessing a CAGR of 0.5% during 2017–25 (Chart 118).

Chart 118: Tire Scrap Generation in Qatar by Material, 2017F-2025F (Tons)



Source: MDPS Environment Statistics 2014, Team analysis

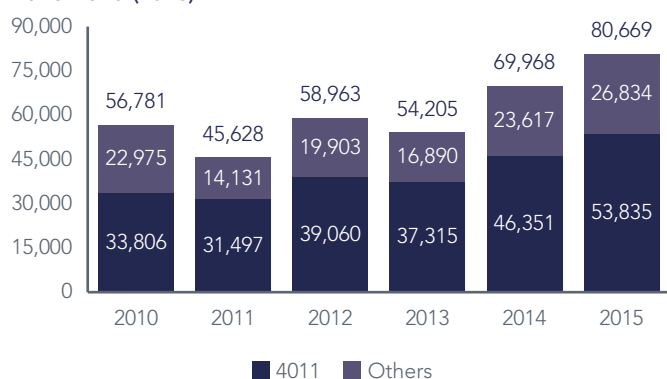
5.6.5. Demand for Recovered Material

Local production: Qatar does not have any rubber production and hence, the requirement is met through imports. As described in the earlier sections, 65% of the rubber is consumed for tire production and since, there are no tire manufacturing companies in Qatar, the demand for tires is fulfilled through imports.

Companies such as Qatar Rubber Industries Co, Shift Rubber Company, Qatar German Gasket Company etc. import raw materials and produce the GRG products domestically.

Imports: Import of rubber and rubber products (HS Code: 40 except for HS Code: 4004 and 4012) increased from 58,791 tons in 2010 to reach 82,684 tons in 2015 (Chart 119).

Chart 119: Qatar's Rubber and Rubber Product Import, 2010-2015 (Tons)



Source: Trademap

Almost 65.1% (53,835 tons) of the imports were done under HS Code: 4011 i.e. new pneumatic tires of rubber. China (31,258 tons), Japan (8,294 tons) and India (3,007 tons) were the leading importers with a combined share of 79.1% (42,559 tons) in the import of tires.

Exports: Export of rubber and rubber products (HS Code: 40 except for HS Code: 4004 and 4012) increased from 1,207 tons in 2010 to reach 2,050 tons in 2015.

Replacement Opportunity for Crumb Rubber:

Most of the rubber and rubber products as stated above are imported in the country. In 2015, Qatar imported 461 tons of reclaimed rubber (HS Code: 4003) and 4,976 tons of natural and synthetic rubber (HS Code: 4001 and 4002) in their primary forms.

Apart from the imports, Al-Hodaifi is the only company that recovers around 3,800 tons of crumb rubber and achieves 40% (approximately 1,500 tons) of sales through the domestic customers while 60% of the crumb rubber is exported¹⁶².

¹⁶² Primary research

¹⁶³ GOIC Database

¹⁶⁴ Company website

¹⁶⁵ "Al khaliqi financed recycling plant now operational", qatarisbooming.com

Going by the current demand-supply scenario, there is a gap of approximately 5,437 tons that can be replaced by tire recovery facilities. Currently, there are four to five tire recovery facilities, apart from many tire recovery facilities which only cut and export rubber tires from Qatar. In addition, there are many upcoming facilities that are expected to start operations in 2017 or 2018.

This may intensify the competition in the domestic market for tire recovery and supply of crumb rubber. However, there is an export opportunity to supply crumb rubber to the tire manufacturing countries such as Japan, USA etc.

5.6.6. Assessment of Supply Landscape

Owing to many challenges, such as high rate of used tire scrap generation, scarcity of space in the landfills and environmental concerns over improper dumping, the government has encouraged rubber recovery in the country since 2011. Currently, there are four recovery facilities in Qatar that convert scrap tires into crumb rubber while there are small traders that cut and export tires. There are many upcoming recovery facilities¹⁶³ that will start their operations later in 2017 or starting of 2018.

1. Al-Hodaifi recycling¹⁶⁴ is a member company of Al-Hodaifi Group and was started in 2011. The company has a land area of 20,000sqm and employs 15 people. Al-Hodaifi utilizes KAHL technology, and currently operates the largest and most technologically advanced tire recycling facility in Qatar. The facility has an annual installed capacity of 7,200 tons with the utilization rate of 80% to 90%. The facility collect tires from the Umm Al-Afai landfill and recovers them to produce rubber granules of varying sizes that are sold to domestic and international recycling companies.
2. Modern Recycling is built over a capital cost of QAR150.06 million¹⁶⁵ and has a land area of 20,000sqm. The equipment has been installed in the factory and are waiting for approvals from KAHRAMAA to commence operations. The facility has an annual installed capacity of around 10,000 tons¹⁶⁶, which would be achieved through its three production lines, each with a capacity to recover 2 tons per hour.
3. Seashore Tire Recycling prior to closing its operations in 2012 had a processing capacity of 200 tires¹⁶⁷ per day i.e., almost 60,000 tires annually. Based on the primary interviews, the company is planning to re-start its operations by the end of 2016.
4. Qatar Recycling, a member of AlAkeed Group, sources waste materials, such as tires or rubber mats, and recovers them into useable crumb, and powders rubber raw materials that are sold to recycling companies¹⁶⁸.

¹⁶⁶ GOIC Database

¹⁶⁷ "QGBC calls for effective utilization of recycled materials in construction", qatarisbooming.com

¹⁶⁸ Company website

Apart from the recovery facilities, there are companies involved in the trading of used tires scrap.

5. Al Mejhar Trading & Contracting¹⁶⁹ entered into tire recovery business in 2015. Their operations include collection of tires from landfills, cutting into pieces and exporting it to Pakistan and India, via export agents. They do not export directly as high shipping prices do not benefit them financially. The facility is planning to import shredding machine from China, which would be used to cut tires in sizes of 5–10cm before exporting them.

Some other trading companies operating in Qatar include Doha al Jazeera for trading and contracting¹⁷⁰, Bittar plus trading¹⁷¹ and Bin jaber for tires trading¹⁷².

However, based on current capacity, if all the recovery facilities would operate at 100% utilization, the number of tires required per annum would be approximately 1.2 million ELTs. The generation of ELTs is expected to be 1.61 million in 2017 and this number is expected to reach 1.68 million in 2025. Thus, there will be an addition of 0.4 to 0.45 million ELTs every year to the already existing stockpile in Qatar. This illustrates that there is sufficient availability of raw material in the next 10 years. However, the raw material availability will have to be re-assessed based on the capacities of the upcoming facilities.

5.6.7. Pricing Analysis

As per the trade data under HS Code 4004, the average export prices of rubber scrap and granules varied from QAR331 per ton in 2008 to QAR230 per ton in 2014. Please note that the prices for 2006 and 2007 are not represented, as there were no exports in the corresponding years.

Although the export prices per ton¹⁷³ in 2005 and 2009 were higher compared with that in other years, the export quantity corresponding to them was very low. Qatar exported only 166 tons and 46 tons in 2005 and 2009, respectively (Chart 120).

Chart 120: Qatar's Rubber Scrap Export Price (HS Code: 4004), 2005-2015 (QAR/ton)



Source: Trademap, Team analysis

¹⁶⁹, ¹⁷⁰, ¹⁷¹, ¹⁷² Recycle in ME, Database, recycleinme.com

¹⁷³ Trademap

Between 2010 and 2012, the market witnessed a periodic rise in prices per ton from QAR404 to QAR545 before the prices declined to QAR265 in 2013 and QAR230 in 2014. The export prices per ton in 2015 saw a double-fold increase over 2014 and was reported to be QAR728 per ton.

However, based on the primary interviews, the market prices vary a lot from the export prices. As per industry experts, prices for rubber scrap and granules vary with sizes. The larger pieces of rubber are priced lower, while rubber granules are priced at a higher level. Mostly, rubber granules are produced in sizes of 5 mesh, 16 mesh and 30 mesh that are sold in Qatar and exported overseas. Current market prices¹⁷⁴ for these granules are QAR1,000, QAR1,050 and QAR1,100 per ton, respectively.

For used pneumatic tires (HS Code 401220), export prices have declined from QAR382 per ton in 2013 to QAR186 per ton in 2015. This was mainly due to the increased number of recovery facilities in Qatar.

5.6.8. Analysis Of Business Model and Presence/ Absence of Key Synergies

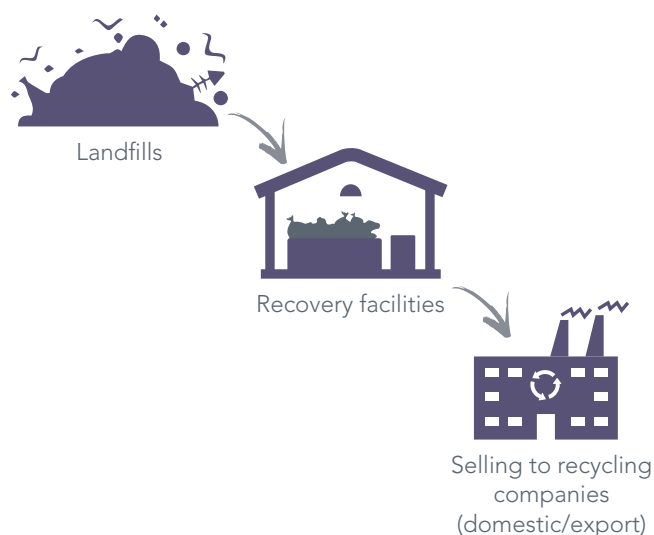
There are two models under which tire scrap recovery is done in Qatar. These are:

Business Model 1: Recovery of Scrap Tire

- Sourcing from Landfills: Rubber Recovery companies collect used tires from landfills after getting their license from the government. They recover the crumb rubber following the complete tire recovery process and sell it to recycling facilities.

Example: Al-Hodaifi recycling, Modern Recycling, Seashore Tire Recycling.

Figure 20: Business Model 1: Recovery of Scrap Tire



¹⁷⁴ Primary interviews & Team analysis

Business Model 2: Trading of Scrap Tire

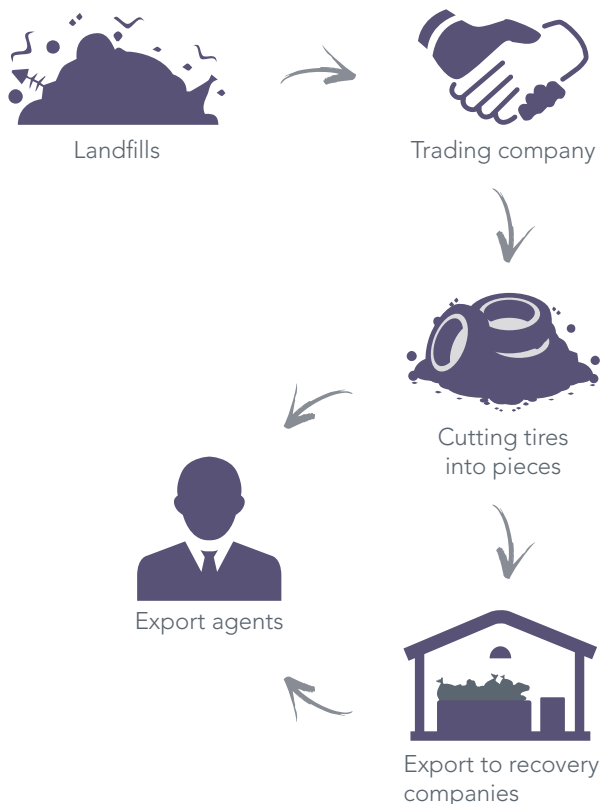
- Sourcing from Landfills: Trading companies collect used tires from landfills after getting license from the government. They cut the tires into pieces and pack it in containers.
- Trading: Trading of scrap tire via two ways:
 - i. Directly by the trading company to international clients.
 - ii. Through export agents, who collect from the trading companies and export without any value addition.

Example: Al Mejhar Trading & Contracting trade through export agents while Doha Aljazeera for Trading and Contracting export directly to the end clients.

However, this business model is not feasible for domestic trade as the government is providing recovery companies the licenses to collect the used tires from landfills without any charges.

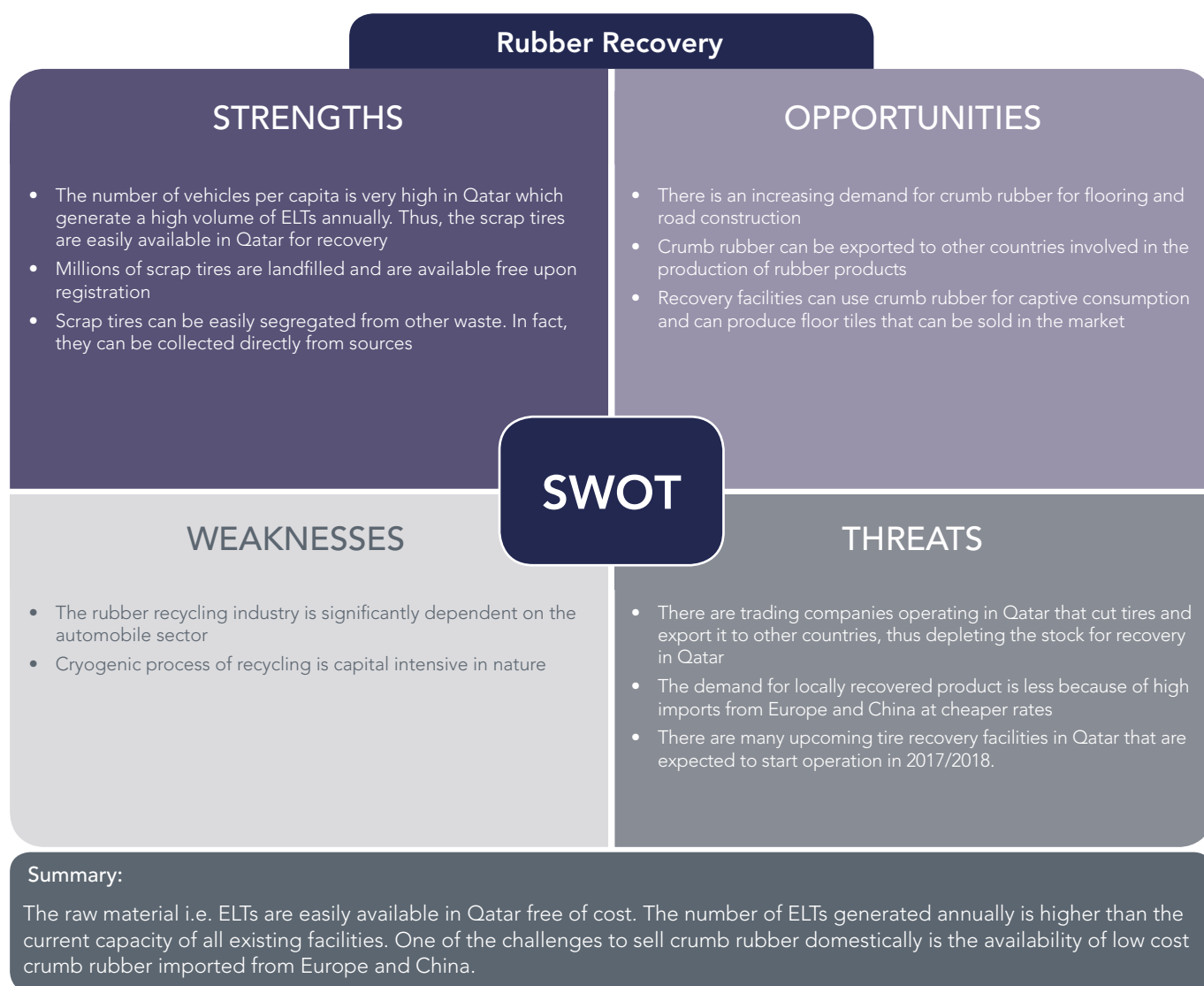


Figure 21: Business Model 2: Trade of Scrap Tire



5.6.9. SWOT Analysis

Figure 22: SWOT Analysis – Rubber Recovery

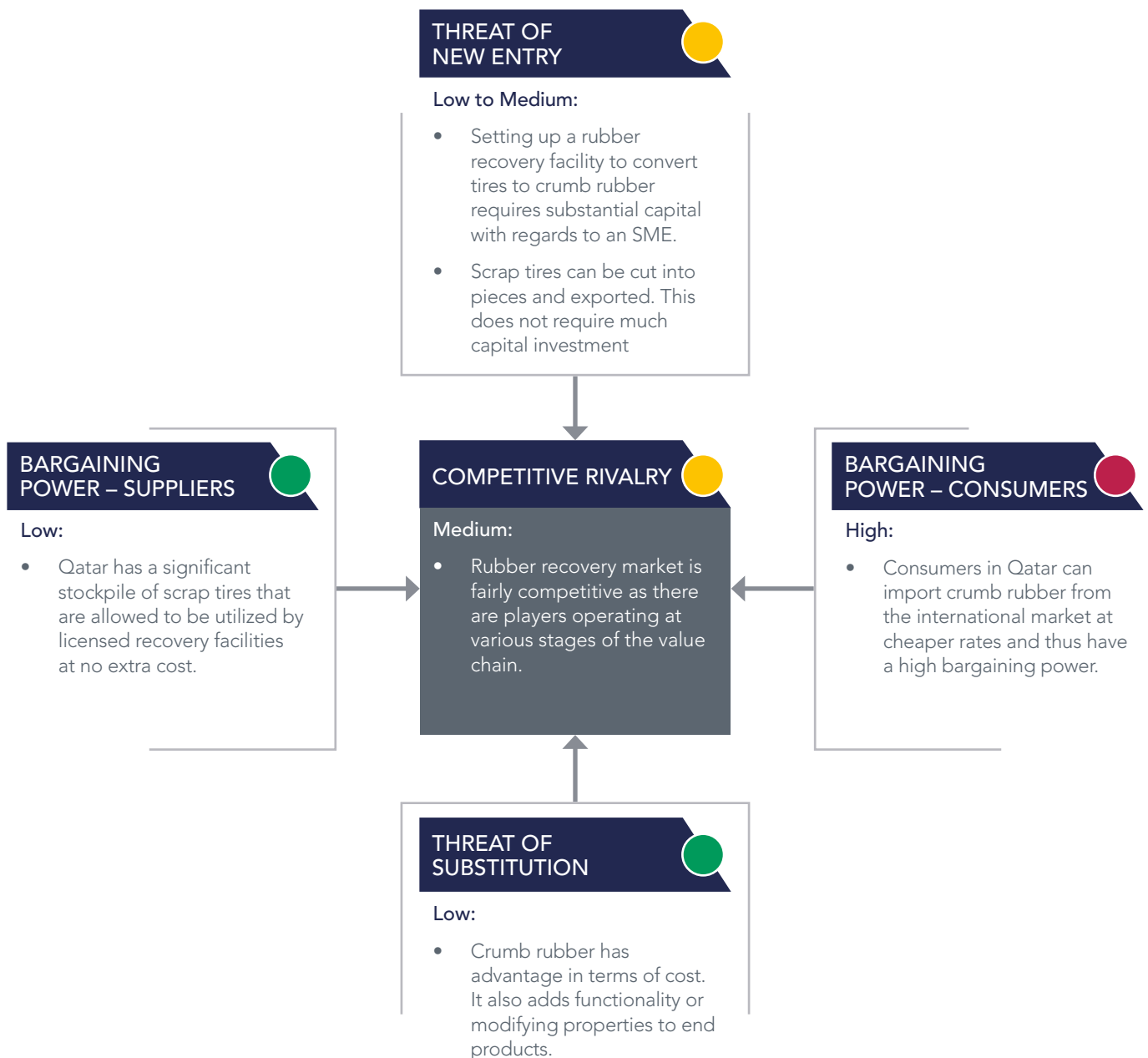


5.6.10. Regulations

- Scrap tires cannot be exported and imported until and unless they are cut into pieces.
- There are designated landfills for dumping scrap tires, and tires dumped elsewhere are deemed illegal.
- Tire recycling plants can only be established in Umm-Al-Afai or Mesaieed region.
- A company needs to register with the government to get the permission for picking up tire scrap.

5.6.11. Michael Porter's Five Forces Model

Figure 23: Michael Porter's Five Forces Model - Rubber



5.6.12. Key Takeaways and Potential Opportunities

- Major source of rubber scrap in Qatar is through ELTs.
- Prior to 2011, there were no rubber recovery facilities in Qatar and thus, ELTs were dumped in the Umm-Al-Afai landfill. Currently, it is estimated that there is a stockpile of 7 million tires in the landfill.
- In 2016, it is estimated that around 29,081 tons of tire scrap will be generated in Qatar and will grow to 31,632 tons in 2025. Rubber content in this scrap is 70% while steel accounts for 16.2%.
- Qatar's export of used tires have witnessed an exponential increase post 2013, majorly because of establishment of tire recovery facilities in Qatar.
- ELTs are available to the tire recovery facilities at no cost. These facilities just require license from the government for access to the landfill.
- Crumb rubber is sold by the recovery facilities depending on the size of the crumbs. The prices vary from QAR1,000 to QAR1,100 per ton.
- Downstream requirements of rubber is mainly in the form of tires and in absence of any tire manufacturing facility in Qatar, the demand for crumb rubber arises from GRG products only.
- There are four to five recovery facilities in Qatar that convert ELTs into crumb rubber while many new licenses have already been approved by the government.
 - Qatar uses rubber for the manufacture of GRG products such as speed breakers, gaskets etc. and the raw and reclaimed rubber for these purposes is imported or sourced from domestic recovery companies.
 - Going by the current market conditions, there is limited demand for recovered products in the domestic market. However, there is export opportunity for crumb rubber to the tire manufacturing countries such as Japan, USA etc.
- The number of ELTs generated annually is higher than the current capacity of all existing facilities. Based on current capacity of recovery facilities and ELTs generated in Qatar, there will be an addition of 0.4 to 0.45 million ELTs every year to the already existing stockpile in Qatar.
 - This illustrates that there is sufficient availability of raw material in the next 10 years. However, the raw material availability will have to be re-assessed based on the capacities of the upcoming facilities.



6. E-WASTE AND BATTERY

6.1. Overview of E-waste and Battery Scrap

6.1.1. Description

E-waste: E-waste as a waste stream, has grown exponentially over the years, owing to factors such as advancement in technology, affordable prices of the gadgets across the globe and short product life span. However, recovery and recycling of e-waste is still in a nascent stage and thus managing e-waste has posed alarming challenges for both developed and developing countries.

E-waste includes all the electrical and electronic equipment (EEE) items as well as their parts which are discarded without the intent of reuse.

E-waste consist of many different substances such as ferrous (50%), non-ferrous metals (13%), plastic (21%), glass, wood, printed circuit boards, rubber and other items¹⁷⁵.

Battery Recovery: Batteries are the most generally used source of power. Batteries contain valuable earth metals such as cadmium, lead, lithium, mercury, nickel, manganese and zinc, and quite a few of these are extremely toxic. Used batteries, if not disposed of properly, can result in hazardous health and environmental conditions. Thus, it is necessary to recycle the used batteries to recover the valuable materials and reutilize them. Materials, which are recovered after recycling the batteries, include metals, acids and plastics.



¹⁷⁵ "Analysis of Existing E-Waste Practices in MENA Countries", sweep-net.org



6.1.2. Classification

E-waste: E-waste consists of all waste from electronic and electrical appliances, which have reached their end-of-life period or are no longer fit for their original intended use and are destined for recovery, recycling or disposal. They are categorized as follows:

Table 18: Categories of E-waste

Classification	Products Covered
Temperature exchange equipment/ cooling and freezing equipment	Refrigerators, freezers, air conditioners and heat pumps
Screens, monitors	Television, laptops, notebooks and tablets
Lamps	Straight and compact fluorescent lamps, high-density discharge lamps and LED lamps
Large equipment	Washing machines, clothes dryers, dish washing machines, electric stoves, large printing machines, copying equipment and photovoltaic panels
Small equipment	Vacuum cleaners, microwaves, ventilation equipment, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, medical devices, monitoring and control instruments
Small IT and telecommunication equipment	Mobile phones, GPS, pocket calculators, routers, personal computers, printers and telephones

Battery Recovery¹⁷⁶: Batteries based on their chemistry are divided as:

Table 19: Classification of Battery (Based On Chemical Composition)

Battery Chemistry	Use
Alkaline manganese (AlMn) and zinc carbon (ZnC)	Clocks, portable audio and devices, torches, toys and cameras
Lithium (Li)	Photographic equipment, remote controls and electronics
Button cells (zinc air, silver oxide, manganese oxide and lithium)	Watches, hearing aids, calculators
Nickel Cadmium (NiCd)	Cordless phones, power tools and emergency lighting
Nickel Metal Hydride (NiMH)	Cellular and cordless phones
Lithium Ion (Li-ion)	Cellular phones, laptops and palms
Lead acid	Automotive/motorcycle starter, lighting and ignition (SLI)
Lead acid standby	Alarm systems, emergency back-up systems, e.g. rail and telecommunications applications
Nickel Cadmium (NiCd) standby	Motive and standby applications, e.g. Satellite and rail applications, Electric and hybrid vehicles

¹⁷⁶ "Impact assessment on selected policy options for revision of the battery directive", ec.europa.eu

In the global consumption of batteries, lead acid batteries comprises 60% of the overall market by revenue, while other batteries account for the remaining 40% market share¹⁷⁷.

Among all types of batteries, Lead acid battery is the largest recycled products globally, while in the case of other battery chemistries, the recycling rate is comparatively very low. This is primarily because:

- i. Recycling of other battery types is not as economical as lead acid batteries¹⁷⁸.
- ii. The collection process for other batteries is not streamlined and generally the batteries get mixed with municipal waste.
- iii. Lithium-ion batteries used in mobile phones and laptops are not removed and get dumped or exported along with e-waste.
- iv. The average lithium cost associated with Li-ion battery production is less than 3% of the production cost. Intrinsic value for the Li-ion recycling business currently comes from the valuable metals, such as cobalt and nickel, which are priced more than lithium. Due to the less demand and low prices of lithium, almost none of the lithium used in consumer batteries is completely recycled¹⁷⁹.

Taking the above-mentioned points into consideration, the report henceforth would cover only lead-acid batteries.

6.1.3. Benefits of E-waste and Battery Recovery

E-waste: Electronic products are made from valuable resources, such as precious, non-ferrous, ferrous metals, plastic and glass, all of which require energy to mine and manufacture. Recycling and reusing these materials from end-of-life electronics conserve natural resources and avoid air and water pollution, and greenhouse gas (GHG) emissions. For example:

Recycling one ton of steel saves 1,100kg of iron ore, 630kg of coal, and 55kg of limestone.



Recycling circuit boards can be more valuable than mining for ore. One ton of circuit boards is estimated to contain 40-800 times more gold than one metric ton of ore¹⁸⁰.



Plastics in e-waste can be recycled into garden furniture. Battery components can be reused in other batteries. Metals can be used in jewelry and automotive parts.



Recycling aluminum uses 95% less energy than producing aluminum using raw materials.



There is 30-40 times more copper in a ton of circuit boards that can be mined from one metric ton of ore.



For every one million cell phones that are recycled, 35,274 pounds of copper, 772 pounds of silver, and 75 pounds of gold and 33 pounds of palladium can be recovered¹⁸¹.

Battery Recovery: Recovery of lead from used batteries consumes 39% less energy when compared to extracting primary lead from its ore. It in turn leads to reduction in greenhouse gases.

Recycling batteries helps to avoid deposits of lead, acid and mercury in water streams/landfills.¹⁸²



Lead from batteries is recycled to make lead plates used in automotive batteries.



The recycled plastic is used as new plastic covers and cases of batteries.



Lead is non-renewable and thus can be recycled for indefinite number of times and has a commercial value¹⁸³.

¹⁷⁷ "Battery Recycling as a Business", batteryuniversity.com

¹⁷⁸ "How to Recycle Batteries", batteryuniversity.com

¹⁷⁹ "The Lithium Battery Recycling Challenge", waste-management-world.com

¹⁸⁰ "20 staggering e-waste facts", earthail.com

¹⁸¹ "11 facts About E-Waste", dosomething.org

¹⁸² "Battery Recycling Facts for National Recycling Month", prnewswire.com

¹⁸³ "Why Recycle Batteries", batteryrecycling.org.au

6.2. E-waste and Battery Recovery Process

E-waste: The recycling of e-waste under controlled conditions generally engages the following steps:

Figure 24: E-waste Recovery Process

A. E-waste collection

E-waste is collected through the following ways:

- Official Take-Back Systems:** In this, municipalities (curbside collection, municipal collection points), retailers (stores, super markets) and commercial pick-up services collect e-waste. Universally collected e-waste categories are large equipment, small equipment, lamps, screens, small IT and temperature exchange equipment.
- Disposal of E-waste in Mixed Residual Waste:** In this scenario, consumers directly dispose e-waste through the normal dustbins together with other types of household waste. As a consequence, disposed e-waste are then treated with regular mixed waste from households. Products generally thrown away in dustbins include small equipment, small IT equipment and lamps.



B. Manual Dismantling and Sorting

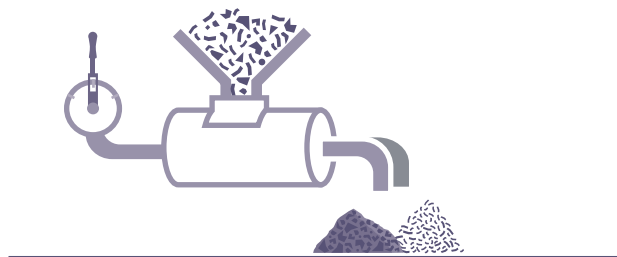
After the e-waste is collected, dismantling is carried out manually. The waste is then sorted based on its characteristics into hazardous and non-hazardous waste.

For ex: parts such as circuit boards, metals, copper, plastic, CRT glass, cables etc. that can be recovered are separated while mercury-containing components are sent to specialized mercury recovery facilities while batteries are sent for processing to recover cadmium, nickel, mercury and lead.

C. Mechanical Shredding

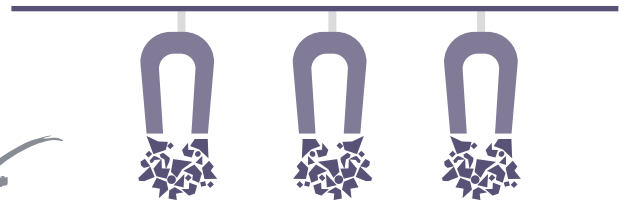
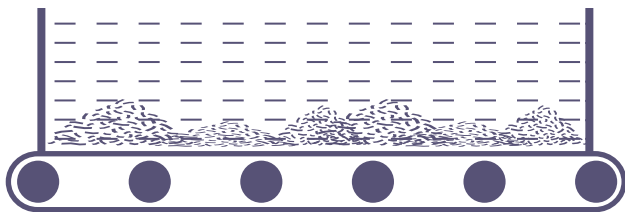
Shredding of remaining waste is done in two steps:

- First size reduction process:** Here, items that cannot be dismantled efficiently are shredded together with other dismantled parts to pieces less than 2 inch in diameter.
- Second size reduction process:** The finer e-waste particles are then spread out through an automated shaking process on a conveyor belt. The spread out e-waste pieces are then broken down further and dust particles are removed.



D. Magnetic Separation

At this step, over-band magnet is used to remove all the magnetic materials, including steel and iron from the e-waste debris.

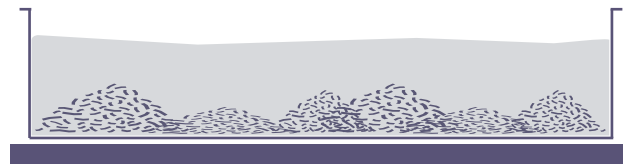


E. Separation of Non-Ferrous Metal

In this, metals and non-metallic components are separated through eddy current technology. Copper, aluminum and brass are separated from the debris to letttv e behind non-metallic materials.

F. Density Separation

Plastic and glass are separated in this step using water. The remaining waste is dumped in the landfills, while metals, non-metals, plastic, glass and circuit boards are resold in the market.



Lead-Acid Battery Recovery: Lead-acid battery comprises of lead and lead dioxide electrodes (Pb and PbO₂), plastic in form of PP (used for casing) and sulphuric acid.

Figure 25: Lead–Acid Battery Recovery Process

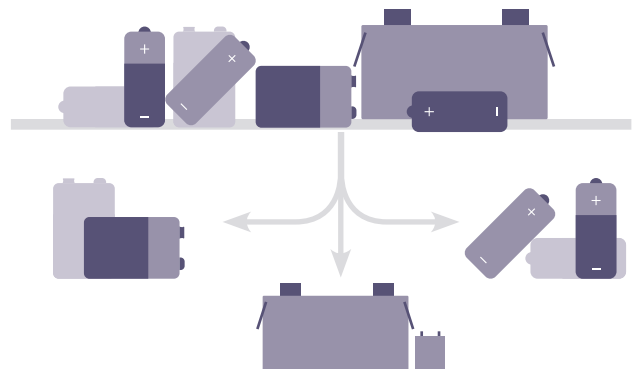
A. Collection of Batteries:

Scrap batteries are collected through automobile workshops, garages etc.

The scrap batteries that are collected are sent to the recovery facilities. In some cases, recovery facilities use a third party to transport the scrap batteries or the garages and workshops deliver it to the recovery facility.

B. Sorting of Batteries:

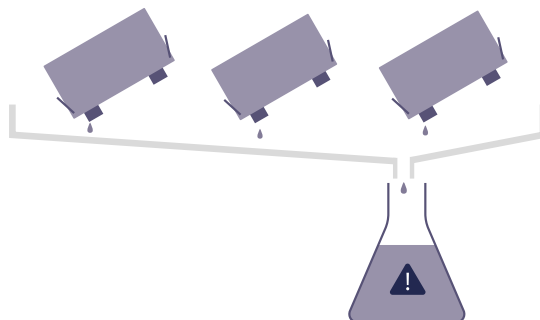
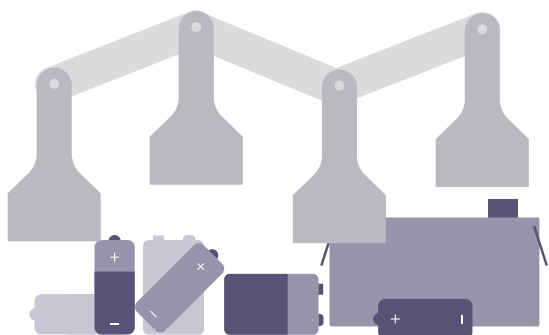
Scrap batteries are manually sorted based on their chemical composition i.e. into lead acid, nickel-cadmium, nickel-metal-hydride and Li-ion batteries and are kept in different boxes and drums.



C. Discharge of Hazardous Acid:

After sorting, the sulphuric acid contained in the lead-acid battery is drained out.

This acid waste is sent for treatment (explained in step G) and is later reused/disposed off as per the environmental guidelines.



D. Breaking Batteries:

Batteries are broken apart in a hammer mill, a machine that hammers batteries into pieces. The broken battery pieces are then placed into a container, where the lead and heavy materials fall at the bottom, while the plastic floats. At this point, the PP pieces, lead and heavy metals are separated and are sent to different recovery streams.

E. Plastic Recovery:

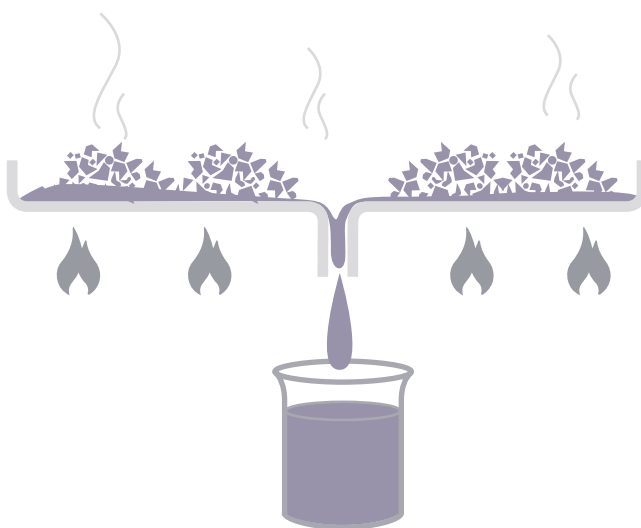
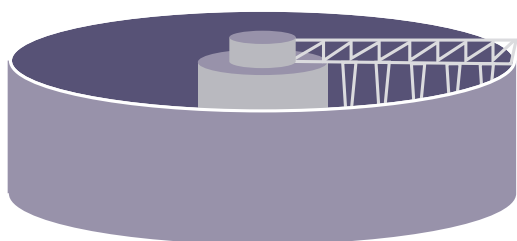
The plastic parts (PP) are washed to remove any traces of hazardous waste and are then melted to a liquid state. Post this, liquid plastic goes through the extruder where plastic pellets are produced.

These plastic pellets are reused for the manufacturing of new battery cases and are also sold to other plastic recycling companies.

F. Lead Recovery:

Lead and lead electrodes are cleaned and sent to the smelting furnaces for melting. Lead in its molten form is then poured into ingot molds and are left for few minutes. The remaining impurities float to the top and are removed while the ingots are left to cool down.

Once the lead ingots are cooled, they are removed from the molds and are sent to battery manufacturers for manufacture of recycled battery.



G. Acid Treatment:

The battery acid removed as described in step C is handled in the following ways:

- The acid is neutralized and the water is further treated and cleaned in the wastewater treatment plant so that it complies with the environmental regulations.
- The acid except for water is also converted into sodium sulphate, an odorless white powder that finds the application as laundry detergent, in glass and textile manufacturing etc.

6.3. Recovered E-waste and Battery Applications¹⁸⁴

Recovered e-waste generates plastic, metal, non-metal, plastic, wood, glass, batteries, mercury, etc., while the batteries generate lead and plastic. These products can be used across industries for the wide range of applications. Some of the applications include:

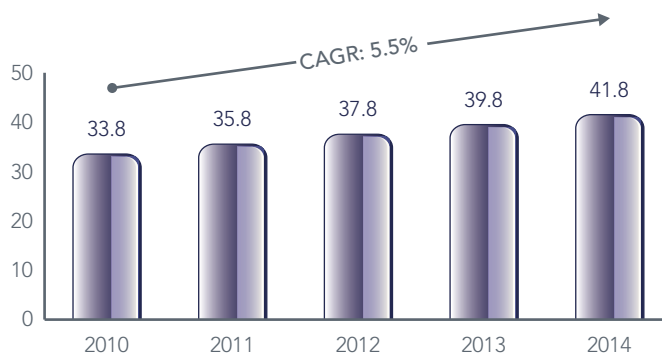
- Plastic: All plastic materials retrieved are used to manufacture items, such as fence posts, plastic sleepers, plastic trays, vineyard stakes and equipment holders or insulators among other plastic products.
- Metal: Scrap metals materials retrieved are sent to recyclers to manufacture new steel and other metallic materials.
- Glass: Lead glass extracted as a product in the recycling process can be used in manufacturing of new glass screens.
- Mercury: Mercury containing devices are sent to mercury recycling facilities that use a specialized technology to eliminate unfit devices and use mercury for dental amalgams, metric instruments and for fluorescent lighting.
- Aluminum ingots: Hard drives are shredded and processed to aluminum ingots for the use in the automotive industry.
- New battery production: Lead is reused for new battery production, which is widely used in the automobile industry.

6.4. Global E-waste and Battery Recovery Market Overview

E-waste: Rapid product innovation coupled with replacement of outdated technology, especially for information and communication, technology (ICT) products and consumer equipment, are fueling the increase of e-waste. Moreover, technological advancements have led to more and more products categorized as electrical and electronic products as they contain either a battery or plug.

The global quantity of e-waste¹⁸⁵ increased from 33.8 million tons in the year 2012 to reach 41.8 million tons in the year 2015, witnessing a CAGR of 5.5% (Chart 121).

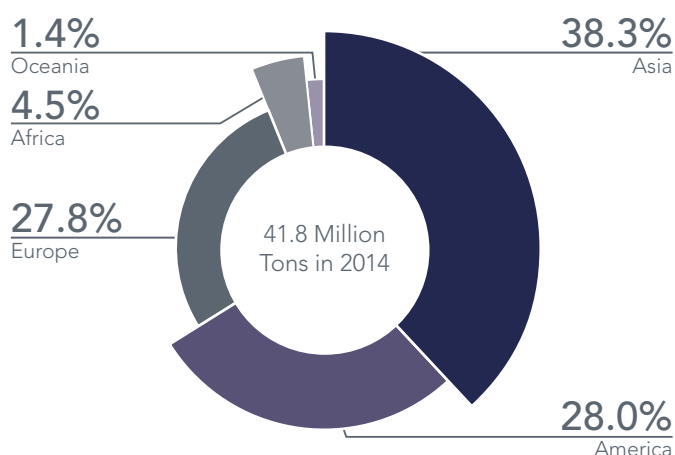
Chart 121: Global E-waste Generation, 2010-2014 (Million Tons)



Source: Global waste monitor 2014

Asia was the leading region for e-waste generation in the year 2014. It accounted for 16 million tons (38.3%) in 2014 and the leading Asian countries for e-waste generation included China (6 million tons), Japan (2.2 million tons) and India (1.7 million tons)¹⁸⁶ (Chart 122).

Chart 122: E-waste Generation, By Continent (2014)



Source: Global waste monitor 2014

¹⁸⁴ "What is E-waste Recycling", conserve-energy-future.com
^{185, 186} "The Global E-waste Monitor 2014", i.unu.edu

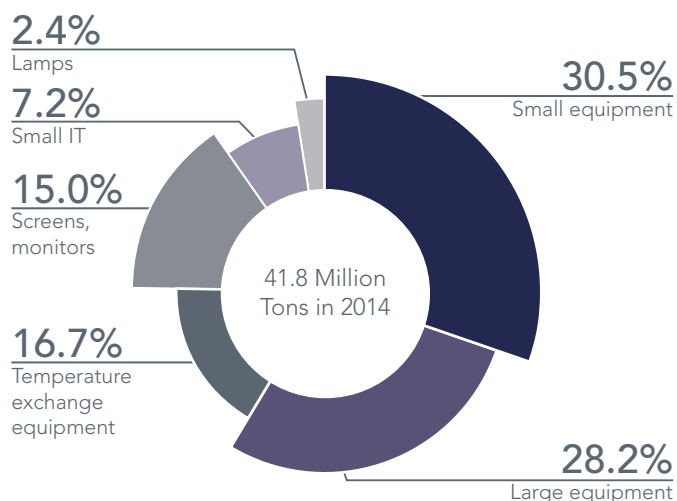
Within the American region¹⁸⁷, 11.7 million tons (28.0%) of e-waste was generated in 2014 with the US, generating 7.1 million tons (60.6%) to hold the major share. Other leading countries in this region were Brazil (1.4 million tons) and Mexico (1 million tons).

Europe closely followed the American region and generated 11.6 million tons of e-waste in 2014. Germany accounted for the largest share with 1.8 million tons of e-waste generation followed by the UK, France and Russia with 1.5 million tons, 1.4 million tons and 1.2 million tons, respectively.

Africa¹⁸⁸ and Oceania¹⁸⁹ together had a share of 5.9% in the world e-waste generation and accounted for 1.9 million tons and 0.6 million tons of waste, respectively, in 2014.

Of the 41.8 million tons of waste generated¹⁹⁰ in 2014, small equipment were the major constituent with 12.8 million tons (30.5%) of waste followed by large equipment, which generated 11.8 million tons (28.2%) of waste. Other major sources of waste generation were temperature exchange equipment and screens, which accounted for 7 million tons (16.7%) and 6.3 million tons (15.0%) of waste, respectively (Chart 123).

Chart 123: E-waste Generation, By Category (2014)



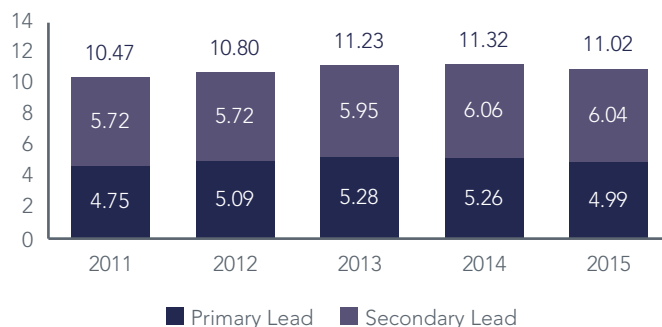
Source: Global waste monitor 2014

As per the estimates reported in Global Waste Monitor 2014, only 16% of e-waste was recycled in 2014. The remaining e-waste was either dumped in the landfills or was contaminated due to mixing with other household and industrial waste.

Lead-Acid Batteries: Lead-acid batteries are rechargeable batteries that are generally used as automotive batteries in vehicles for starting, lighting and ignition (SLI).

The production of lead increased from 10.47 million tons in the year 2011 to reach 11.02 million tons in 2015¹⁹¹, witnessing a CAGR of 1.3% (Chart 124).

Chart 124: Global Lead Production, 2011-2015 (Million Tons)



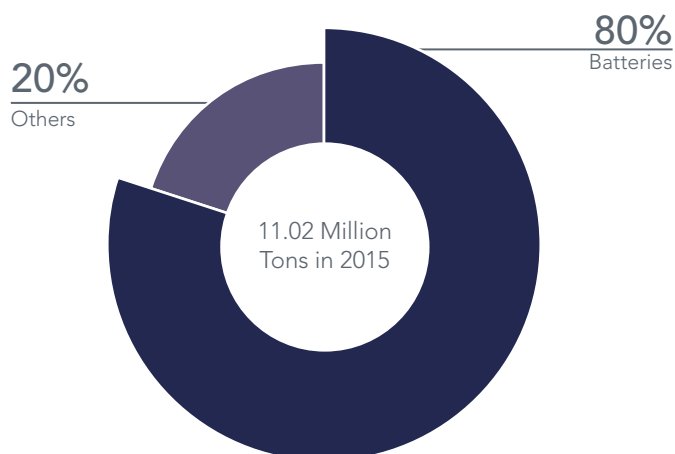
Source: Bloomberg

During 2011–15, the production of secondary lead, also known as recycled lead¹⁹² increased from 5.72 million tons to 6.04 million tons. In 2014, secondary lead production accounted for 54.8% of all lead produced throughout the world.

Among regions, Asia¹⁹³ was the leading producer of secondary lead and accounted for 47.2% share while the Americas (North and Latin American regions combined) and the European Union accounted for 28.8% and 22.0% share, respectively.

The use of lead¹⁹⁴ in 2015 was more oriented toward batteries that accounted for 80% of the total lead consumption. Other product segments accounted for 20% market with split being: rolled and extruded products (6%), pigments (5%), shot/ammunition alloys (3%), alloys (2%), cable sheathing (1%) and other compounds (3%) (Chart 125).

Chart 125: Global Lead Consumption, By End Use (2015)



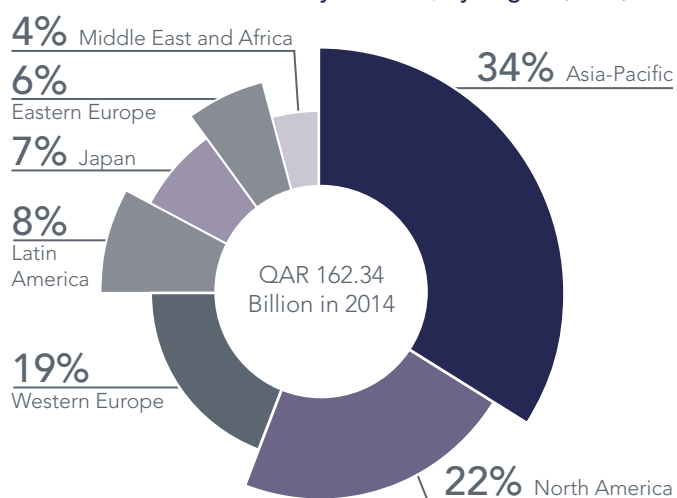
Source: Bloomberg

^{187,188,189,190} The Global E-Waste Monitor 2014, i.unu.edu

^{191, 192, 193, 194} Bloomberg-Database

Globally, 74% of lead used in manufacturing new lead batteries comes from recycling¹⁹⁵. Global market for lead acid battery for 2014 was USD44.6 billion (QAR162.34 billion) with Asia-Pacific being the leading consumer of lead batteries. It was followed by North America and Western Europe with 21.6% and 18.7%, respectively (Chart 126).

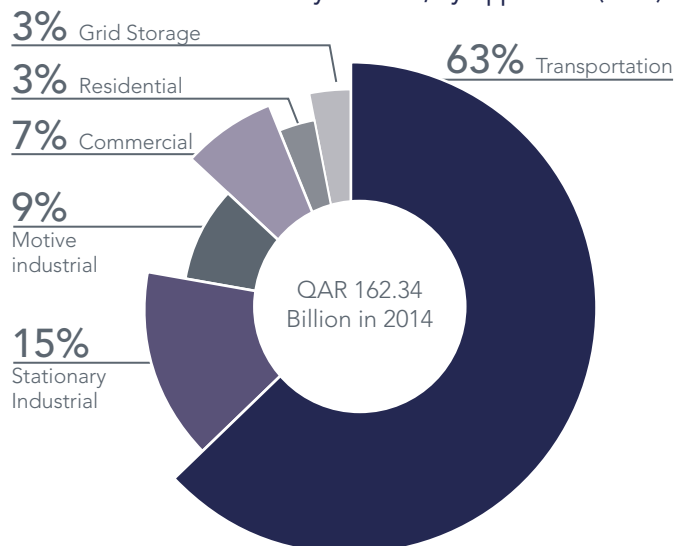
Chart 126: Lead-Acid Battery Revenue, By Region (2014)



Source: Future Market Insights

Based on applications, the market is segmented as transportation, stationary industrial, motive industrial, commercial, residential and grid storage. Transportation and stationary industrial segments collectively contributed to about 77.9% of market revenues in 2014. Stationary industrial application segment accounted for 15% of the total revenues while other segments combined had a revenue of 7.1% (Chart 127).

Chart 127: Lead-Acid Battery Revenue, By Application (2014)



Source: Future Market Insights

As per report by Transparency Research, the global market for recycled battery was estimated to be USD7.1 billion in 2014. Based on battery chemistry, lead acid batteries dominated the overall market with a share of approximately 45% owing to the fact that these batteries are easy to extract and require less operational excellence¹⁹⁶. By weight, the most important constituent of lead-acid battery is lead (65%) and plastic (15%)¹⁹⁷. The remaining 20% of the weight is distributed among acids, ebonite and other materials.

Europe being a major region that implements energy conservation technologies had led the battery recycling market in 2014 while North America was the second leading region in the battery recycling market. Stringent environmental norms imposed by the government institutions in the US and Canada are major drivers for the growth of the battery recycling market in this region. In the US¹⁹⁸, about 100 million auto batteries a year are replaced, and 99% of them are recycled. With fewer environmental regulations and low labor cost, Asia-Pacific market has grown in the recent years. A major part of recycling in this region is controlled by unofficial battery recyclers. Due to these unofficial and low-cost operations, Asia-Pacific region has attracted an increased number of used battery imports lately¹⁹⁹.

Majority of the trade in e-waste and batteries is carried out without dismantling or any value addition to the waste collected. The recovery process is primarily done at the destination or the importing country e.g. Singapore.

As per the UN Comtrade, the global trade of e-waste and batteries (HS Code-8548) for the year 2014 was documented at 569,402 tons. However, the trade data for e-waste has not been tracked completely by the reporting countries. This is because most of the national take-back legislations does not cover all e-waste categories. In some countries, a legislation exists for only one type of appliance and the collection amount for e-waste is low. As per the United Nations Environment Program²⁰⁰, approximately 90% of the global trade for e-waste is done illegally. In addition, most developing countries have significant self-employed population who are engaged in the collection and recycling of e-waste. These people work on a door-to-door basis to buy e-waste from households, dismantle the waste and then sell it to refurbishers and recyclers for the production of new products.

¹⁹⁷ "Lead Battery Scrap", gravitatechnomech.com

¹⁹⁸ "Global Battery Recycling Market is anticipated to Expand at a CAGR of 10.90% by 2024", europlat.org

¹⁹⁹ "Who Knew? A Car Battery Is the World's Most Recycled Product", greencarreports.com

²⁰⁰ "Meeting the E-waste Challenge", knowledge.wharton.upenn.edu

¹⁹⁵ "Facts about Lead", batterycouncil.org

¹⁹⁶ "Battery Recycling Gets a Fillip Globally Thanks to Strong Government Support", Transparency market research.com
Materials Recovery

6.5. GCC E-waste and Battery Recovery Market Overview

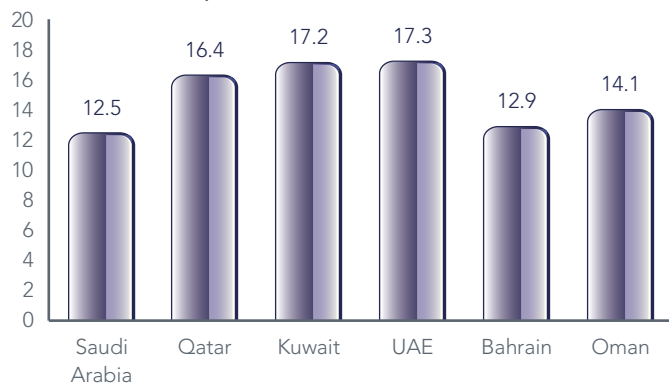
6.5.1. Market Overview

Technological advancements, high per-capita income and cheap rate of electronics have led to increased consumption within the region. Because of the advancements in technology, life span of computers and mobile phones has also dropped over time and thus, the amount of e-waste generated around the region has risen dramatically.

Of the total e-waste and batteries collected in the region, only a small percentage (estimates suggest this be approximately 5%)²⁰¹ is sent to the recycling facilities, while the remaining is usually dumped in the landfills and poses significant health and environmental threats.

Annual e-waste generated per-capita by GCC countries was higher when compared with the global average of 5.9kg²⁰². In 2014, UAE's annual per capita waste generation was 17.3kg, while Kuwait and Qatar closely followed with per-capita generation of 17.2kg and 16.3kg, respectively, annually. Other GCC countries, such as Oman, Bahrain and Saudi Arabia, also had annual per-capita e-waste generation above the global average of 5.9kg (Chart 128).

Chart 128: Per-Capita E-waste Generation (Kg) (2014)



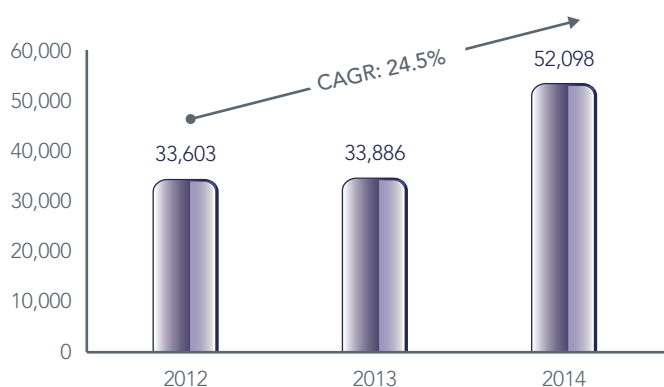
Source: Aljazeera

Battery recycling market is still at the nascent stage with few recycling companies present in the market. Currently, most of the used batteries are dumped in the open environment. In UAE, it is estimated that 25,000 tons of lead-acid batteries are scrapped annually²⁰³.

Due to the non-availability of proper e-waste and battery scrap management in the GCC region, exports²⁰⁴ (HS Code-8548) increased from 33,603 tons in 2012 to 52,098 tons in 2014, witnessing a CAGR of 24.5%.

In 2014, The UAE was the leading exporter with 30,086 tons (57.7%) of the region's trade. Approximately 78.4% of the exports from the UAE were directed to Korea while the remaining 21.2% was spread across the rest of the countries (Chart 129).

Chart 129: GCC E-waste and Battery Export, 2012-2014 (Tons)



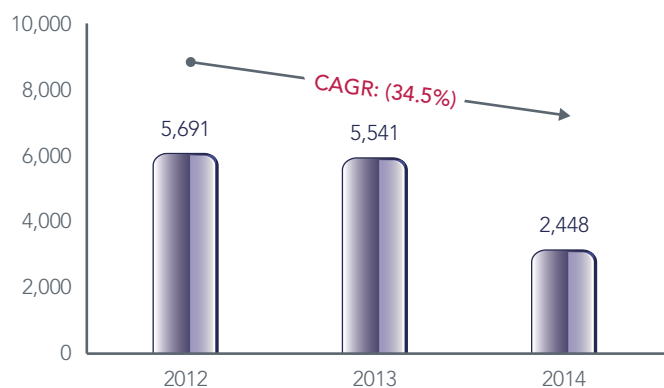
Source: Trademap

Kuwait was the second-largest exporter of e-waste and batteries from the GCC region and accounted for 18,737 tons (35.9%) of the region's trade in 2014. In comparison with 2013, Kuwait witnessed a surge of 359.8% in their export quantity in 2014. Of the total exports from Kuwait, 64.6% (12,117 tons) were directed to Korea, while 33.5% (6,293 tons) to Pakistan.

Bahrain share of GCC e-waste and batteries exports in 2014 was 5% (2,656 tons) with India and Korea being the leading importers of e-waste and batteries. They accounted for 49.9% and 46.5% of exports, respectively.

Imports²⁰⁵ in the region decreased from 5,691 tons in 2012 to 2,448 tons in 2014, observing a negative CAGR of 34.4%. The UAE was the only prominent country and accounted for 55.6% (1,357 tons) of the imports. Other leading countries for e-waste and batteries imports were Saudi Arabia and Qatar with 17.1% and 11.6% share, respectively (Chart 130).

Chart 130: GCC E-waste and Battery Import, 2012-2014 (Tons)



Source: Trademap

²⁰¹ "Significance of E-Waste Management", ecomena.org

²⁰² What are the effects of Qatar's electronic throw-away culture?, theedge.me

²⁰³ Lead Alert in the UAE, gulfnews.com

^{204, 205} Trademap

6.5.2. Leading Companies in the GCC Market

Some of the regional companies operating in the recovery of e-waste and battery include:

Table 20: E-waste and Battery Recovery Companies in the GCC Market

Company	Year of Establishment	Country	Activity	Annual Capacity (tons)	Segment
Holoul Electronic Recycling Treatment Company	2012	Saudi Arabia	<ul style="list-style-type: none"> Collection Recovery 	NA	e-waste
Enviroserve	2005	UAE	<ul style="list-style-type: none"> Collection Recovery Disposal 	9,852	e-waste
Ecyclx	1996	UAE	<ul style="list-style-type: none"> Collection Recovery Disposal 	NA	e-waste
Be'aah	2007	UAE	<ul style="list-style-type: none"> Collection Recovery Disposal 	NA	e-waste
Sims Recycling Solutions	2012	UAE	<ul style="list-style-type: none"> Collection Recovery 	NA	e-waste
Madenat Al Nokhba Recycling Services LLC	1986	UAE	<ul style="list-style-type: none"> Collection Recovery Disposal 	NA	e-waste
Scheibye Middle east	2003	UAE	<ul style="list-style-type: none"> Collection Recovery Disposal 	NA	e-waste
Metal & Recycling Company [MRC]	1987	Kuwait	<ul style="list-style-type: none"> Collection Recovery Disposal 	NA	e-waste
Emirates Lead Company FZC	2005	UAE	<ul style="list-style-type: none"> Recovery 	37,150	Batteries
Kuwait Factory For Spent Battery Recycling	NA	Kuwait	<ul style="list-style-type: none"> Recovery 	NA	Batteries
Crown Recycled Material Supplies	NA	Kuwait	<ul style="list-style-type: none"> Recovery 	NA	Batteries
Oman Lead Company	NA	Oman	<ul style="list-style-type: none"> Recovery 	NA	Batteries
Arab Lead Company	2016	Oman	<ul style="list-style-type: none"> Recovery 	10,950	Batteries

*UAE²⁰⁶: A new battery recovery plant by Bin Nawi Group is due to be completed in 2018 and will have a maximum annual treatment capacity of 100,000 tons per year. In the second phase, new batteries for the industrial sector shall be produced from the recycled car batteries.

²⁰⁶ "Lead Acid Battery Recycling Plant in Abu Dhabi by GAUFF Power International", gauff.net

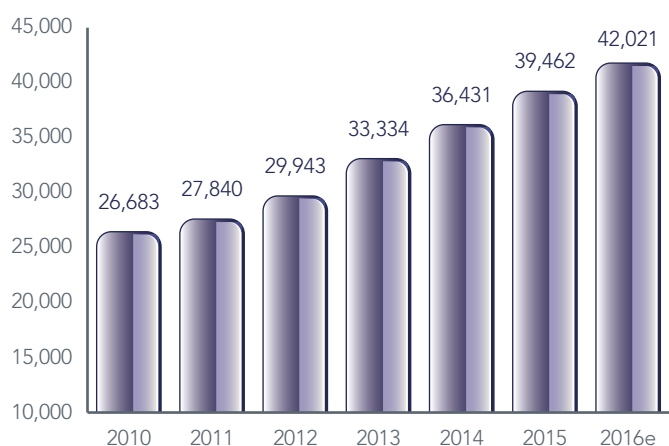
6.6. Qatar E-Waste and Battery Recovery Market Overview

6.6.1. Historical and Current Waste Generation

Qatar has one of the highest per-capita e-waste generation annually i.e., 16.3kg. Increasing population in the country coupled with the availability of gadgets at cheap prices has been the major driver behind this high per-capita waste generation.

During 2010, approximately 26,683 tons of e-waste was generated that increased to 39,462 tons in 2015, witnessing a CAGR of 8.1%. In 2016, pegged with the population, it is estimated that approximately 42,021 tons of e-waste would be generated (Chart 131).

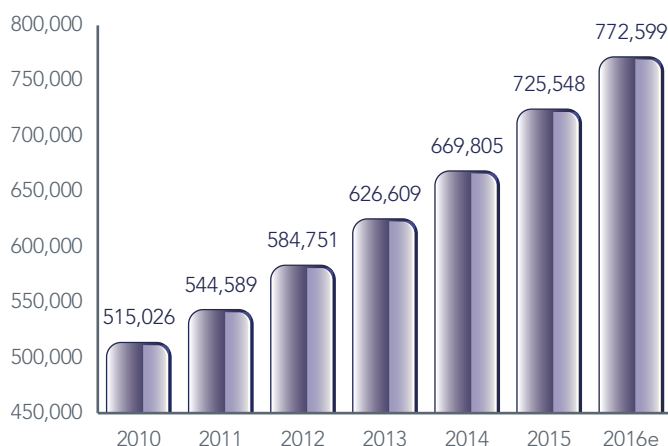
Chart 131: E-waste Generated in Qatar, 2010-2016E (Tons)



Source: United Nations University, Team analysis

Major source of battery scrap generated in Qatar is through automobiles that use lead-acid batteries, which have an average life span of 18 months. During 2010, 515,026 batteries was estimated to be scrapped and the quantity is estimated to have increased to 725,548 batteries in 2015. The average weight of scrap batteries is estimated to be 18.33kg²⁰⁷ (Chart 132).

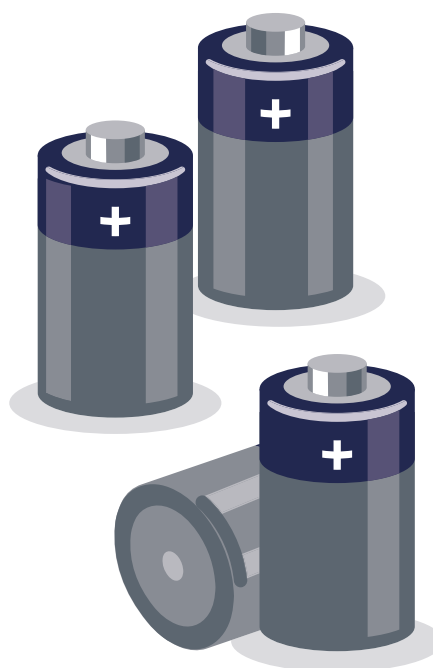
Chart 132: Number Of Scrap Batteries Generated In Qatar, 2010-2016E



Source: MDPS Transport and communication statistics 2014, Primary research

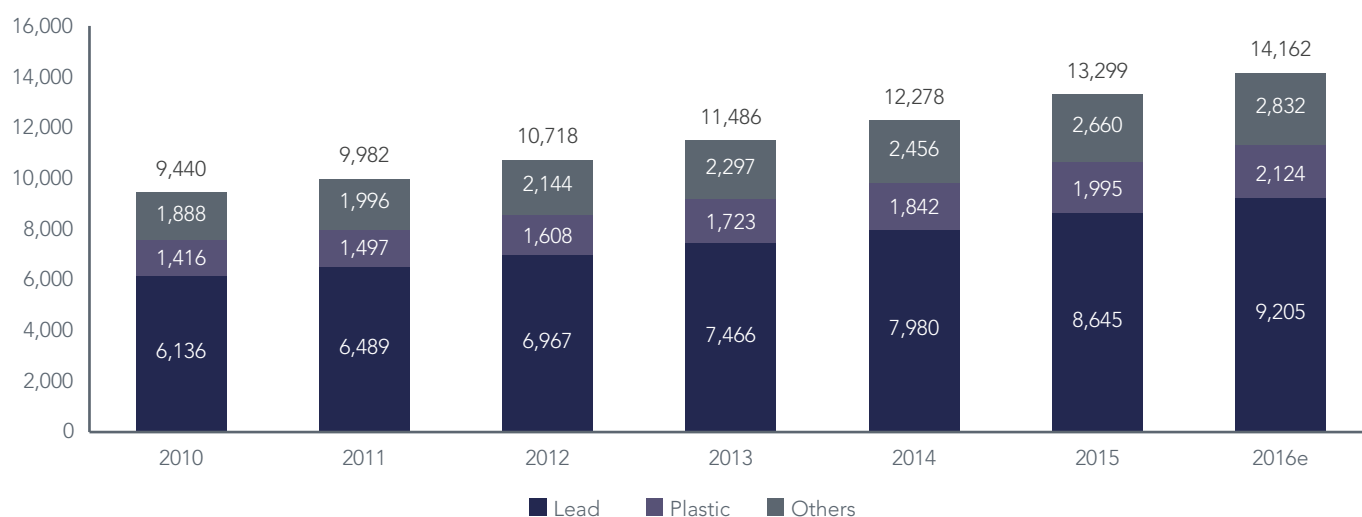
Recovery of battery generates lead (65%), plastic (15%) and other components (20%) such as acid, ebonite, etc., by weight.

Based on the average lifespan of battery, number of automobiles in the country (described in the Introduction section) and the average weight of the scrap battery, approximately 9,440 tons of battery scrap was generated in 2010 and it increased to 13,299 tons in 2015 at a CAGR of 5.39%.



During 2010–15, lead component in the scrap batteries increased from 6,136 tons to 8,645 tons, while plastic scrap increased from 1,416 tons to 1,995 tons. In 2016, approximately 772,599 batteries are estimated to be scraped, generating a volume of 14,162 tons (Chart 133).

Chart 133: Battery Scrap Generated in Qatar by Material, 2010-2016E (Tons)



Source: MDPS Transport and communication statistics 2014, Primary research

6.6.2. Market Size Segmentation by Product Segments

Generally, e-waste generated in Qatar is landfilled as it is disposed through MSW by residents. This is due to lack of awareness among people regarding the recovery of e-waste. The e-waste generated in Qatar is mainly composed of small equipment followed by large equipment and small IT equipment (definition explained in introduction). However, the exact percentage share of the segments is not known.

Among batteries, only lead-acid batteries are recovered in Qatar as the collection process is simpler compared to other batteries. These batteries are collected through garages and are not mixed with MSW. Other type of batteries, such as mobile batteries, are generated through e-waste that is usually packaged and exported to other countries, and hence are not recovered in Qatar.

6.6.3. Analysis of Exports and Imports

The identified HS Code for e-waste and battery scrap is 8548. The graphs represented are at four-digit level.

Exports²⁰⁸: The total export of e-waste and battery scrap between 2005 and 2015 was 28,743 tons. The majority of exports (86.9%) were done between 2009 and 2012, which accounted for 24,998 tons.

The volumes increased during 2010 when 9,151 tons of scrap was exported, but the market started declining post 2010. In 2011 and 2012, the market was in a declining phase when 5,949 tons and 5,287 tons of scrap, respectively, were exported. Post 2012, the exports have been miniscule and in 2015, 1,500 tons of scrap was exported from Qatar (Chart 134).

Chart 134: Qatar's E-waste and Battery Scrap Export, 2005-2015 ('000 Tons)



Source: Trademap

²⁰⁸ Trademap

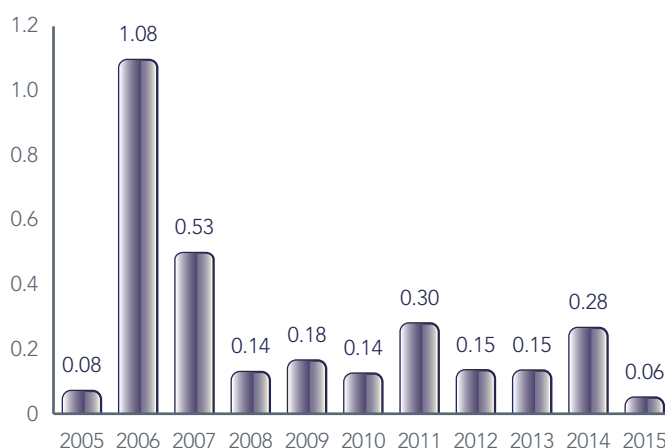
This decline in exports could be associated with the establishment of Rassas battery recycling that started its operation in 2013. They are currently recovering and recycling 4,000 tons of lead acid batteries per annum.

Under the eight-digit HS Code 85481000, 97.5% (28,040 tons) of the total exports was done under waste of primary cells, batteries, electric accumulators and electrical parts of machinery, between 2005 and 2015.

During 2014, all the exports were done to India while in 2015, Korea emerged as the only importer.

Imports²⁰⁹: Qatar imported a total of 3,078 tons of e-waste and batteries scrap between 2005 and 2015. The import during any single year varied from 1,078 tons in 2006 to 60 tons in 2015. In 2014, the UAE was the major exporter and accounted for 131 tons (46.2%) of the total imports of 284 tons. In 2015, the US, Germany, China, the UK and Korea were the major exporters (Chart 135).

Chart 135: Qatar's E-waste and Battery Scrap Import, 2005-2015 ('000 Tons)



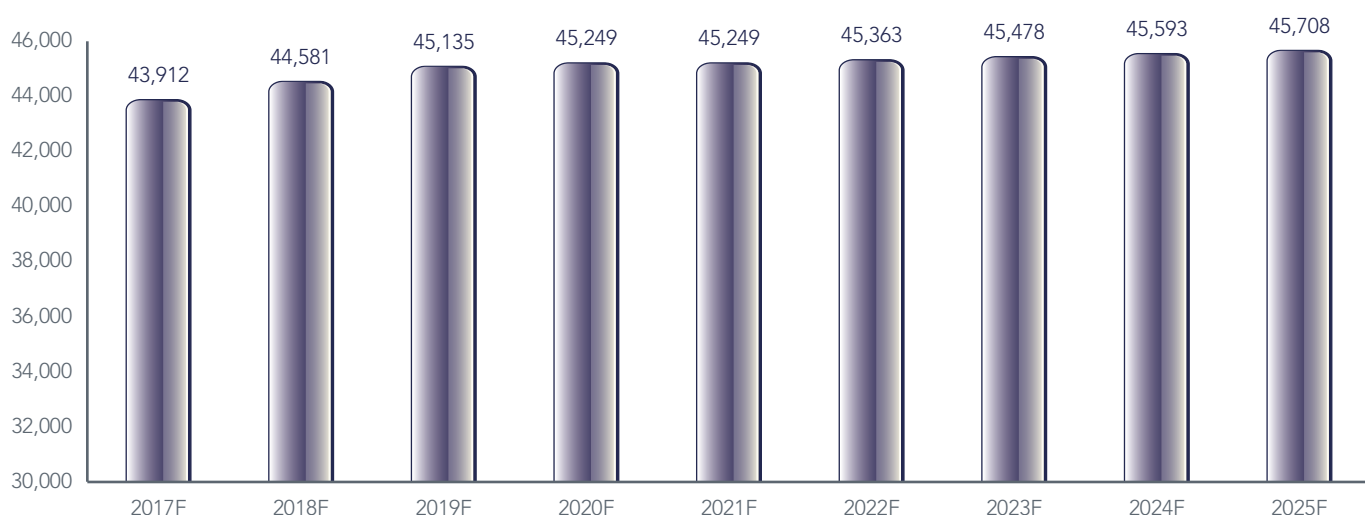
Source: Trademap

6.6.4. Waste Generation Forecast

E-waste generation would be driven by the changing technology and with the introduction of new gadgets in the market that are expected to be cheaper in price due to cost-based competition. The average per-capita generation of e-waste (excluding battery scrap) annually is expected to be 16.3kg.

Considering the population estimates and the per-capita e-waste generation, the quantity of E-waste is expected to increase from 42,021 tons in 2016 to reach 43,912 tons in 2017 and 45,708 tons in 2025, witnessing a CAGR of 1.06% (Chart 136).

Chart 136: E-waste Generation in Qatar, 2017F-2025F (Tons)

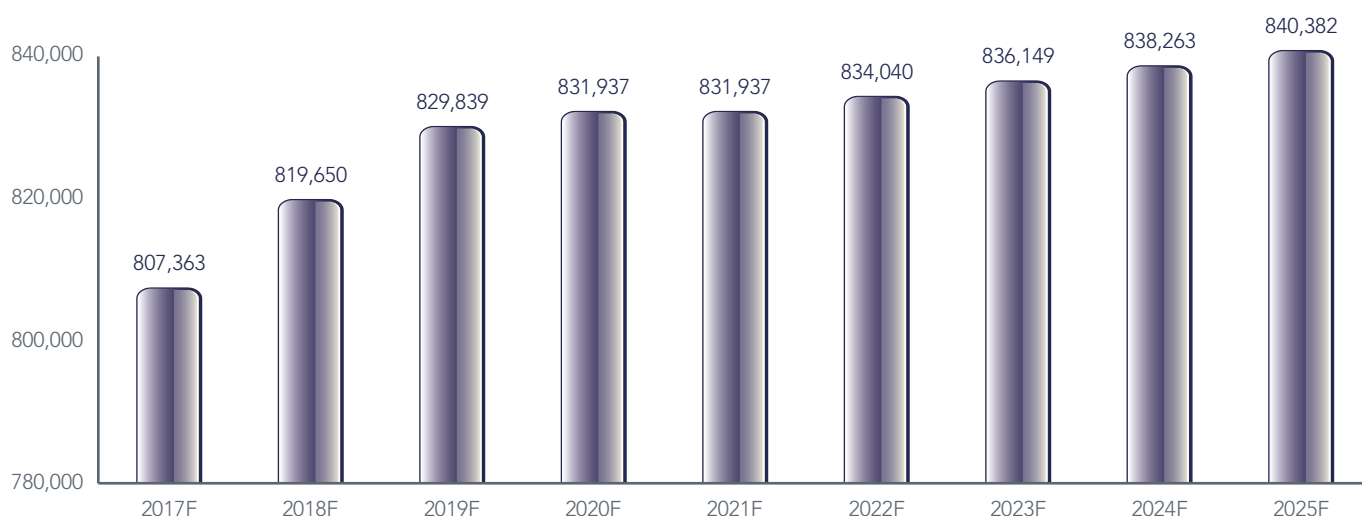


Source: United Nations University, Team analysis

The demand forecast from 2017 to 2025 has been done based on the number of expected automobiles (discussed in the Introduction section) and on the average life of a lead-acid battery that is assumed to be of 18 months. The average weight of a scrapped battery is estimated to be 18.33kg.

It is estimated that the number of scrap batteries would increase from 772,599 in 2016 to reach 807,363 in 2017, and is likely to grow to 840,382 in 2025, witnessing a minimal CAGR of 0.5% (Chart 137).

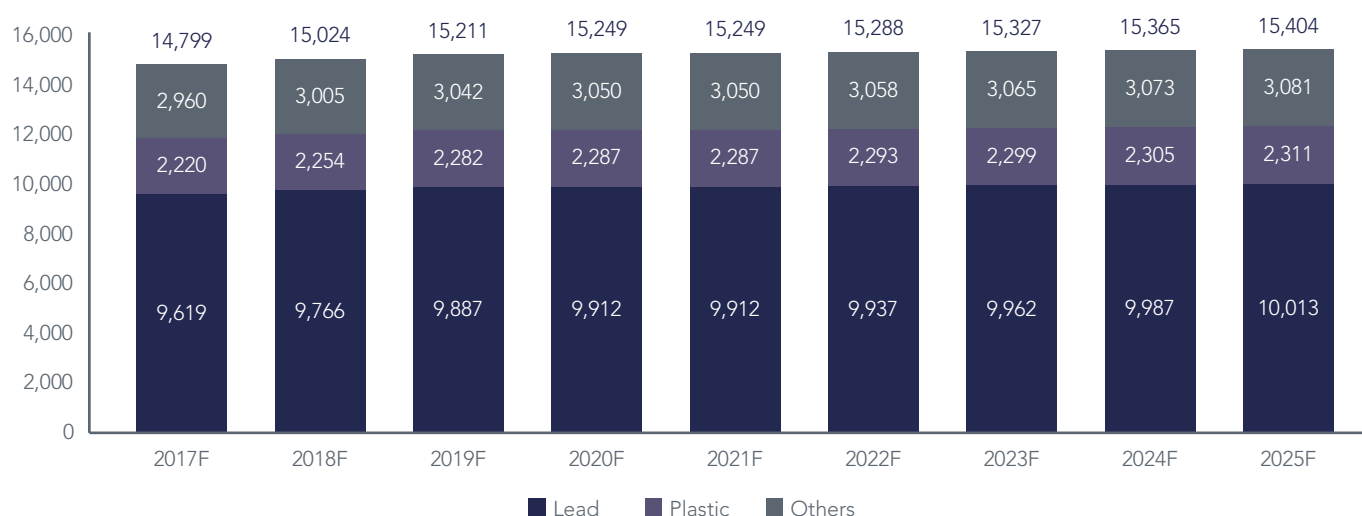
Chart 137: Number of Scrap Batteries Generation in Qatar, 2017F-2025F



Source: MDPS Transport and communication statistics 2014, Primary research

In volume terms, the battery scrap is estimated to increase from 14,162 tons in 2016 to 14,799 tons in 2017 and 15,404 tons in 2025. Major constituent of this scrap as explained in earlier sections would be lead (65%) followed by plastic (15%) and other components accounting for the remaining 20% (Chart 138).

Chart 138: Battery Scrap Generation in Qatar by Material, 2017F-2025F (Tons)



Source: MDPS Transport and communication statistics 2014, Primary research

6.6.5. Demand for Recovered Material

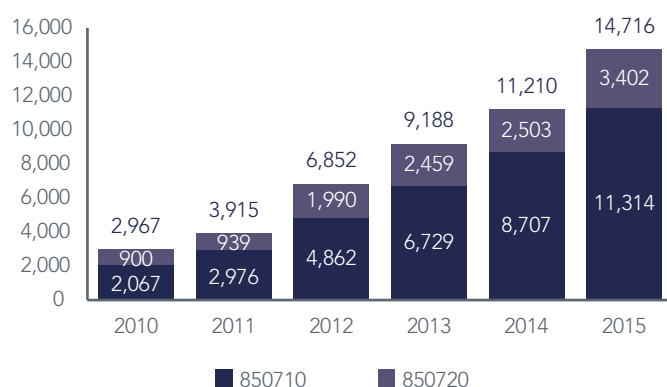
E-waste: Most of the e-waste generated through households and small businesses in Qatar is dumped in the landfills. Even if e-waste is collected in Qatar, it is exported to Singapore without any value addition as there are no manufacturers of these products in Qatar. Thus, in case of e-waste, there is no domestic demand for recovered material. However, a material recovery facility can collect and export to countries producing electronic equipment.

Lead-Acid Battery: Demand for new lead-acid batteries in the country is equal to the replacement rate of old batteries used in the automotive industry.

Local production: There is no local production of lead-acid batteries in Qatar except for Rassas battery recycling plant that is involved in recovery as well as recycling of approximately 4,000 tons of scrap batteries annually. The capacity of the plant is expected to reach 10,000 tons by 2030.

Imports: Imports of lead-acid battery is done under HS Code: 850710 (Lead-acid accumulators of a kind used for starting piston engine starter batteries) and 850720 (Lead acid accumulators excluding spent and starter batteries). Qatar imported 14,716 tons of batteries in 2015, increasing from 2,967 tons in 2010 (Chart 139).

Chart 139: Qatar's Lead-Acid Battery Import, 2010-2015 (Tons)



Source: Trademap

Under HS Code: 850710, 11,314 tons of imports were made in 2015. Saudi Arabia (3,243 tons) and Korea (2,918 tons) were the major importers with a combined share of 54.5%.

Under HS Code: 850720, 3,402 tons of imports were made in 2015. Korea, China, US, France and Sweden were the top 5 exporters of this product to Qatar with a combined share of 61.8%.

Replacement Opportunity for Recovered Batteries

Qatar has an annual estimated demand of 772,599 batteries in 2016. In terms of weight, it is estimated to be around 14,162 tons (taking average weight of battery to be 18.33 kg). It is estimated that 840,382 batteries (15,404 tons) will be required in 2025.

Some of this demand can be fulfilled by recovery and recycling of scrap batteries domestically. This presents an opportunity for a new recovery facility to enter the battery recovery business as the current lone battery recycling facility even at full capacity will not be able to cater to the total demand in Qatar. A new recovery facility can also operate by only recovering the materials from the batteries and selling it separately either in international market or domestically to Rassas battery.

6.6.6. Assessment of Supply Landscape

Based on the primary interviews, there are only two companies operating in the e-waste and battery recovery sector.

In case of e-waste, there exists illegal trading and dumping. There are no proper collection channels in the country especially for e-waste generated from households and small businesses. Most of the e-waste generated from households and small businesses are mixed with MSW due to lack of awareness and are dumped in the landfills. Currently, there exists only one player in this segment, details of which are described below.

1. Al-Haya Waste Management²¹⁰ was started in 2003 and is spread across 10,000sqm of land. The company is engaged in the collection of e-waste such as computer, mobile phones, laptops, TV LED screens and accessories from the industries operating in Qatar.

Their annual collection is almost 50 tons and all the scrap collected is exported to Cemelia Resources Company, Singapore without any value addition or processing.

Going forward, Al Haya plans to expand the facility and dismantle e-waste into various components before exporting it.

Prior to 2013, scrap batteries were exported from the country. However, post establishment of Rassas battery recycling facility, the exports have reduced drastically. Currently, there is only one player in this segment and sourcing of scrap batteries is not a challenge.

²¹⁰ Company website

2. Rassas Battery Recycling Factory²¹¹ was established in 2013 and is the only battery-recycling factory in Qatar. It has an annual capacity of processing 10,000 tons of battery and 100% capacity utilization is expected to reach in 2030. The scrap batteries are sourced through workshops and garages.

The company recovers lead and plastic from used batteries and uses them internally for the production of new batteries (end product). Hazardous sulphuric acid generated as a result of battery recovery is treated and disposed of as per the government guidelines.

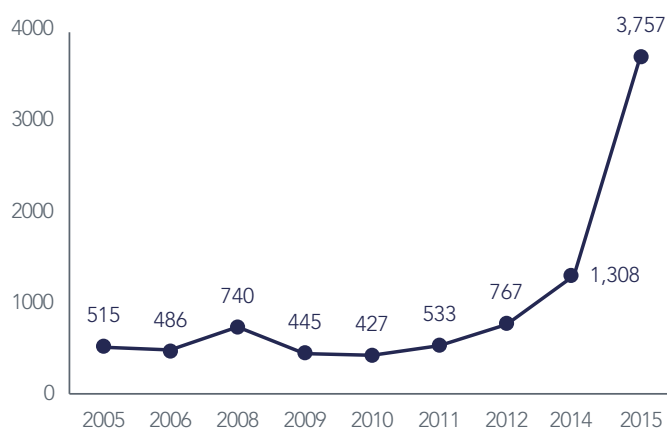
The new batteries produced are sold domestically and are also exported to other countries as per the demand and order.

6.6.7. Pricing Analysis

As there is no facility that completely recovers e-waste and only one battery recovery facility, scrap is generally exported. In addition, the graph does not represent data for 2007 and 2013, as there were either no exports or the data is inconsistent.

For the remaining years between 2005 and 2015, the export prices²¹² per ton saw an increase from QAR515 per ton to QAR3,757 per ton, growing at a CAGR of 21.98% (Chart 140).

Chart 140: Qatar's E-waste and Battery Scrap Export Price, 2005-2015 (QAR/Ton)



Source: Trademap, Team analysis

6.6.8. Analysis of Business Model and Presence/Absence of Key Synergies

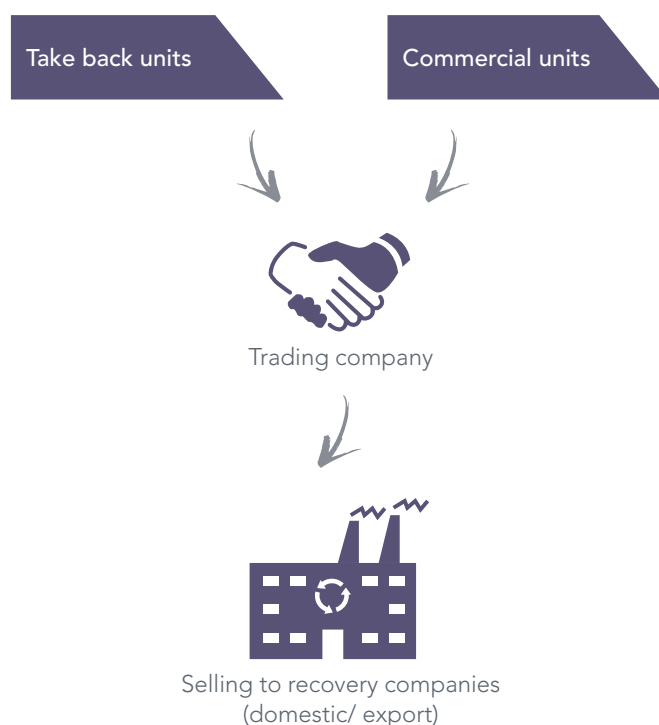
E-waste and battery scrap recovery facility in Qatar operates under the following business model.

Business Model 1: Trading of E-waste – there are two ways to source e-waste:

- By Take-Back Units: Scrap can be collected from take-back units, such as electronic shops for mobiles and computers, while used batteries can be collected from garages and workshops. This scrap is then sold to the trading units.
- Through Commercial Units: Facilities can collect e-waste directly from the commercial units, such as offices and industries. Once collected, trading units pack the e-waste scrap and export it overseas.

Example: Al Haya Waste Management is involved in collection and packaging of e-waste.

Figure 26: Business Model 1: Trading of E-waste



²¹¹ "Press release: Qatar to open battery-recycling factory", gulfnews.com

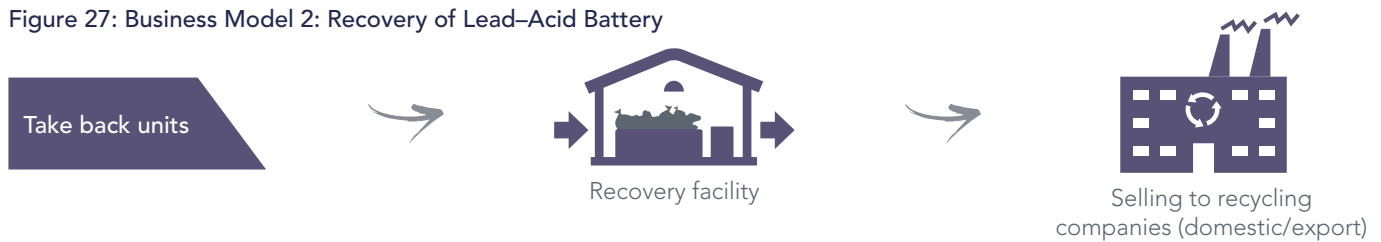
²¹² Trademap

Business Model 2: Recovery of Lead–Acid Battery–

- By take-back units: Batteries can be collected from garages and workshops. The recovery facilities buy the scrap and follow the recovery process.

Example: Rassas Battery Recycling Factory

Figure 27: Business Model 2: Recovery of Lead–Acid Battery



This is the only feasible model for a lead–acid battery recovery facility as the garages and workshops store used batteries upon replacement.

6.6.9. SWOT Analysis

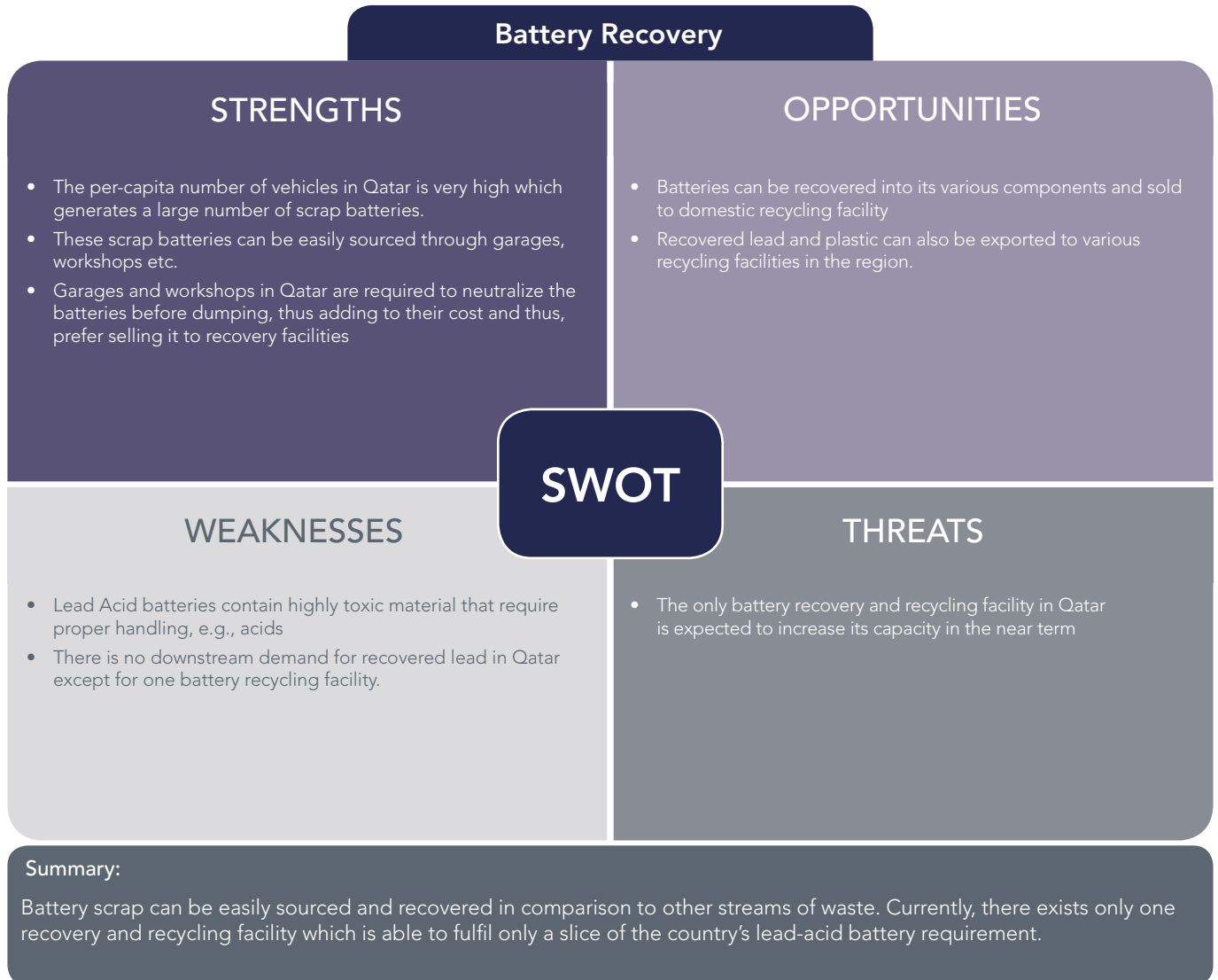
Figure 28: SWOT Analysis – E-waste-Recovery



Summary:

Recovery of e-waste in Qatar is low due to the absence of proper collection channels and because of illegal trading. In addition, there is an absence of downstream demand for the recovered e-waste and hence, the market for e-waste recovery is still under-developed.

Figure 29: SWOT Analysis – Battery Recovery

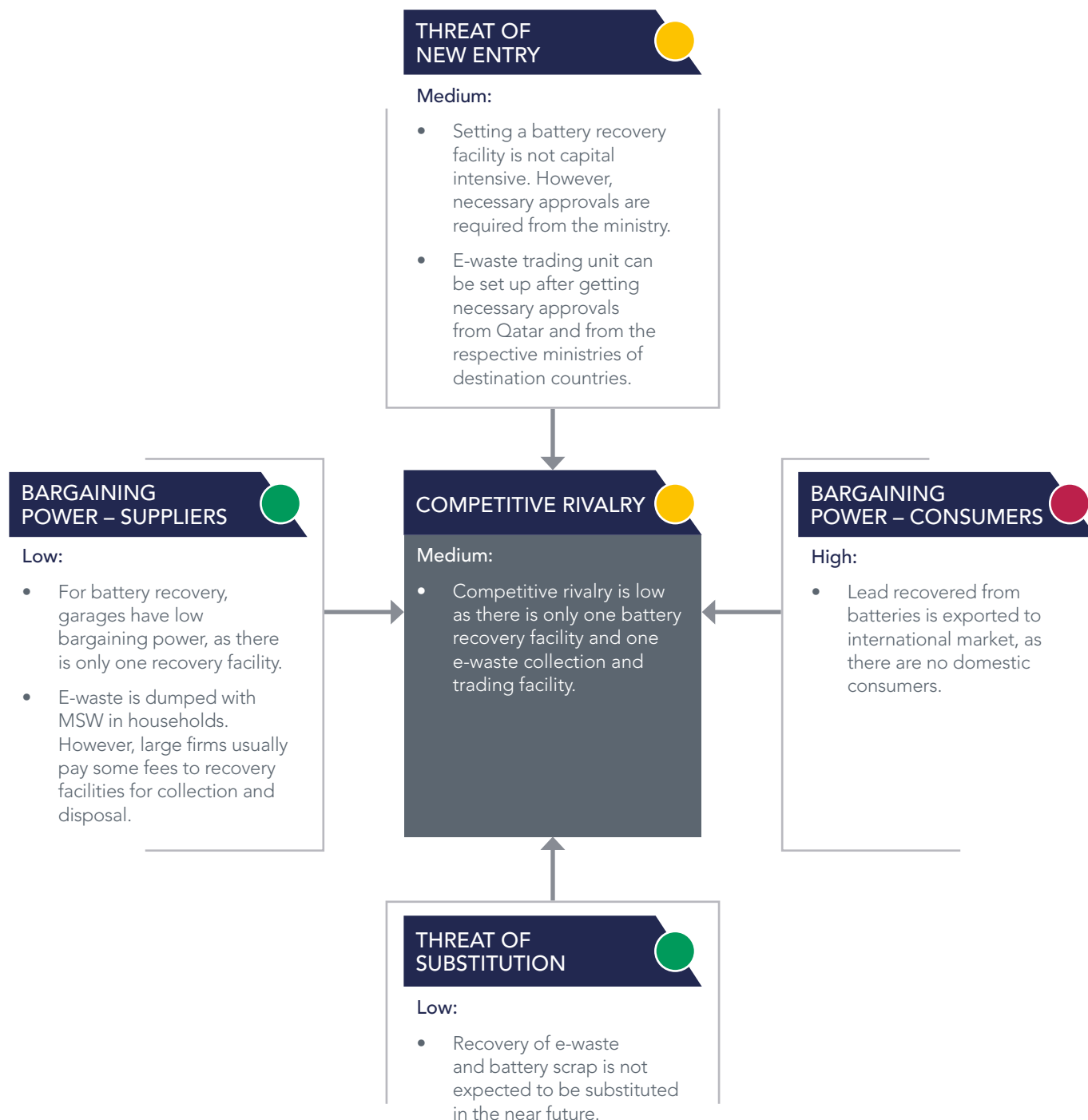


6.6.10. Regulations

- Qatar is a party to the Basel convention which prohibits hazardous waste exports to the developing nations. Since e-waste consist hazardous waste, the export of e-waste is also restricted to developing countries.
- Export of hazardous waste would be permitted only if necessary facilities and technical capacity are not available in Qatar to ensure the disposal of waste in an environmentally sound manner. However, the importing country must certify the availability of appropriate facilities for treatment and recovery while import is prohibited.
- The transit of hazardous waste through the national territory is prohibited except in cases where a specific approval is obtained from the Supreme Council for Environment in Qatar.
- Currently, no firm rules or regulations are in place for the disposal of electronic goods in Qatar, but through government initiatives and as a part of corporate social responsibility there are programs in which discarded electronic products are collected.

6.6.11. Michael Porter's Five Forces Model

Figure 30: Michael Porter's Five Forces Model – E-waste and Battery



6.6.12. Key Takeaways and Potential Opportunities

- Qatar generates 16.3 kg per capita of e-waste against a global average of 5.9 kg.
- With the increase in population, it is estimated that 42,021 tons of e-waste will be generated in 2016 and will reach 45,708 tons in 2026 in Qatar.
- In case of e-waste, there is a high amount of illegal trading and lack of collection channels in the country. In addition, most of the e-waste generated from households are mixed with MSW due to lack of awareness and hence dumped in the landfills.
- There is one facility collecting e-waste in the country. The company without any value addition exports e-waste to Singapore.
- Going forward, there is no domestic demand for recovered material. However, a material recovery facility can collect and export to countries producing electronic equipment.
- Lead-acid batteries are the major source of battery waste in Qatar. These batteries are generated by the automotive industry. The number of batteries in Qatar is expected to increase from 772,599 (14,162 tons) in 2016 to 840,382 (15,404 tons) in 2025.
- There is only one recovery facility with a capacity to process 4,000 tons of waste batteries. The capacity of the plant is expected to reach 10,000 tons by 2030.
- There is sufficient availability of raw material for the recovery facility in Qatar.
 - The recovery facility can use recovered batteries for captive consumption and can produce batteries to be sold domestically and internationally.
 - A new recovery facility can also operate by only recovering the materials from the batteries and selling it separately either in international market or domestically to Rassas battery.





7. GLASS

7.1. Overview of Glass Scrap

7.1.1. Description

Glass is a commodity used worldwide for applications ranging across sectors, such as domestic, construction, automotive and packaging. It is used as packaging material for bottles and jars, as a structural component in buildings and automobile windows, in other domestic applications like cookware, light bulbs, etc., and for specialized technical applications in science and engineering (e.g., glass fiber, glass ceramics and optical communications).

Glass is made from three ingredients: sand, limestone and soda ash. For every ton of glass that is recycled, more than a ton of raw material is conserved.

The increasing focus on energy sustainability, reducing landfill space and strengthening of government regulations on the recycling industry have led to increased glass recycling.

Glass bottles and jars are a 100% recyclable commodity and can be recycled infinite times without any loss in purity or quality. Recycled glass cullet is mixed with new raw materials in a proportion varying from 10% to 95% in volume. In addition, as an industry benchmark, an addition of 10% cullet (recycled broken or waste glass used in glass-making) results in a 2.5% to 3% reduction of furnace energy consumption during the production of glass²¹³.

However, some glass products are contaminated due to the mixture of chemicals during their production process and have very high melting points. Some of the glass items that are not recycled include²¹⁴:

- Any glass contaminated with stones, dirt and food waste
- Ceramics, such as dishware, ovenware and decorative items
- Heat-resistant glass, such as Pyrex
- Mixed colors of broken glass
- Mirror or window glass
- Metal or plastic caps and lids
- Crystal
- Light bulbs
- Cathode-ray tubes (CRTs) found in some televisions and computer monitors

²¹³ "Increased glass recycling", climatetechwiki.org

²¹⁴ "What Can I Recycle", wm.com



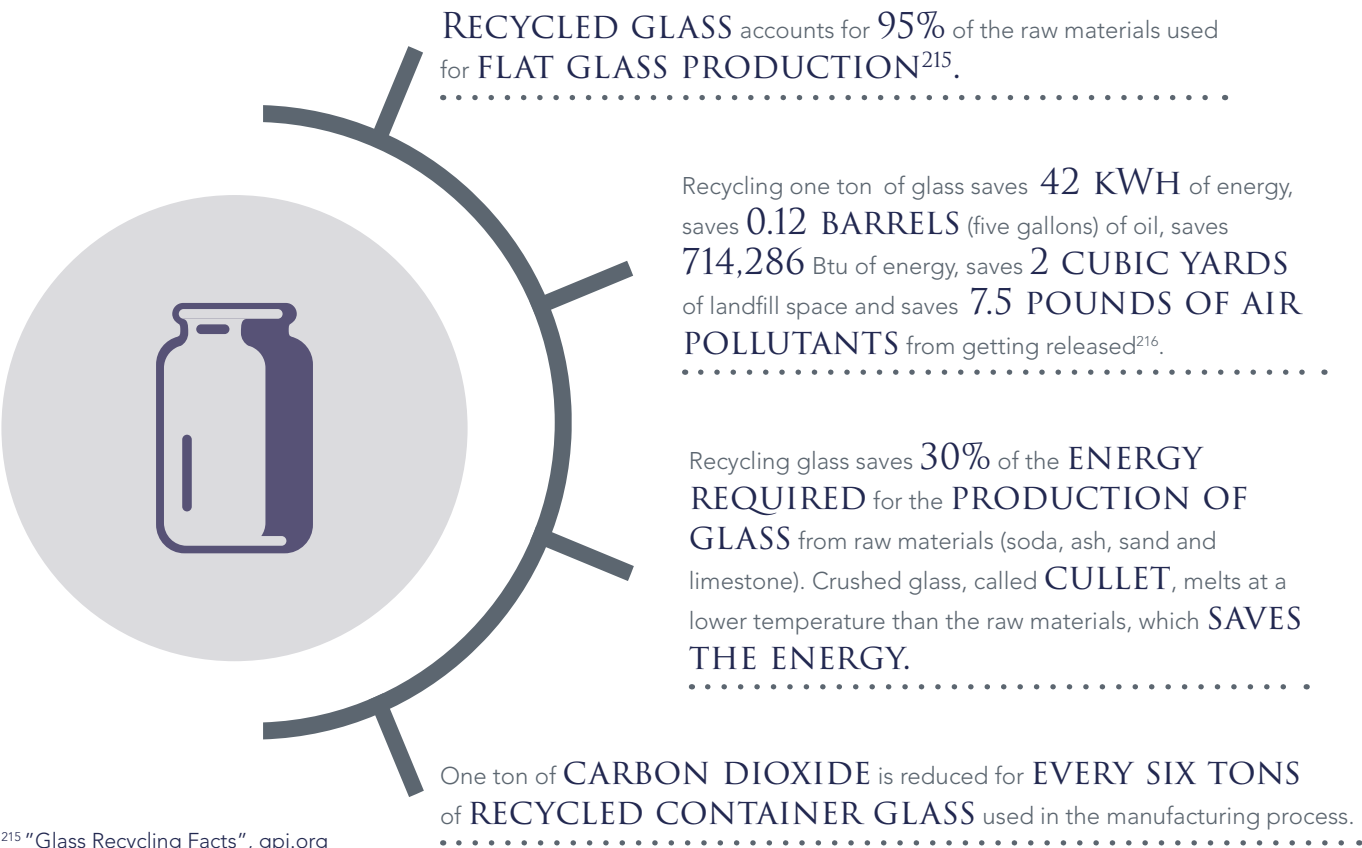
7.1.2. Classification of Glass Waste

Separating recycled container glass by color ensures that new bottles match the color standards required by the end users. Thus, glass waste is classified into three categories depending on the color:

Table 21: Categories of Glass Scrap

Classification	Properties and Use
Clear (flint) glass	<ul style="list-style-type: none">• Clear glass is made up of a combination of silica (sand), soda ash and limestone.• These are used for items, which are not affected by light, such as food items and water.
Brown (amber) glass	<ul style="list-style-type: none">• Brown glass is manufactured by addition of nickel, sulfur and carbon to molten glass.• Brown glass absorbs the ultraviolet radiation, at wavelengths that are shorter than 450nm (nanometers), so it offers the best protection from potentially damaging light.
Green (emerald) glass	<ul style="list-style-type: none">• Green glass is manufactured by adding iron, chromium or copper to molten glass.• Green glass does not have 100% light protection ability as at 370nm it still allows about 70% of light to pass and is thus used for liquids that can be partially exposed to light.

7.1.3. Benefits of Glass Recovery



²¹⁵ "Glass Recycling Facts", gpi.org
²¹⁶ "Recycling Facts & Tips", wm.com

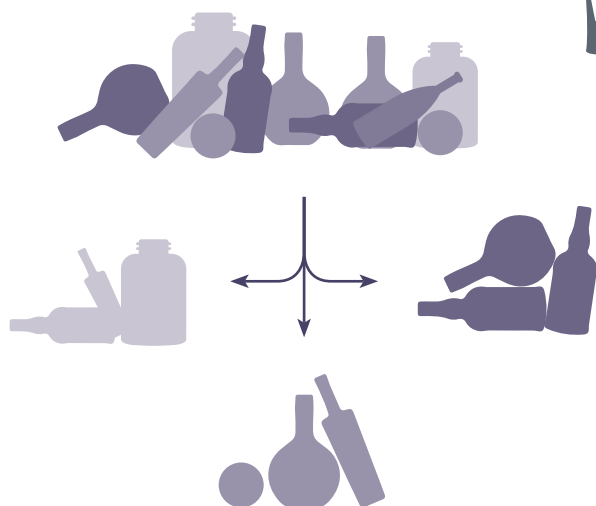
7.2. Glass Recovery Process

Figure 31: Glass Recovery Process

A. Glass Waste Collection

Glass waste is collected from restaurants, shopping malls, hotels, nightclubs, wine shops and from households with the other domestic waste. However, glass collected as part of domestic waste if not properly handled mixes with tons of other recyclables and is difficult to sort.

In addition, glass waste is collected from stores dealing with glass sheets. The off-cuts of glass are dumped in a separate bin and are sent to the recovery centers for recycling of glass.



B. Color Sorting

The delivered material is segregated manually to remove unsuitable constituents (metal caps, ceramic parts, etc.).

Ceramics, window glass, crystals are removed because these materials do not have the same physical and chemical properties as that of a bottle glass (different melting points, and a wide array of different metal-oxide inclusions making them unsuitable for bottle recycling).

Waste is sorted based on the color into clear, brown and green glasses. This sorting is done before the glass is crushed as the process will not be economical if the crushed glass pieces have to be sorted based on color.

This color-based sorting can be done after the crushing of glass wherein crushed glass is fed to the vibrating feeders that are illuminated from both below and above with different types of light, and are installed with high-definition cameras to detect the (RGB) Red, Green and Blue spectrum of the glass.

C. Crushing of Glass

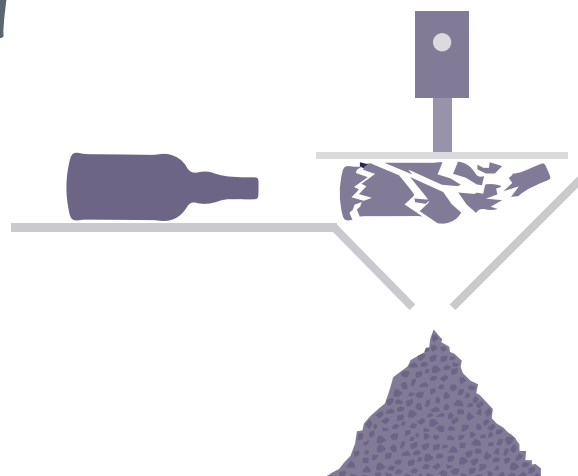
After the sorting stage, the next stage involves crushing and grinding of glass waste into tiny pieces that are known as cullets.

D. Removal of Contaminants

Glass cullet is passed through a magnetic field to remove metal bottle caps.

- Cullet is fed to an enclosed chamber where it passes through air. This removes lightweight objects, such as paper and plastic.
- Cullet moves through a vertical dryer that removes the moisture from the cullet as well as glass dust and paper labels that are separated from bottles and jars.

Cullet is then free from contamination and is sent to recycling plants that process glass cullets for the preparation of new glass containers.



7.3. Recovered Glass Applications

Glass cullet produced through the glass recovery process has wide applications in the glass industry. In addition, recycled glass has uses across other industries, such as construction. Some of the applications include:

- **New Bottles and Jars:** Cullets of different colors are sold for the preparation of new bottles and jars that have application in food and beverage packaging.
- **Abrasive Media:** Recycled glass is used to prepare surfaces of water tanks, bridges, commercial ships and manufacturing equipment.
- **Aggregate Material:** Glassphalt is produced using recovered glass and is applied to roads, highways and airports to make the surface less slippery and less prone to cracks.
- **Landscaping:** It can also be used for decoration purposes in filling vases, for plants in covering surfaces, for flower beds as mulch covering and in fountains and ponds as a sparkler.

7.4. Global Glass Recovery Market Overview

Recycling of glass generated because of packaging industry has seen a surge during the recent years. Usually, in developing nations the glass waste generated is dumped in the landfills resulting in increased environmental challenges and contamination of sand.

Owing to this increased environment concerns, such as contamination of soil, climate change and increase in the quantity of glass waste generated, recycling has gained an increased focus around the globe. However, glass-recycling rate varies greatly across regions.

In the US, glass waste accounted for 11.54 million tons (4.5%) of total MSW (254 million tons) generated in 2013. Only 3.15 million tons (27.3%) of glass was recycled, while the remaining 8.39 million tons of waste was discarded (Chart 141).

Chart 141: Glass Scarp in the US, 2012-2013 (Million Tons)



Source: USEPA – 2013

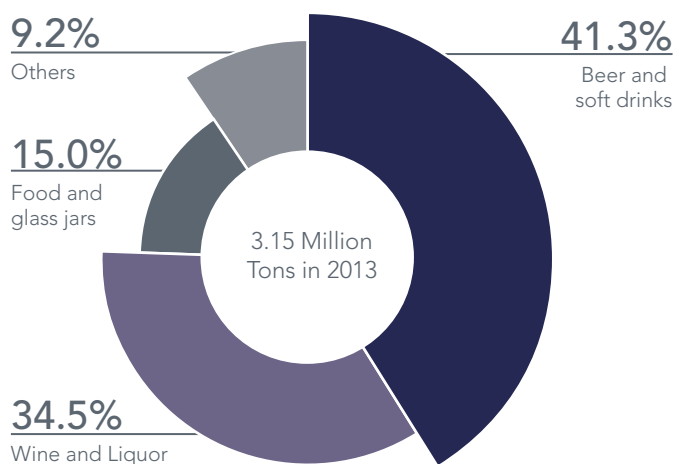
²¹⁷ "Advancing Sustainable Materials Management", epa.gov

²¹⁸ "Glass recycling hits 73% in the EU", feve.org

Glass waste in the US was classified into two broad categories²¹⁷:

- **Durable glass waste:** This accounted for 2.28 million tons and was discarded with zero recycling.
- **Containers and packaging waste within the US** accounted for 9.26 million tons and had a recycling rate of 34% (3.15 million tons) in 2013. From this 3.15 million tons of recovered waste, beer and soft drink bottles had a share of 41.3%, while wine and liquor bottles accounted for 34.5%. Of the remaining 24.2%, food and other glass jars accounted for 15% with the remaining 9% of the glass was unclassified (Chart 142).

Chart 142: Glass Recovered in the US (2013)



Source: USEPA – 2013

The EU recorded a growth in the average recycling rate from 69% in 2012 and 71% in 2013 to 73% in 2015. Within the EU region, more than 11.8 million tons of containers were recycled in 2013 through a bottle-to-bottle closed-loop²¹⁸.

As per the European Container Glass Federation (FEVE) statistics for 2013, within Europe, Denmark, Sweden, Switzerland, Belgium, Luxembourg and Austria had a recycling rate of over 90%. Generally, countries within Europe witnessed an increase in recycling rate with Austria recording the highest. In Austria, the recycling rate increased from 85% in 2012 to reach 93% in 2013. Other countries that marked a high increase in the recycling rates included Sweden, Germany, Slovenia and the Netherlands Table 22.

Table 22: Glass Container Recycling Rate in the EU (2013)

Country	EU Glass Container Recycling rate (2013)
DENMARK	98%
SWEDEN	97%
SWITZERLAND	96%
BELGIUM	95%
LUXEMBOURG	95%
AUSTRIA	93%
NORWAY	90%
GERMANY	88%
SLOVENIA	87%
IRELAND	79%
NETHERLANDS	79%
FINLAND	77%
ITALY	76%
CZECH REPUBLIC	75%
FRANCE	73%
LITHUANIA	72%
ESTONIA	72%
SPAIN	70%
UNITED KINGDOM	68%
BULGARIA	61%
CROATIA	57%
PORTUGAL	56%
LATVIA	55%
ROMANIA	47%
POLAND	43%
SLOVAK REPUBLIC	38%
GREECE	36%
CYPRUS	35%
HUNGARY	32%
TURKEY	23%
MALTA	21%

The global trade of glass cullet and scrap (HS Code-7001) accounted for 3.3 million tons in 2015, witnessing a decline of 1.9% during 2011–15 (Chart 143).

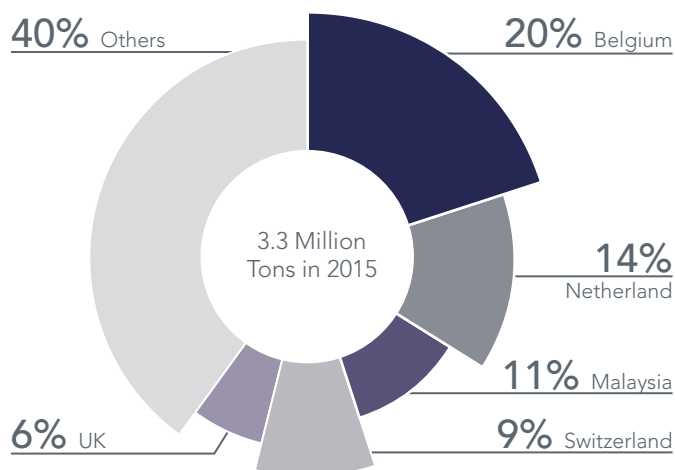
Chart 143: Global Glass Scrap and Cullet Trade, 2011-2015 (Million Tons)



Source: Trademap

Belgium, which had a recycling rate of 96% in 2013 was the leading global exporter with 0.7 million tons (20%), while the Netherlands ranked second with 0.5 million tons (14%) of the trade. Other leading exporters included Malaysia, Switzerland and the UK with a combined share of 0.9 million tons (26%) (Chart 144).

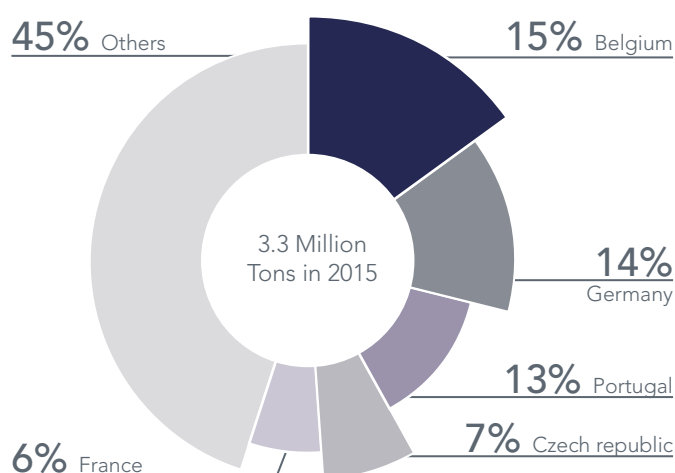
Chart 144: Leading Glass Scrap Exporters (2015)



Source: Trademap

For imports²¹⁹, Belgium was the leading global importer with 0.5 million tons (15%). The UK and the Netherlands were the leading exporters to Belgium and accounted for a combined share of 80.7% in its import. Other leading importers of glass scrap included Germany, Portugal, the Czech Republic and France with a combined share of 1.3 million tons (40%) (Chart 145).

Chart 145: Leading Glass Scrap Importers (2015)



Source: Trademap

7.5. GCC Glass Recovery Market Overview

7.5.1. Market Overview

If glass container, a 100% recyclable commodity, is left in landfills it would take hundreds of years to degrade naturally. In the GCC region, the glass waste generally coming from domestic sources is absorbed in the landfills as segregation of glass is not possible. Usually, glass containers are recyclable and are generated by beer, wine and alcoholic products that are minimal in the GCC region due to cultural restrictions. Other glass containers that are disposed are a part of domestic waste. This glass waste is contaminated when mixed with other waste and breaks into small crystals due to improper handling of waste.

The trade of glass scrap in the region was dominated by the inter GCC trade among the member countries.

The export²²⁰ of glass scrap and cullets (HS Code: 7001) from GCC countries (including inter GCC trade) decreased from 11,250 tons in 2012 to 8,990 tons in 2014, witnessing a negative CAGR of 10.6%. In 2014, almost 90% of the GCC exports were from Saudi Arabia and Qatar. Saudi Arabia exported 5,491 tons (61.1%) of cullet and scrap. It also exported 3,476 tons of glass waste and cullet to Kuwait, and about 1,615 tons to the UAE, apart from other countries like Oman and Germany. Oman ranked third in the GCC exports and accounted for 6.4% of the glass exports. All of the exports from Oman were directed to Iraq (Chart 146).

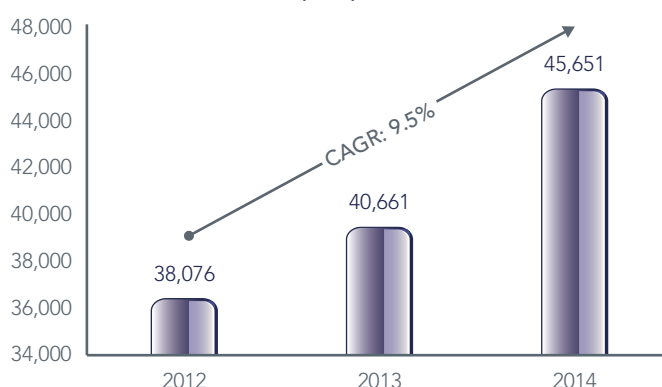
Chart 146: GCC Glass Scrap Export, 2012-2014 (Tons)



Source: Trademap

The imports²²¹ of glass cullets registered a CAGR of 9.5% during 2012 and 2014. The imports increased from 38,076 tons in 2012 to 45,651 tons in 2014 (Chart 147).

Chart 147: GCC Glass Scrap Import, 2012-2014 (Tons)



Source: Trademap

The UAE and Saudi Arabia due to the presence of glass manufacturing companies were the leading importers of glass cullet and scrap with a combined share of 74.2%.

In 2014, Saudi Arabia accounted for 19,539 tons (42.8%) share of glass cullet and scrap in the GCC imports, with over 99% of them coming from the UAE.

The UAE imported 14,336 tons (31.4% of GCC imports) of cullets and scrap in 2014. Ghana had the major share (40.6%) in the UAE's import, while Sri Lanka accounted for 21.7%. Saudi Arabia also imported 1,653 tons of cullets to the UAE in 2014.

The share of Kuwait, Oman and Bahrain in the GCC imports was 5,577 tons (12.2%), 3,862 tons (8.5%) and 2,284 tons (5%), respectively. Qatar imported a negligible amount of 53 tons during 2014.

^{219, 220, 221} Trademap

For Kuwait, almost 80% of the imports were from Saudi Arabia and the UAE, while for Oman 84% imports were from China. In case of Bahrain, all glass imports came from Germany.

7.5.2. Leading Companies in the GCC Market

In the GCC region, the glass manufacturing companies do most of the glass recovery as they utilize the recovered glass cullets for their in-house production purposes. However, currently there are no companies operating in the glass recovery sector.

In UAE, Orwell International has signed an agreement with TSSC, Dubai to start the first national glass bottle closed-loop (bottle to bottle) recycling program in the UAE²²². The value of this deal is estimated to be USD3.3 million. Through this facility, waste glass bottles that are currently landfilled in UAE is expected to be recovered and recycled.

7.6. Qatar Glass Recovery Market Overview

7.6.1. Historical and Current Waste Generation

Glass scrap in Qatar is generated from glass containers and construction activities, and is collected along with other MSW. In MSW, glass scrap accounts for approximately 3%²²³. Due to lack of source segregation and improper handling, glass scrap is generally broken down into particles and hence not separable from other types of waste. There is no collection/recovery of glass scrap generated from MSW and hence, it is dumped in the landfills.

During 2010, approximately 25,399 tons of glass scrap was generated and landfilled. In 2015, the glass scrap increased to 34,988 tons, witnessing a CAGR of 6.7% between 2010 and 2015. In 2016, the amount of glass scrap is estimated to be 37,558 tons, a year-on-year increase of 7.35% (Chart 148).

Chart 148: Glass Scrap Generated from MSW in Qatar, 2010-2016E (Tons)



Source: MDPS Environment Statistics 2014, Team analysis

7.6.2. Market Size Segmentation by Product Segments

As glass scrap generated in Qatar is landfilled due to the contamination and absence of any glass recovery facility, the proportion of different types of glass scrap is unknown.

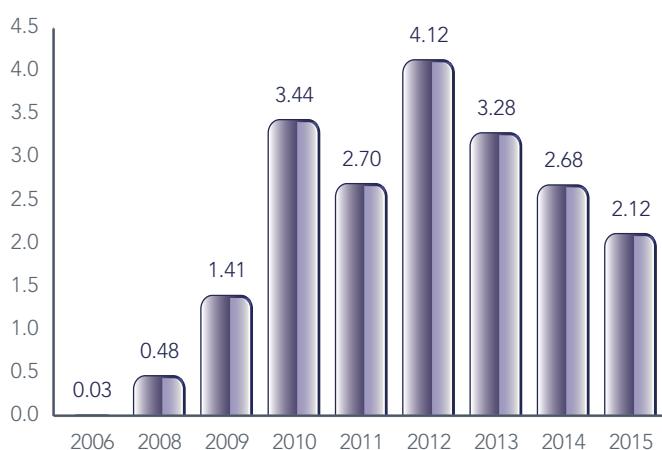
7.6.3. Analysis of Exports and Imports

In this section, the trade of glass cullets and waste is described as per the data under HS Code: 7001. The analysis presented below is at four-digit HS Code.

Exports²²⁴: Despite the fact that there are no companies engaged in the recovery of glass, the country still exported a considerable amount of glass cullets and scrap during 2008–15. This export was the glass scrap generated by the manufacturing companies that use glass in their production processes in one form or the other. The exports of glass cullets and scrap saw an increase from 479 tons in 2008 to 4,124 tons in 2012, registering a CAGR of 71.34%. Prior to this, during 2001–07, there was almost no exports of glass cullets and scrap from Qatar.

In 2012, the country exported the maximum quantity of scrap and cullet in a single year (4,124 tons). However, the export of scrap and cullet post 2012 has seen a continuous downfall. The country exported 2,121 tons in 2015, a decline of 19.9% from 2012 (Chart 149).

Chart 149: Qatar's Glass Scrap and Cullets Export, 2005-2015 ('000 Tons)



Source: Trademap

At eight-digit HS code, the trade of glass scrap and cullet is done under 70010000 and 70019999 only. Except for 2014, the trade was carried out under 70010000 every year.

UAE, Kuwait and Saudi Arabia imported glass cullet and scrap from Qatar between 2005 and 2015. In 2015, the UAE accounted for 842 tons (39.7%) of the exports, while Kuwait and Saudi Arabia had a share of 795 tons (37.5%) and 484 tons (22.8%), respectively.

²²² "World First National Glass Bottle Closed-Loop Recycling Programme Launched in the UAE", pelmfg.com

²²³ Research paper by Imad A. Khatib: "Municipal Solid Waste Management in Developing Countries"

²²⁴ Trademap

Please note that this export quantity was not due to the collection of glass scrap in Qatar but was re-exports. In 2013 and 2014, country re-exported 3,282 tons and 2,731 tons respectively and these were all directed to Saudi Arabia, Kuwait and UAE. Prior to 2013, no data or information is available regarding re-exports of glass scrap and cullets.

Imports²²⁵: As the country does not have any glass recovery facility, the imports (HS Code: 7001) have been miniscule. In fact, the imports have seen a negative CAGR of 22.22% from 2005 onward until 2015.

The imported quantity in 2015 was only 48 tons while in 2005 it was 586 tons. The imports were done primarily from the UK in the form of glass cullets that accounted for 24 tons in 2015 (Chart 150).

Imports of glass cullets in Qatar are miniscule and is used for landscaping and decoration purposes.

Chart 150: Qatar's Glass Scrap and Cullet's Import, 2005-2015 (Tons)



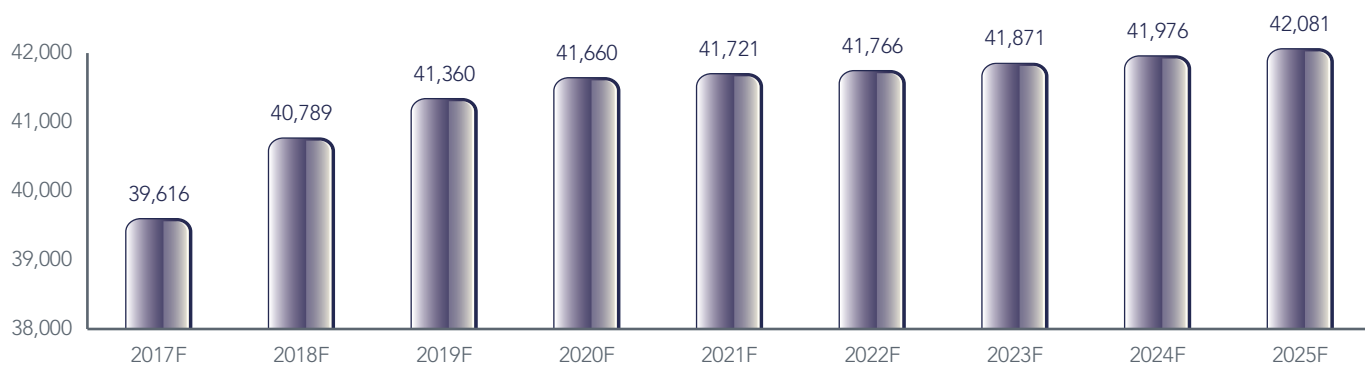
Source: Trademap

7.6.4. Waste Generation Forecast

The generation of glass scrap during 2017–25 is estimated based on the average per capita MSW generated during the period 2008–14 that is equal to 1.37kg per person per day. Glass accounts for approximately 3% of the MSW generated.

Based on the population forecast and per capita waste generation, it is estimated that approximately 37,558 tons of glass scrap will be generated in Qatar in 2016. This is expected to reach 39,616 tons in 2017 and could increase to 42,081 tons in 2025 (Chart 151).

Chart 151: Glass Scrap Generation from MSW in Qatar, 2017F-2025F (Tons)



Source: Trademap, Team analysis

²²⁵ Trademap

7.6.5. Demand for Recovered Material

There are no glass manufacturing companies in Qatar and hence, the entire demand is fulfilled through imports from UAE, China and Saudi Arabia.

Thus, the recovery companies if set up in Qatar will have to export the recovered cullets to other countries. Domestically, recovered cullets can be used for preparation of glassphalt which can be used for roads, highways and airports or in landscapes and for decorative purposes.

7.6.6. Assessment of Supply Landscape

Based on the primary research conducted with the recovery facilities operating in different products segments and with the waste management companies, we understand that there are no glass recovery facilities in Qatar and currently, all the waste generated is disposed in landfills. The leading waste management company, such as Seashore, dumps almost 1,200 tons of glass waste annually in landfills.

7.6.7. Pricing Analysis

Glass is a 100% recyclable material that can be recycled infinite times. However, if glass is broken down into small crystals, its value declines considerably. Qatar exports glass scrap that is in the form of small crystals and is generated from manufacturing companies, a major reason behind the low export price per ton. The export price²²⁶ from 2006 and 2015 has varied in the range of QAR42 per ton and QAR337 per ton with an only exception in 2009, when the export price was maximum i.e., QAR476 per ton.

In 2007, there was no exports on glass scrap from Qatar and hence, the corresponding data is not represented in the graph (Chart 152).

Chart 152: Qatar's Glass Scrap Export Prices, 2005-2015 (QAR/Ton)



Source: Trademap, Team analysis

²²⁶ Trademap

7.6.8. Analysis of Business Model and Presence/Absence of Key Synergies

As stated in the earlier sections, Qatar neither has a glass recovery facility nor has any scrap trading facility, and thus, glass scrap is disposed in landfills. The glass scrap, which is non-decomposable in nature, has piled up over the years in the designated landfills, resulting in the shortage of dumping areas. However, in line with Qatar National Development Strategy that focuses on increasing the recovery rate of products, facilities can be set up for recovery of glass. The most feasible business models for glass recovery are illustrated below:

Business Model 1: Trading of Scrap Glass – glass scrap in this model can be collected via:

- **Take-Back Units:** Similar to the practice in the European countries, take-back units can be set up in the country for the collection of glass containers, directly from end consumers.
- **Waste Management Companies:** Waste management companies can collect glass containers from households and commercial units, such as shopping malls and offices, by placing a separate bin.

This container waste is sorted by the take-back units based on color and then resold to the recovery facilities operating in the country or exported overseas.

Figure 32: Business model 1: Trading of Scrap Glass



Business Model 2: Recovery of Scrap Glass – in this model, waste management companies can collect waste from households and commercial units mixed with other solid waste, or can place bins (sorted at source) in commercial places for the collection of glass containers. This waste post collection can be separated by the waste management facility and then directed to the glass recovery facilities operating in the country.

Figure 33: Business Model 2: Recovery of Scrap Glass



7.6.9. SWOT Analysis

Figure 34: SWOT Analysis – Glass Recovery



Summary:

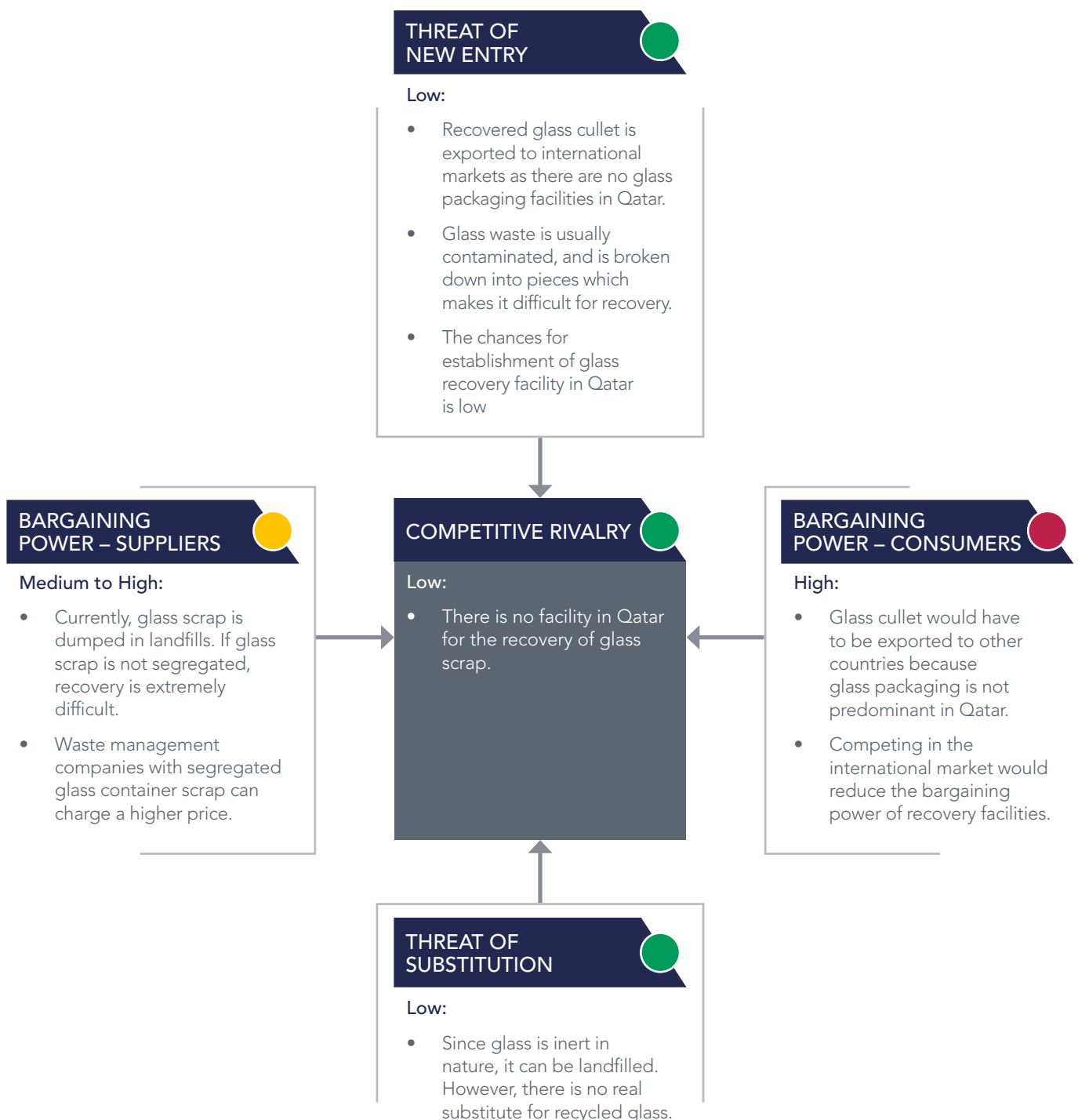
Glass containers can be recovered and recycled endlessly but due to the absence of proper collection channels in the country, they are dumped in the landfills. There is no downstream opportunity for recovered glass in Qatar and hence, the recovered glass cullets can only be exported to other countries.

7.6.10. Regulations

- Currently, glass is not recycled in Qatar and is dumped in the landfills. There are no clear regulations on handling, recovery and export of glass waste.

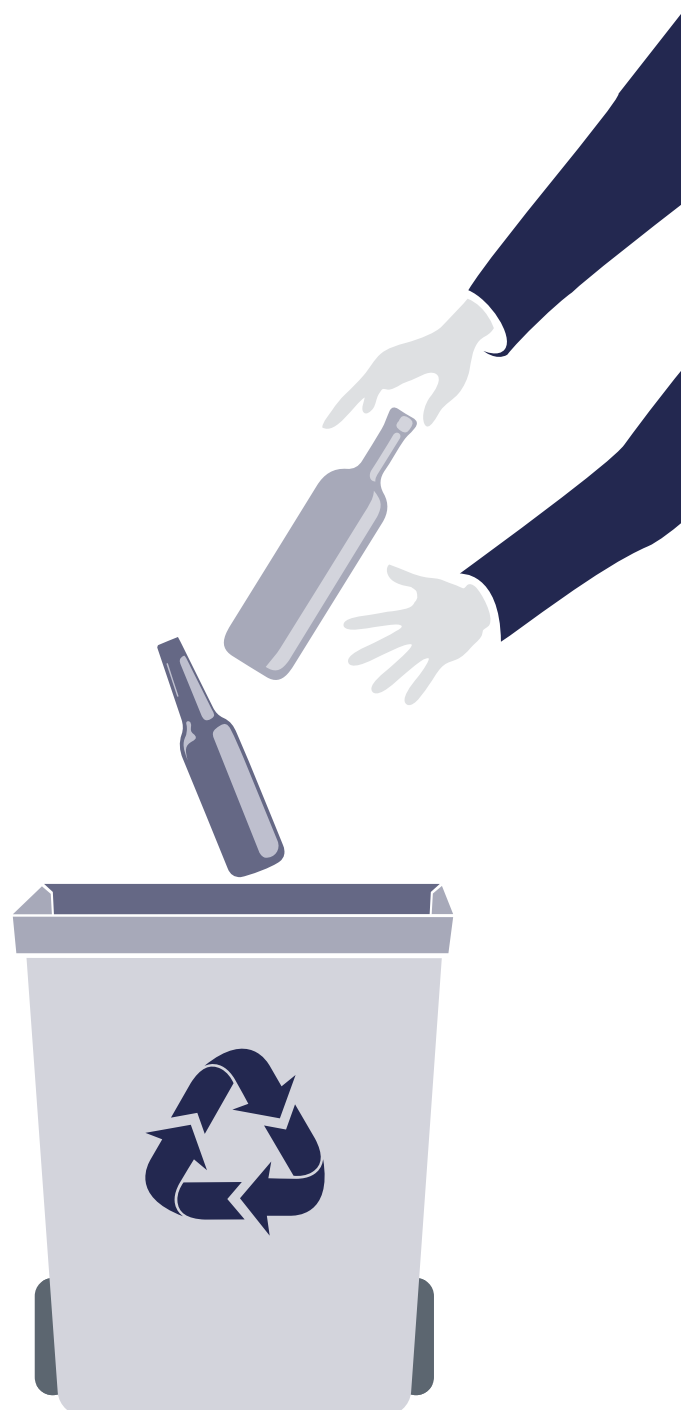
7.6.11. Michael Porter's Five Forces Model

Figure 35: Michael Porter's Five Forces Model – Glass



7.6.12. Key Takeaways and Potential Opportunities

- Glass scrap in Qatar is generated through glass containers, construction activities and households, most of which is comingled with MSW.
- Glass scrap generated in Qatar is mixed with other waste and is not segregated at source. This results in contamination of glass. In addition, due to lack of awareness, glass containers gets broken into pieces and is difficult to recover.
- Qatar is estimated to generate 37,558 tons of glass waste in 2016 and will reach 42,081 tons in 2025.
- Currently, there is no glass recovery facility in Qatar and hence the generated scrap is dumped in the landfills.
- There is no potential for glass recovery firms in Qatar because of the absence of any glass manufacturer.
 - Domestically, recovered cullets can be used for preparation of glassphalt which can be used for roads, highways and airports or in landscapes and for decorative purposes



8. WASTE OIL

8.1. Overview of Waste Oil

8.1.1. Description

Lube Oil: Oil production is done by either using crude oil or synthetic oil. The products of crude oil are gasoline, lubricant, diesel heating oil, residual fuel oils, liquefied refinery gas, still gas, coke, etc. Upon the use of oil for different applications, it becomes contaminated and is discarded for any future use. This contaminated oil is known as waste oil.

The Basel Convention defines waste oil as the oil from industrial and non-industrial sources, which has been used for lubricating or other purposes, and has become unsuitable for its original purpose due to the presence of contaminants or impurities or the loss of original properties. Such waste oils are classified as hazardous waste.

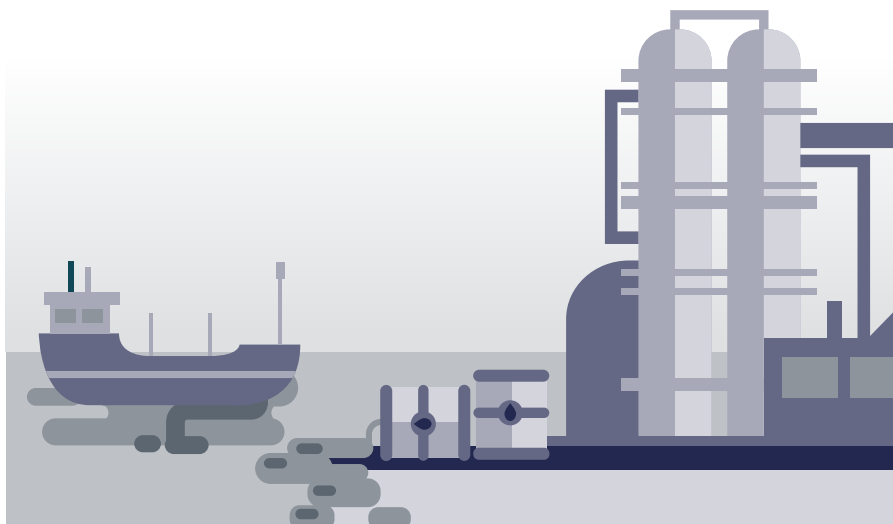
This waste oil can be recovered through separation and refinement. Certain types of waste oils, such as lubricants in particular, can be reprocessed and reused as a lube base stock or clean burning fuel. Waste oils and residues that cannot be reused in any manner are disposed in an environmentally sound manner.

WCO: As the natural reserves of crude oil is a non-renewable source of energy, countries have started focusing on alternate fuels.

Cooking oil is used in the preparation of food or semi-cooked food and is heated at a temperature of 160°C to 200°C in the presence of light. Usually, the cooking oil for frying purposes is used repeatedly in hotels/ restaurants for economic viability.

When used repeatedly, edible oil witness changes such as increase in the free fatty acids content, color darkening that highly depends on the frying process intensity/ duration and cooking oil type.

The remaining oil generated as a result of cooking that is not appropriate for cooking purposes is known as Waste Cooking Oil. This WCO is yellowish in color and is also known as yellow grease. This also includes the unused cooking oil abandoned for reasons such as spoilage.



8.1.2. Classification

Waste oil is generated by different industries. A brief description of major waste oil generating sources is given below:

Table 23: Categories of Waste Oil

Classification	Definition
Automotive waste oil	<ul style="list-style-type: none">Waste oils are generated in service stations, garages, new car dealer showrooms, other retail establishments and automotive fleet service areas.Such waste oils are flammable and contain toxic ingredients.
Industrial waste oil	<ul style="list-style-type: none">Industrial waste oils may be either lubricating or non-lubricating ones, including turbine oils, gas engine oils, refrigeration oils, heat transfer oils, compressor oils, hydraulic oils and metal cutting oils.
Marine waste oil	<ul style="list-style-type: none">Ocean-going ships and vessels generate a high quantity of waste oils, lubrication greases and contaminated fuel oils.This waste oil is discharged during port calls.
Power sector waste oil	<ul style="list-style-type: none">Transformers used in the power sector use oil as an internal coolant to provide added insulation and protection against arcing.This oil is contaminated due to chemical interactions with windings and other solid insulation, and also because of high operating temperature.
Other waste oil	<ul style="list-style-type: none">Aviation waste oils include gas turbine and piston engine oil.The other major sources of waste oil are the railways, and mining operations and similar activities.

WCO is categorized on the basis of collection source:

From Restaurants in the Form of Used Cooking Oil: This is generally collected by the restaurants in the bottles/ jars and supplied to recovery facilities operating in the region.

From Grease Trap: The oil that is drained out is collected through the grease trap. This is done because oil tends to clog the sewers and hamper wastewater treatment process.

Unused Cooking Oil: This category of oil is unused in nature but gets contaminated due to external factors and is not fit for cooking purposes.

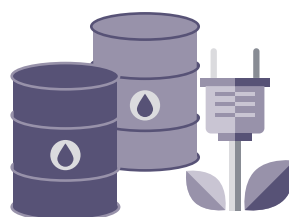


8.1.3. Benefits of Waste Oil Recovery



30% to 40%

Recycled base oils save up to 30% to 40% of energy required in the primary production of lubricants.



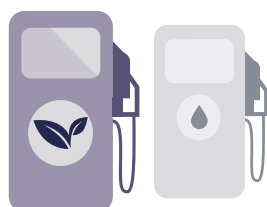
Recycling two gallons of automotive used oil saves enough energy to generate electricity of an average home in the US for at least a full day.



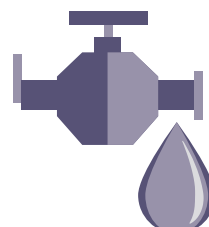
As per an EPA environmental report, it was found that a gallon of used oil produces 2.5 quarts of lubricating oil. In comparison, it takes 42 gallons of crude oil to produce the same amount of 2.5 quarts of lubricant.



WCO is recovered in the form of biodiesel, a resource that is renewable in nature. The recovered product do not release any chemicals and thus is good for the environment.



Biodiesel does not emit any greenhouse gases in comparison to the petroleum products such as petrol and diesel.



Improper and ineffective draining system adapted by the restaurants results in contaminating the water. As per estimates, one liter of WCO poured into natural water may pollute 500,000 liter of water²²⁷. Thus, recovery of WCO results in reducing the water pollution also.

²²⁷ "Journal: Applications of Waste Cooking Oil Other Than Biodiesel: A Review", ijche.com

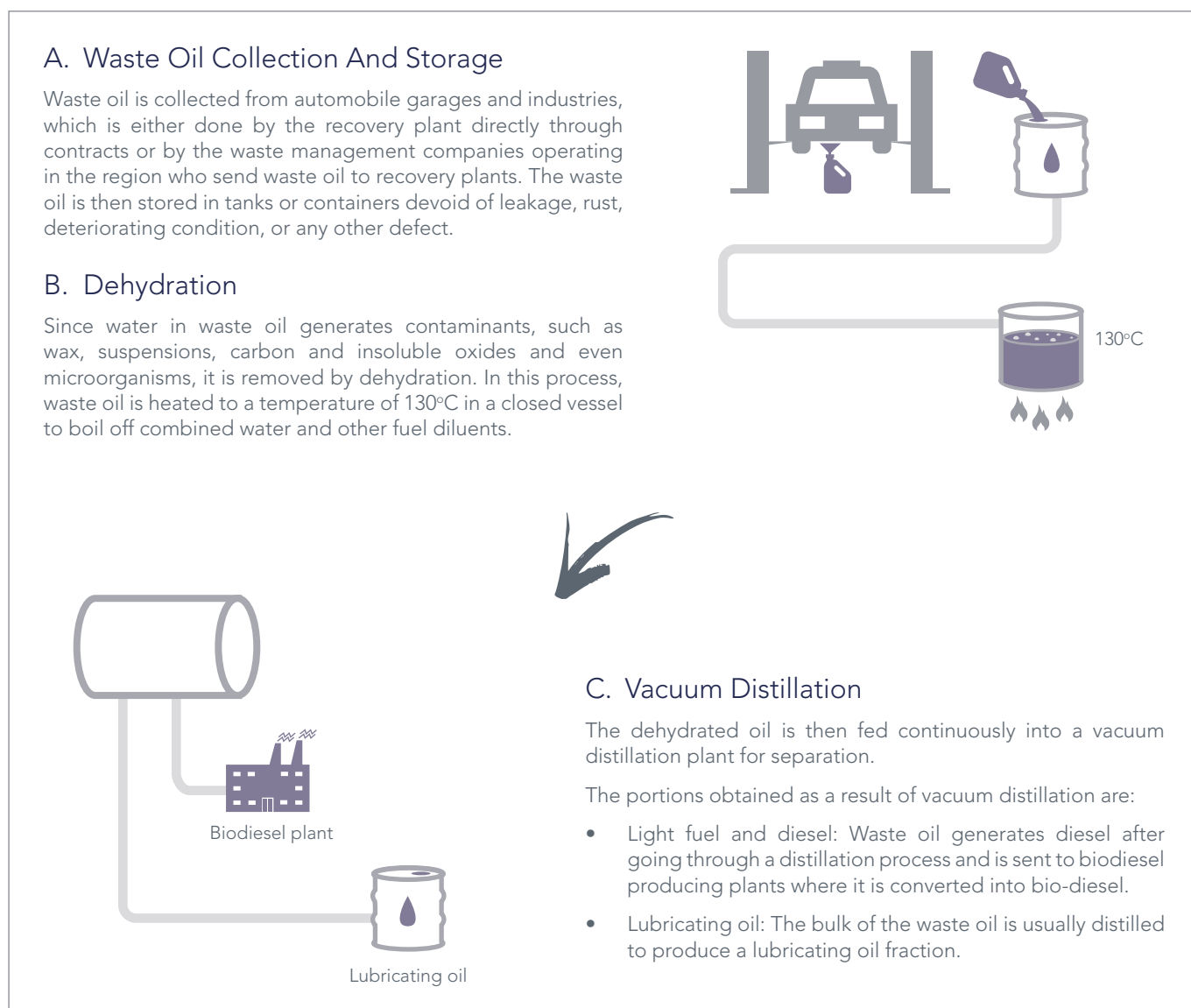
8.2. Waste Oil Recovery Process

Lube Oil: Lube oil recycling can be done in the following different ways:

- **Reconditioning On-site:** In this process, a filtering system is used to remove impurities at the site where the oil is being used, prolonging the life of the oil. This method is useful for factories or other large operations that generate a lot of waste oil.
- **In a Petroleum Refinery:** Waste oil goes through a petroleum refining process to produce gasoline.
- **Re-refining into Base Stock for New Lubricating Oil (Lube to Lube conversion):** Re-refining prolongs the life of oil resource indefinitely. In this, oil is dewatered, distilled and hydro-treated to remove contaminants. The recovered product is virtually identical to virgin oil stock. This process is explained in detail in this section.
- **Processing and Burning for Energy Recovery:** In this process, oil is filtered to remove water and contaminants, and then burned to produce heat to power industrial operations. This is the least preferred method as once the oil is burned, there's no way to recycle it again.

Waste lube oil is recovered into base oil using the following method:

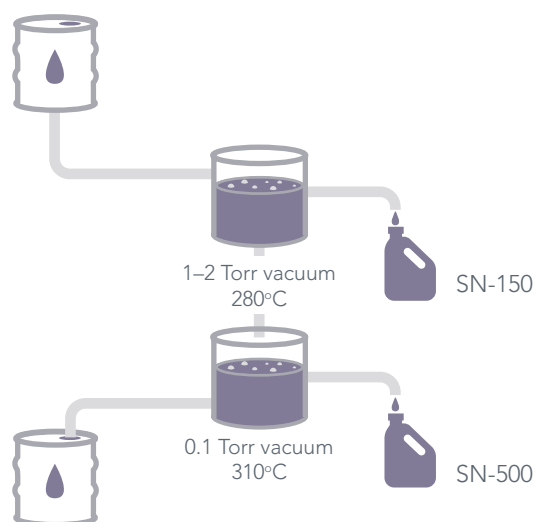
Figure 36: Waste Oil Recovery Process



D. Separation of Oil Fractions

Thin film evaporation system consists of two thin film evaporators, W-101 and W-102 to recover SN-150 and SN-500 grade base oil, respectively.

- SN-150: W-101 is operated at 1–2 Torr vacuum at 280°C. The lubricating oil free from diesel is fed here and SN-150 is obtained as a product, and collected in product receivers, while the residue goes to residue receivers due to gravity.
- SN-500: Residue from W-101 is pumped and fed into W-102 by rotary gear pump. This is operated at 0.1 Torr vacuum at 310°C. In W-102, SN-500 is obtained as a product and collected in product receiver tank, while the residue gets settled in residue collection tank by gravity.
- Residue: Residues, such as carbon, wear metals, additives, lead and oxidation products, are generated as a part of this process and are used as bitumen extender for laying roads.



E. Solvent Extraction

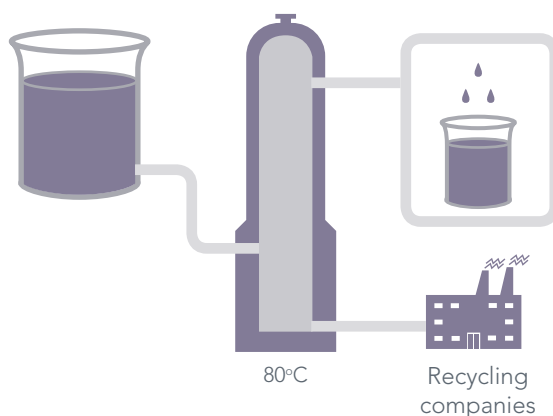
Once the lubricating oil is separated through vacuum distillation process, Methyl Ethyl Ketone (solvent) is added to it in the ratio of 2:1.

The lubricating oil and solvent mixture is allowed to settle in a separator tank. The aromatic content and degraded additives present in the lubricating oil settle at the bottom of the container and the mixture of lubricating oil and solvent forms a layer at the top.

F. Atmospheric Distillation

A mixture of lubricating oil and solvent obtained during solvent extraction is subjected to atmospheric distillation. The atmospheric distillation is carried out at the boiling temperature of Methyl Ethyl Ketone, i.e., about 80°C.

The MEK vapor produced is condensed and is again used as solvent by blending with fresh solvent, while lubricating oil is sent to the recycling companies. Oil produced at this stage is similar to that of the base lubricating oil.



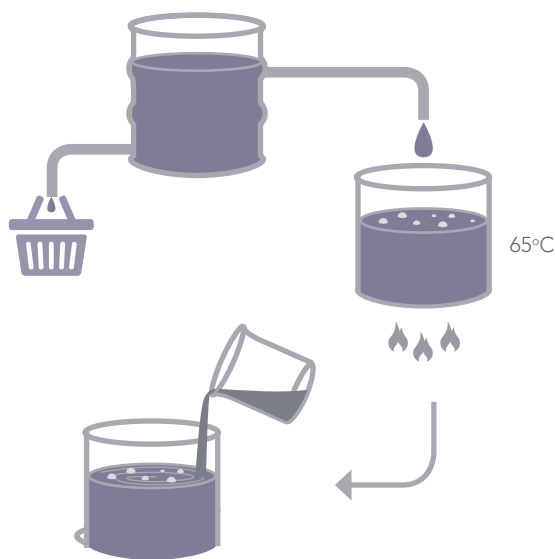
WCO: WCO is processed through a series of chemical reactions that result in the recovery and production of biofuel primarily biodiesel. The process includes:

Figure 37: WCO Recovery Process

A. Collection and Storage of WCO

Recovery facilities collect the WCO from fast food restaurants and food manufacturers and also from schools, hospitals and even homes (in countries which have awareness programs for recovery of waste oil).

The recovery facility stores the waste oil for few days so that the heavy waste mixed with WCO settles down. The longer it is left to settle, more quantity of heavy waste settles down and water gets separated from WCO.



B. Removal of sludge

This sludge is removed from the bottom of WCO and the remaining oil is further processed.

C. Heating of WCO

The WCO is boiled at 65°C so that it can undergo chemical reaction.

D. Catalyst reaction

A swirl effect is created in a reactor and boiled WCO is mixed with methanol.

E. Separation of glycerol and oil

As a result of the chemical reaction, glycerol is produced, which is separated and the remaining oil is poured into dry wash columns.

F. Dry wash

In this step, serial dry wash columns with water saving ion exchange resin are used. This process further separates the impurities from the oil by use of magnets.

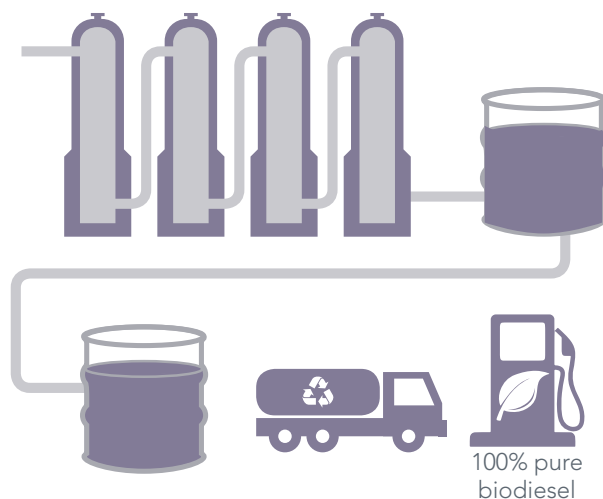
G. Removal of methanol and water

The remaining oil is poured into a recovery tank where methanol (catalyst) is removed.

After this, it is treated for the removal of water traces from the oil.

H. Purification

This is the last and final step for the conversion of WCO to biodiesel. The oil is purified and produces B100 i.e. 100% pure biodiesel.



8.3. Recovered Waste Oil Applications

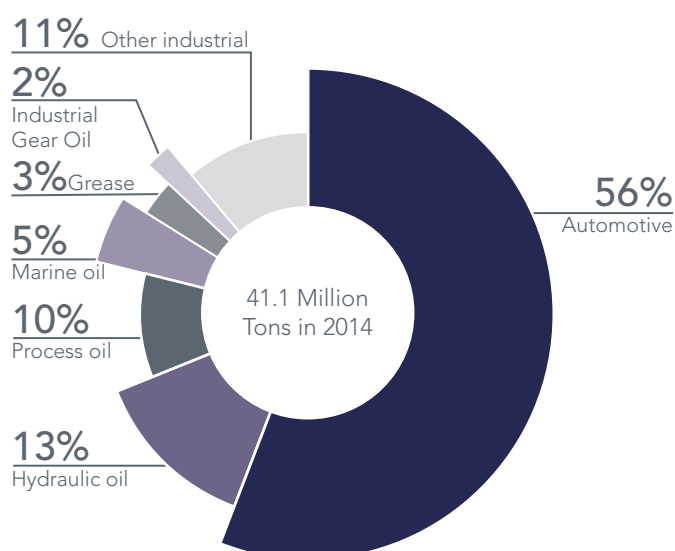
Recycled oil can be used for the following applications²²⁸:

- Burner oil and re-refined base oil for use as a lubricant, hydraulic or transformer oil
- Bitumen-based products
- An additive in manufactured products.
- Biodiesel produced as a result of WCO recovery can be used in automobiles (either in pure form or after mixing with petroleum diesel) and for power equipment such as generator sets and other heavy machineries.

8.4. Global Waste Oil Recovery Market Overview

Lube Oil: Lubricants are used for a diverse range of applications across different sectors. However, a major portion of lubricants is consumed in the transport sector. The demand in this sector is driven by the replacement of motor oil that is done after every 10,000–20,000km. In addition, rapid growth in the number of cars and trucks in the developing nations is also an important factor driving the high percentage of automotive lubricants. This product segment thus comprise 56% of the global lubricant usage²²⁹ (Chart 153).

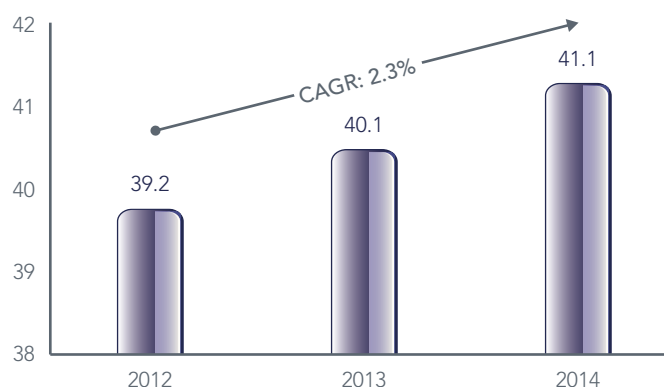
Chart 153: Global Lubricant Market, By End-use (2014)



Source: UNEP-2013

In 2014, global lubricant market comprises only 1.1% (41.1MMT) of the total crude oil products. As per the report published by the Fredonia Group, the global lubricant market increased from 39.2 MMT in 2012 to reach 41.1 MMT in 2014, witnessing a CAGR of 2.3%²³⁰ (Chart 154).

Chart 154: Global Lubricant Market, 2012-2014 (MMT)



Source: Fredonia group

Owing to improper collection practices, indiscriminate dumping, burning of oil, etc., the global waste oil collected for recycling accounts for 16 MMT of the total lubricant used.

As per UNEP, Asia accounts for 30% of the global waste oil generation followed by the US with 22%²³¹. However, in Europe²³², approximately 5.89 MMT of the total lubricant oil was consumed in 2012, of which, waste oil generated amounted to 2.7 MMT (45.8%). Approximately 2.17 MMT (80%) of the waste oil generated was collected and processed. This was used primarily for the replacement of heavy fuel oil and coal and a portion of the collected waste was re-refined and used as base oil.

In 2012, among the EU member countries²³³, Germany (at 21%) had the highest amount waste oil generated followed by France (19%) and the UK (18%), primarily being the largest economies in the EU. Germany collected 99% of the waste oil generated while Luxembourg collected 98%. Spain, Austria, France and Greece witnessed a collection rate of less than 70% (Chart 155).

²²⁸ "Used motor oil a valuable resource", environment.gov.au

²²⁹ "International Environmental Technology Centre, Policy Brief on Waste Oil-What, Why and How", unep.org

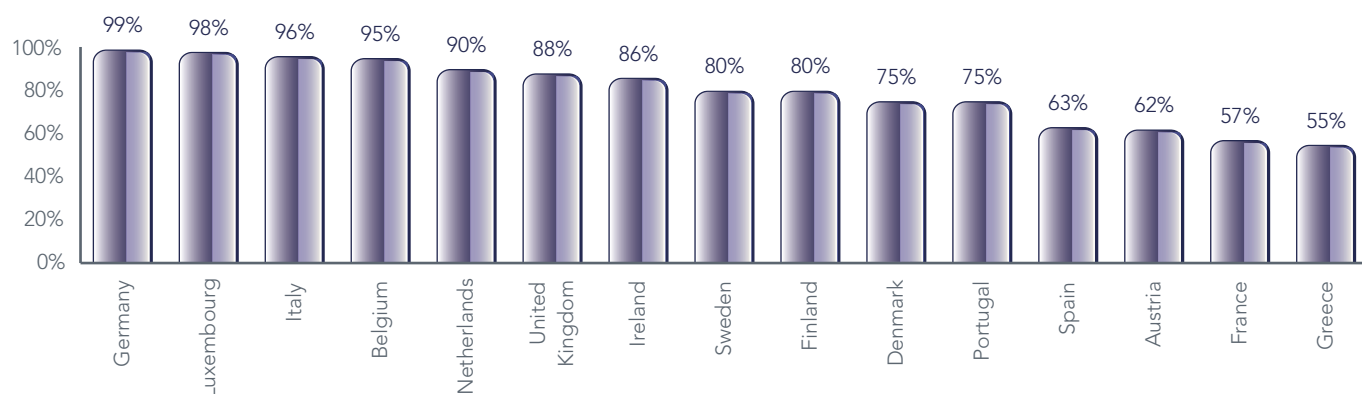
²³⁰ "World Lubricants", fredoniagroup.com

²³¹ "Compendium of Recycling and Destruction Technologies for Waste Oils", Page 28, unep.org

²³² "Addressing New and Emerging Waste Issues through 3Rs Approach", uncrd.or.jp

²³³ "presentation at European Recycling society conference", Page 8, green-planet.or

Chart 155: Waste Oil Collection Rate in the EU (2012)



Source: GEIR

In the US, 4.09 MMT of waste oil, i.e., 1.3 billion gallon (1 gallon = 0.0031 ton of oil), is produced each year, of which 2.48 MMT (800 million gallons) are recycled while almost 40% is not²³⁴.

In Asian countries, such as China and Japan, there are no rigorous national-level recycling programs being implemented. The waste oil collected is used, treated and burned to replace heavy oil and coal with little refining processes.

WCO: As per Allied Market Research²³⁵, The global advanced biofuel market, which includes vegetable oil, is expected to reach USD24 billion by 2020.

Ecofys (a leading consultancy in renewable energy, energy & carbon efficiency, energy systems & markets and energy & climate policy) estimates that maximum collectable WCO potential in the gastronomy sector of EU-27 was around 972,000 tons in 2013²³⁶.

As per estimates by BioDieNet Project²³⁷ (focuses on biodiesel production from used cooking oil) in 2009, the total UCO potential i.e. expected generation in the EU-27 was 3.55 million tons i.e. 8 liters of WCO per capita. Of this 3.55 million tons of WCO, the contribution of the household sector was 1.748 million tons per year. It is estimated that over 60% of the household WCO is disposed inappropriately.

In the United Kingdom, the government has set up a policy named RTFO for reducing the amount of GHG emitted by the automobiles. The RTFO requires that a certain percentage of fuel is renewable and provides a valuable incentive for the biofuels industry, which contribute towards meeting this obligation²³⁸. The standards set under RTFO suggest that fossil petrol is mixed with bioethanol in a ratio of 52:48 while biodiesel is mixed with fossil diesel in equal ratio.

It is estimated that UK generates around 250 million liters of WCO annually²³⁹. Of this 250 million tons, it is estimated that 150 to 200 million liters is generated by commercial units while the remaining is generated by households. In 2013, around 99 million liters of the waste was collected and recycled into biodiesel while the remaining 151 million liters remained uncollected. Most of the collected waste is from commercial units and households account for less than 5% of the collected WCO.

As per the National Render Agency, in the US, it is estimated that 926,400 tons of WCO²⁴⁰ was collected in 2015, growing from 868,800 tons in 2010 at a CAGR of 1.6% (Chart 156).

Chart 156: WCO Collection in the US, 2010-2015 ('000 tons)



Source: National Render Agency, USA

²³⁴ "Best Practices for Waste Oil Management", machinery lubrication.com

²³⁵ "McDonald's UAE completes 5 million kilometres on McFuel biodiesel", the national.ae

²³⁶ "Low ILUC potential of wastes and residues for biofuels", ecofys.com

²³⁷ "Trends in the UCO market", gov.uk

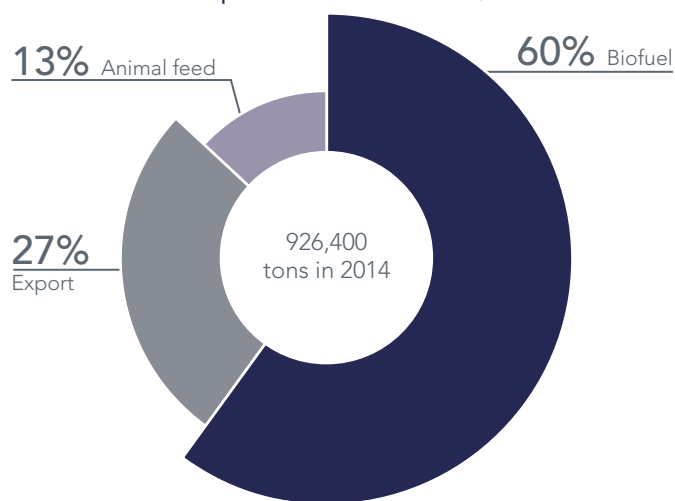
²³⁸ "Renewable Transport Fuel Obligation Annual Report 2014-15", gov.uk

²³⁹ "Environmental Audit Committee – Green Economy", publications.parliament.uk

²⁴⁰ The International magazine of rendering April 2016, pubs.rendermagazine.com

The WCO collected is put to use for different purposes. Around 558,900 tons of WCO was used in the generation of biofuel while 114,700 tons was consumed for animal feed, with some used in oleo chemicals. The remaining (252,800 tons) was exported with major EU-28 being the major shareholder (Chart 157).

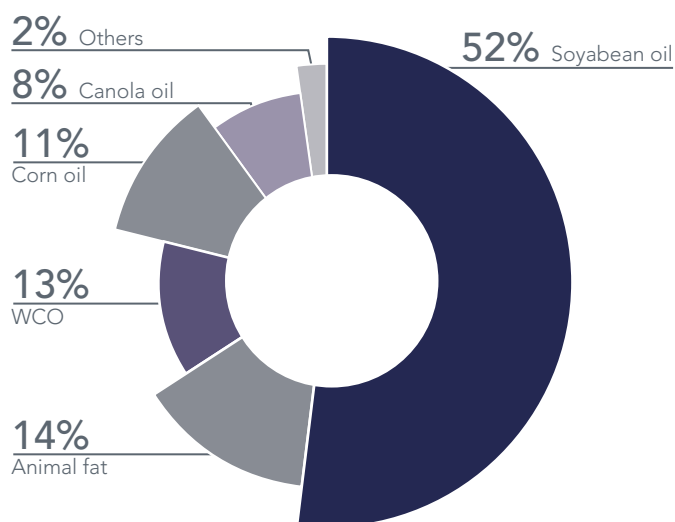
Chart 157: Consumption of WCO in the US, 2015



Source: National Render Agency, USA

More than 80% of biodiesel produced²⁴¹ in the US is from vegetable oil. Amongst different categories of vegetable oil, soybean oil accounts for approximately 52% while animal fat and WCO hold a share of 14% and 13% respectively (Chart 158).

Chart 158: Source of Biodiesel Generation in the US (2015)



Source: US EIA

²⁴¹ EIA Database, eia.gov

²⁴² "Compendium of Recycling and Destruction Technologies for Waste Oils", Page 28, unep.org

²⁴³ "The future of waste oil refining in the UAE", arabianoilandgas.com

²⁴⁴ "Turn your waste cooking oil into biodiesel", gulfnews.com

²⁴⁵ "UAE recycling: Dubai plant takes used cooking oil and turns it into fuel", thenational.ae

8.5. GCC Waste Oil Recovery Market Overview

8.5.1. Market Overview

Lube Oil: In the GCC region, recycling waste oil is a relatively new phenomenon as the region, owing to large oil reserves, never focused on waste oil recycling. Historically, many local governments in the GCC region discouraged waste oil recycling, as it was perceived as competition to the state-owned grease and lube manufacturers.

However, in the past few years, with the rapid increase in automobiles, which is the largest lubricant oil-consuming segment, the region has seen establishment of recycling plants for re-refining of waste oil. In addition, waste oil recycling industry in GCC has seen a growth over the past decade as the waste oil generators, such as gas stations, garages and industries, saw refiners as an economical way for disposal the used oil.

As per UNEP waste oil report²⁴², the Middle East region consumes about two million tons of lubricants annually. Within the GCC region, the UAE and Saudi Arabia are the leading markets for waste oil recycling. Estimates suggest that in the UAE about 200,000–250,000 tons of waste oil is collected annually²⁴³.

Under the HS Code: 271091 (Waste oils containing polychlorinated biphenyls, polychlorinated terphenyls or polybrominated biphenyls), UAE was the only exporter with 5,500 tons in 2014. In 2012 and 2013, Oman exported 245 and 692 tons respectively. All the exports from Oman were directed to UAE only.

UAE was the only importer of waste oil. The quantity of waste oil imported to UAE during 2012, 2013 and 2014 was 3,845 tons, 9,183 tons and 4,952 tons respectively. 33% of the imports in 2015 were done from Iran while 60% of waste oil was sourced through unknown destinations.

WCO: Recovery and recycling of WCO in the GCC region is still in the nascent stage primarily due to lack of collection channels, easy availability of crude oil at low prices and low awareness of WCO recycling amongst households and fast food units.

However, the UAE and Oman have started focusing on the advantage of biofuels and have launched social awareness campaigns and initiatives through tie-up with leading food chains and universities. They organize events to educate the public about the benefits of WCO recycling.

For ex: Tadweer²⁴⁴ (the Centre of Waste Management Abu Dhabi) has launched an initiative to convert household's cooking oil waste into biodiesel for vehicles. For this initiative, the residents are provided with five liter containers for WCO collection.

McDonalds²⁴⁵ in UAE has 135 outlets and supplies around 300,000 liters a month through 16 vehicles to one of the recovery facilities to get it refined into various forms of biodiesel. Until November 2015, McDonald UAE fleet has completed 5 million kilometers on biodiesel.

In Oman²⁴⁶, Coeja Eco Solutions started recovery and recycling of WCO from 2012. They collect WCO from 11 McDonald outlets and recover them into biofuel.

8.5.2. Leading Companies in the GCC Market

Some of the leading companies operating in the region:

Table 24: Waste Oil Recovery Companies in the GCC Market

Company	Year of Establishment	Country	Activity	Annual Capacity	Type of Waste Oil
United Lube Oil Company Ltd	2002	Saudi Arabia	• Recovery	100,000 Tons	Lube Oil
Global Environmental Management Services	2008	Saudi Arabia	• Collection • Recovery	NA	Lube Oil
Ocean International Lube Oil Re-Refining Company	2006	Saudi Arabia	• Recovery	NA	Lube Oil
Kuwait Lube Oil Company	1998	Kuwait	• Recovery	NA	Lube Oil
AGAS LUBES W.L.L.	2011	Bahrain	• Recovery	36,000 Tons	Lube Oil
Master Lube LLC	2010	UAE	• Recovery	15,000 Tons	Lube Oil
Oil Tech LLC	NA	UAE	• Recovery	NA	Lube Oil
DureOil Middle East Foundation	NA	UAE	• Recovery	1,000,000 Liters	Lube Oil
ME LUBES	2009	Oman	• Collection • Recovery	80,000 Tons	Lube Oil
Neutral Fuels	2009	UAE	• Collection • Recovery	NA	WCO
Coeja Eco Solutions	2009	UAE/Oman	• Collection • Recovery	NA	WCO

8.6. Qatar Waste Oil Recovery Market Overview

8.6.1. Historical and Current Waste Generation

Lube Oil: Waste oil in Qatar is generated through automobiles, industries and ships operating in the country. However, a major portion of the waste oil is through automobiles.

Table 25: Waste Oil Generated by Type of Vehicle

Type of vehicle	Frequency of change (kilometers)	Average Waste Oil generated/service (liters)	Number of times oil changed annually	Waste Oil generated in a year per vehicle (ton)
Sedan	5,000	3.83	3.00	10.2
SUV	10,000	5.10	2.00	9.0
HCV	15,000	12.75	6.24	70.5

²⁴⁶ Bio-diesel from used cooking oil to power vehicles in Oman, muscatdaily.com

In 2015, Qatar had around 1,088,321 registered vehicles. The frequency of oil change assumed for Cars, SUV's and HCV's is estimated to be 5,000 kms, 10,000 kms and 15,000 km respectively.

Based on primary interviews, it is assumed that lubricants in cars are replaced three times a year while in case of SUV's it is done twice a year. In case of HCV's waste oil replacement is done almost six times annually.

Based on the above assumptions and considering the density of waste oil as 0.886 kg/liter, the amount of waste oil generated by Sedan and SUV is 10.2 MT and 9 MT per annum per vehicle while HCV generates around 70.5 MT per annum per vehicle. The number of kilometers clocked by an HCV is much higher and hence the waste oil generated is significantly high.

Average weight of the waste oil generated through automobiles is thus, estimated to be 15.54 kgs per vehicle annually based on the split of sedans, SUV and HCV in the country.

Based on the number of automobiles in the country and the average waste oil generated, the waste lube oil generated by automobiles increased from 12,008 tons in 2010 to 16,917 tons in 2015. In 2016, it is estimated that automobiles will generate approximately 18,014 tons of waste lube oil.

As automobiles account for 55% of the waste lube oil, total waste oil generation (automobiles, industries, marine and other sources combined) in the country during the period of 2010 and 2015 increased from 21,833 MT to 30,758 tons, registering a CAGR of 8.9% (Chart 159).

Chart 159: Waste Oil Generated in Qatar, 2010-2016E (Tons)



Source: MDPS Transport and communication statistics 2014, Team analysis

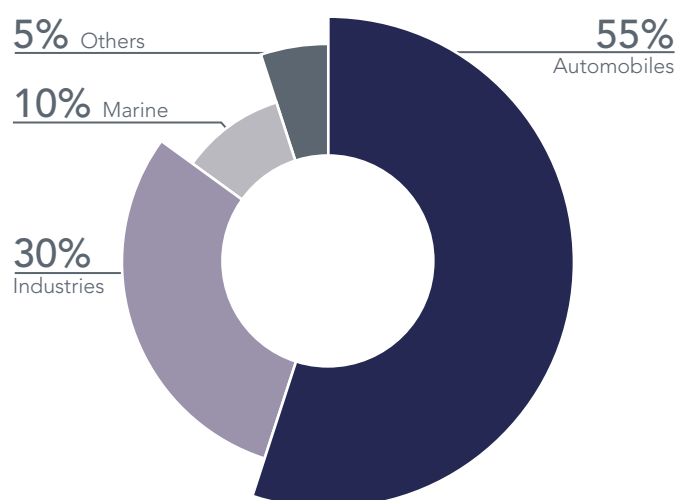
In 2016, it is estimated that approximately 32,753 tons of total waste lube oil will be generated in Qatar, with a y-o-y growth of 6.48%.

WCO: Due to lack of awareness amongst the hotels and households about potential advantage of recycling WCO, majority of the generated WCO is thrown away. In addition, there are no proper collection channel/ companies operating in the country and hence there is negligible amount of WCO collected in the country. Even the WCO generated historically can't be recovered as it has been disposed of.

8.6.2. Market Size Segmentation by Product Segments

Lube oil: Waste oil is generated through automobiles, industries and marine ships. Based on the primary research, it is estimated that around 55% of the waste oil is generated through automobiles while industrial equipment account for 30% of the waste. Marine waste oil account for 10% while other sources such as aviation sector etc. account for the remaining 5% (Chart 160).

Chart 160: Waste Oil Generation in Qatar, By Source (2015)



Source: Primary research

After recovery of waste lube oil from different sources, the recovered material is in the form of base oil. Approximately 70% of the waste lube oil is recovered in the form of base oil while the remaining quantity includes diesel, water and other contaminants.

8.6.3. Analysis of Exports and Imports

Lube Oil: Trade of waste lube oil is done under HS Code: 27109100 (Waste oils containing polychlorinated biphenyls, polychlorinated terphenyls or polybrominated biphenyls).

In 2015, Qatar exported 4 tons of waste oil while the imports were also equal to 4 tons.

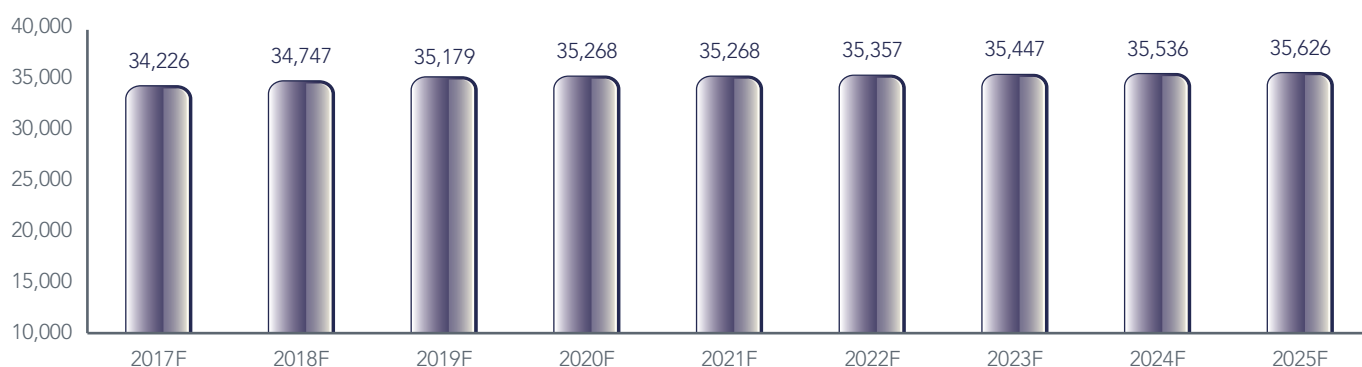
There are stringent regulations that prohibit the export and import of waste oil from Qatar. Hence, there is negligible export-import of waste oil.

8.6.4. Waste Generation Forecast

Lube Oil: Based on the estimates (as explained in 8.6.1) average weight of the waste oil generated through automobiles is approximately 15.54 kgs per vehicle annually.

The total waste lube oil is estimated to increase from 32,753 MT in 2016 to 34,226 MT in 2017 and grow at a minimal CAGR of 0.5% to reach 35,626 tons in 2025. This slowdown is primarily driven by the automobile sector as the sales of vehicles in Qatar is expected to decrease during this period (Chart 161).

Chart 161: Waste Oil Generation in Qatar, 2017F-2025F (Tons)



Source: MDPS Transport and communication statistics 2014, Team analysis

WCO: In UK approximately 3.54 Kg (WCO generated= 250 million liters, Density=0.91 gm/cm³, Population=64.1 million) of WCO was generated and 1.40 kg of WCO was collected per-capita (WCO Collected= 99 million liters) in 2013.

If Qatar creates awareness amongst the public/commercial units and develops collection channels and the necessary infrastructure, it has a potential to collect WCO in the range of 3,500 ton to 4,000 tons annually.

8.6.5. Demand for Recovered Material

Lube Oil: Waste lube oil as discussed in earlier sections can be recycled into lube base oil that is further treated with the additives so as to produce re-usable lube oil.

QALCO is the only lubricant producing company operating in Qatar. It has an annual production capacity of 20,000²⁴⁷ tons and is currently operating at a 95% utilization rate. They also have grease oil production with an annual capacity of 3,000 tons.

Replacement Opportunity for Recovered Lube Oil:

The replacement opportunity for recovered lube oil is approximately 23,000 tons i.e. production of QALCO. Estimated waste lube oil in 2016 is 32,753 tons and is forecasted

to reach 35,626 tons in 2025. Approximately 70% of this can be recovered²⁴⁸ in form of base oils i.e. 22,927 tons in 2016 and increasing to 24,938 tons in 2025.

Based on primary research, the estimated waste oil collected in Qatar is approximately 29,000 tons which will generate approximately 20,000 tons of recovered lube oil. In addition, there are four to five upcoming recycling facilities that are expected to start operation within a year. This will lead to a saturation in the domestic market and the waste oil recovery facilities will have to look to export most of their recovered lube oil.

WCO: WCO can be recovered in the form of biodiesel and has applications in automotive industry. However, there is no demand for recovered WCO in Qatar due to cheap prices of fossil fuels and lack of awareness amongst the people about benefits of biofuels.

Going forward, if the country develops the collection channels along with the necessary infrastructure to collect WCO and encourages use of biodiesel, this can be a potential alternative to fossil fuels.

²⁴⁷ QALCO: Company website

²⁴⁸ "Waste Framework Directive revision", geir rerefining.org

8.6.6. Assessment of Supply Landscape

Lube Oil: Currently, based on the primary interviews, there are only three companies operating in the waste oil recovery sector in Qatar. However, licenses have been issued to three to five new waste oil recovery facilities that would be operating in Mesaieed region. These facilities currently are either in the construction phase or in equipment installation phase, and are expected to commence business by 2017.

1. Al-Haya waste management²⁴⁹ apart from e-waste recovery is also involved in the recovery of waste lube oil. This facility is spread across the land area of 10,000sqm and was started in 2003. The company has 45 employees in the waste lube oil recovery division. The company collects 24 tons of waste oil on a daily basis (approx. 720 tons monthly) from garages, industries and through long-term contracts with companies, and convert it to base oil i.e., SN-500 and SN-700.
2. Qatar Reclamation Oil Plant²⁵⁰ (established in 2003) and National Petroleum Product Company²⁵¹ (established in 2011) are the other two companies involved in the recovery of waste oil; however, their combined recovery capacity is close to 20,000 tons of waste lube oil per annum.
3. Seashore Waste Management²⁵² collects 200 cubic meter of waste oil on a monthly basis and sells it to recovery facilities operating in the country.

These companies also source their waste through garages, industries and through long-term contracts with logistic and shipping companies.

8.6.7. Pricing Analysis

Lube Oil: Lubricant oil prices vary in line with the international oil prices. Because of the crude oil prices decreasing substantially post 2014, prices for waste oil has also declined.

This is evident from the fact that CFR prices Middle East for Group 1 SN 500 base oil declined from a price range of USD1,025 to 1,040 per ton²⁵³ in June 2014 to USD575 to 600 per ton in June 2016. For SN 150, market price are USD10 lower than the market price for SN 500.

In addition, garages in Qatar have to comply with the regulations and are expected to dispose waste oil post treatment and removal of any hazardous waste. This processing and disposal costs them an extra amount and hence they prefer selling it to the waste oil processing companies. Based on the primary interviews, waste oil was collected at QAR15 per 160 kgs in 2015 while currently; it is sourced free of cost.

8.6.8. Analysis of Business Model and Presence/Absence of Key Synergies

Lube Oil: As per the amendment in Basel Convention dated 28 February 2002²⁵⁴, export of hazardous waste from Qatar for the purpose of recovery and final disposal is restricted and thus, waste oil recovery facility in Qatar operates under the following business models:

Business Model 1: Recovery of Waste Oil – there are two ways to source waste oil:

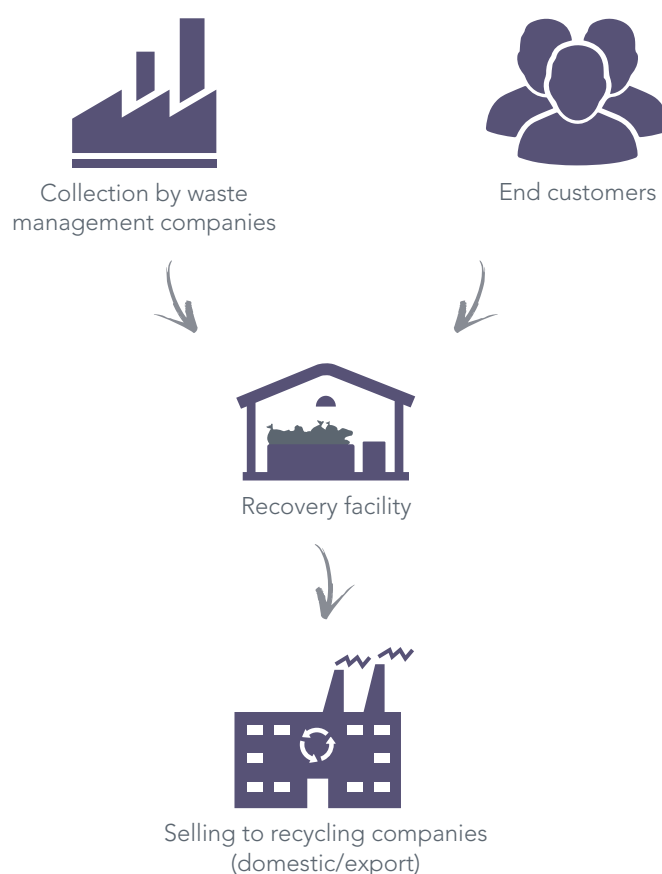
- By Waste Management Companies: Waste management companies source waste oil from industries, garages, etc., and upon storage sell them to recovery facilities operating in the country.

Example: Seashore Waste Management Company

- By recovery facilities: Recovery facilities through long-term contracts with garages and industries collect the waste oil directly and recovers them in form of SN-150, SN-500 and SN-700. This recovered base oil is then sold to lubricant manufacturers operating in the domestic and international markets.

Example: Al Haya Waste Management, Qatar Reclamation Oil Plant and National Petroleum Product Company

Figure 38: Business Model 1: Recovery of Waste Oil



²⁴⁹ Company website

²⁵⁰ Tradee.com

²⁵¹ Company website

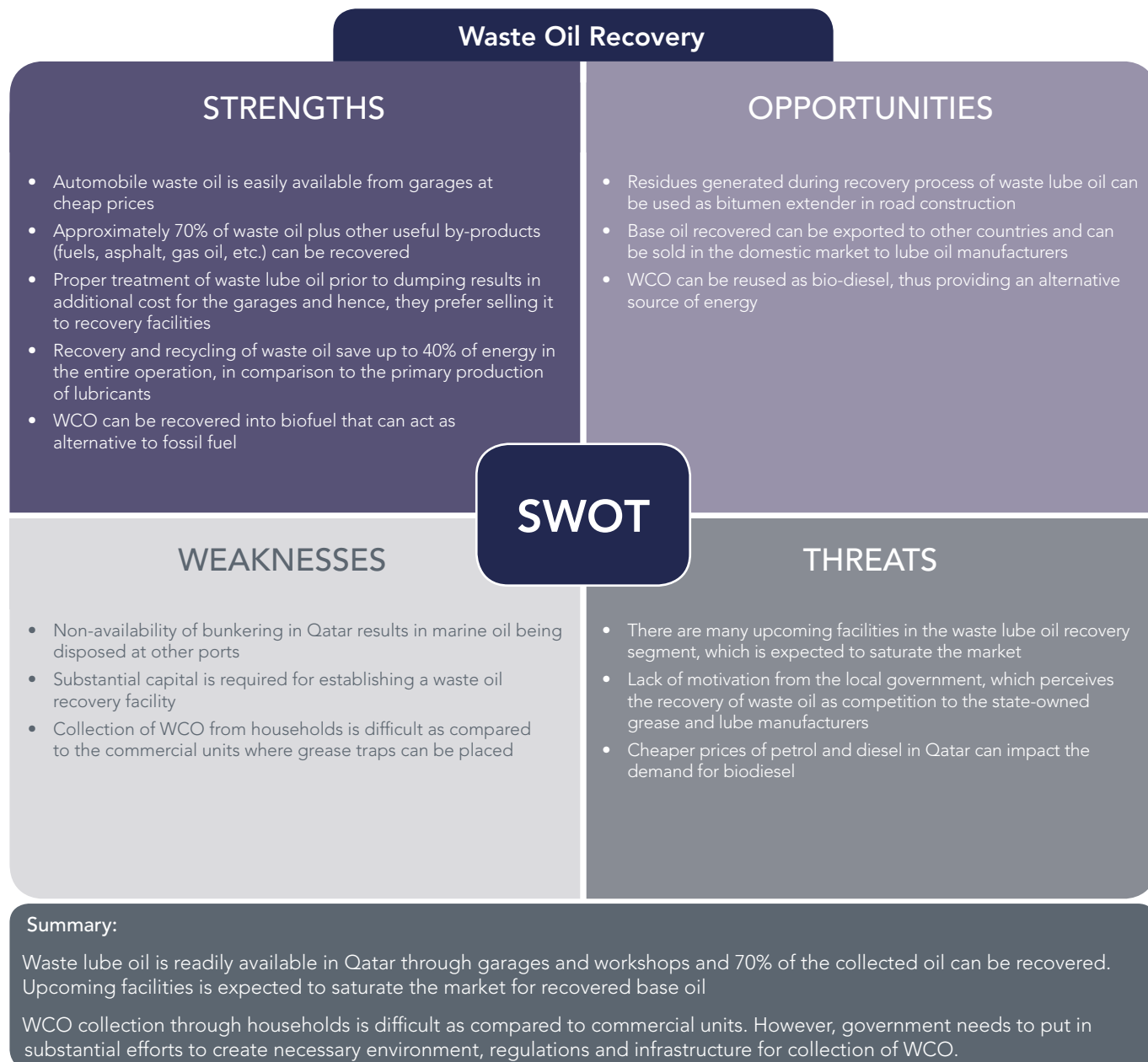
²⁵² Primary research

²⁵³ ICIS.com

²⁵⁴ "Country factsheet-Qatar", basel.int

8.6.9. SWOT Analysis

Figure 39: SWOT Analysis- Waste Oil Recovery

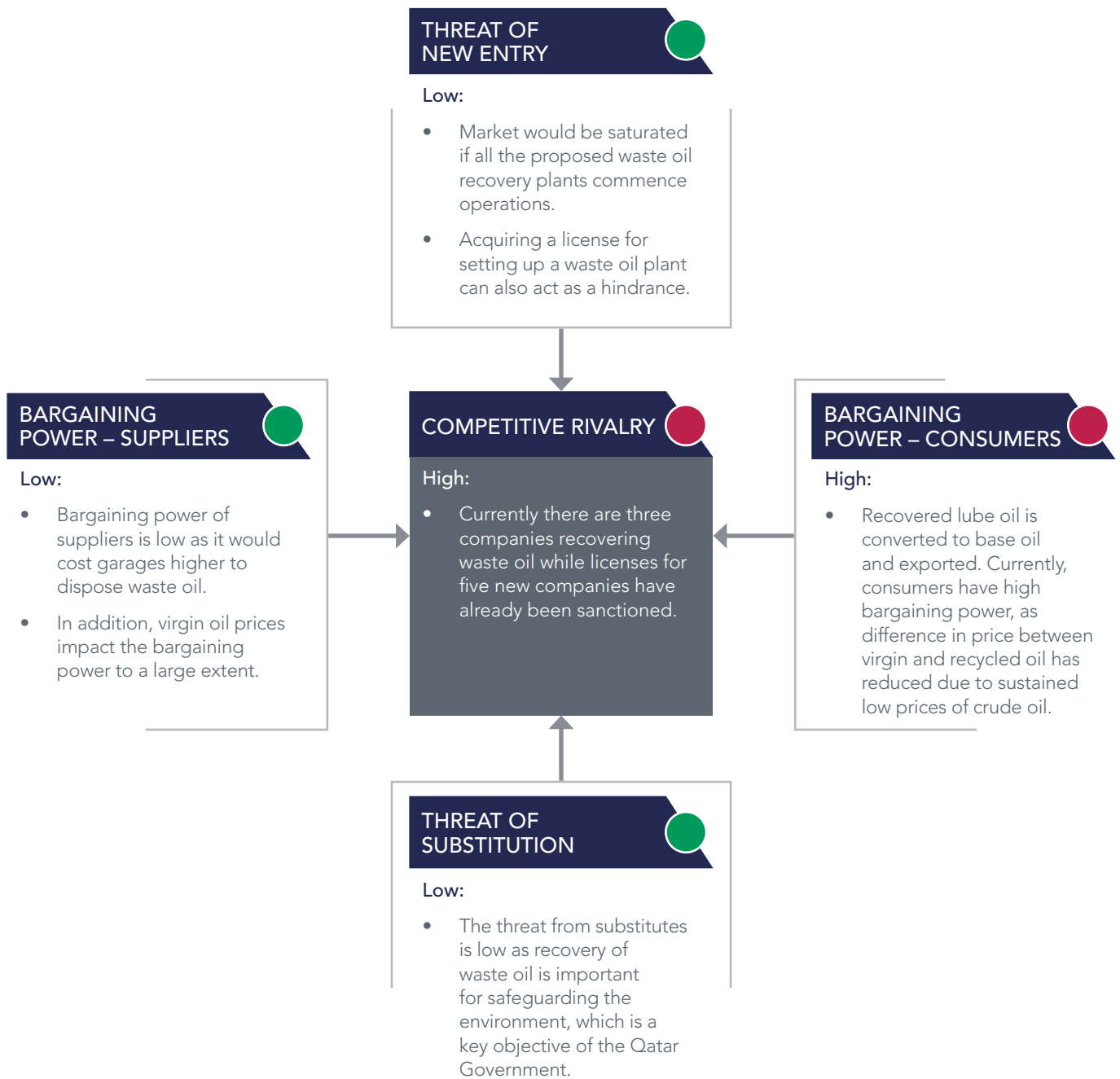


8.6.10. Regulations

- It is prohibited to dispose hazardous waste other than in places identified under the Basel convention and in accordance with its terms and conditions.
- The party in charge of producing, handling or transporting hazardous substances in gaseous, liquid and/or solid forms must take all precautions to prevent any damage to the environment.
- Article 17 of Law No. (4) 1983 concerning the Exploitation and Protection of Marine Life in Qatar restricts the dumping of petroleum products or waste products into the sea without approval in writing from the concerned authorities.
- There is no regulation or restriction on the trade of recovered lube oil i.e. base oil from Qatar.

8.6.11. Michael Porter's Five Forces Model

Figure 40: Michael Porter's Five Forces Model – Waste Oil



8.6.12. Key Takeaways and Potential Opportunities

- Lube oil is generated majorly through automotive, ships and industrial means in Qatar.
- Waste lube oil in Qatar is easily accessible and can be collected from garages, petrol stations etc.
- Waste lube oil generated by the automobile on an average is estimated to be 15.54 kgs per annum. Based on this, it is estimated that 18,014 tons of waste lube will be generated by automobiles in Qatar.
- Total waste lube oil in Qatar is estimated to be 32,753 tons in 2016 and is forecasted to reach 35,626 tons in 2025.
- Qatar has one lube oil blending facility (QALCO) with a capacity of 20,000 ton. They also have grease oil production with an annual capacity of 3,000 tons.
- There are three waste lube oil recovery facilities in Qatar. They recover waste lube in form of base oil and sell the recovered base oil to QALCO.
- There are four to five upcoming recycling facilities that are expected to start operation within a year. This will lead to a saturation in the domestic market and the waste oil recovery facilities will have to look to export most of their recovered base oil.
- WCO generated in the country is disposed of due to lack of awareness amongst the hotels and households about potential advantage of recycling.
- If Qatar creates awareness amongst the public/commercial units and develops collection channels and the necessary infrastructure, it has a potential to collect WCO in the range of 3,500 ton to 4,000 tons annually.
- WCO can be turned into biodiesel and can be used in automobiles. However, it will be difficult to replace fossil fuels especially in Qatar due to cheaper fuel prices.





9. RECYCLED AGGREGATES

9.1. Overview of Aggregates

9.1.1. Description

Due to the growth in the global construction industry, especially in the developing economies, the quantity of CDW generated is growing annually. CDW hold a major share in the total waste generated around the globe.

Construction waste are mainly leftovers from new construction materials, such as unused and incorrect materials, surplus stencils or nails, packages of construction materials or components, surplus concrete materials, damaged materials and all other waste required for activities at a construction site. Demolition waste is mainly a collection of all construction materials from a building, after the removal of certain hazardous materials, such as asbestos and mercury-containing parts.

Thus, CDW debris is defined as that part of the solid waste stream that results from land clearing and excavation, and construction, demolition, remodeling and repairing of structures, roads and utilities. In addition, it includes the materials generated because of natural disasters. Components of CDW debris include concrete, asphalt, wood, brick, metals, wallboard, piping, metal material and roofing shingles.

Waste generated is manually sorted, usually at source through different containers or at the sorting plants and is diverted to the designated recycling plant depending on the material.

Concrete, a widely used commodity and a major constituent of CDW is a mixture of coarse aggregates, fine aggregates and cement, which are mixed in appropriate quantities as per the desired strength. Cement accounts for 7–15% of the total weight while aggregates account for 60–75% of the weight. Water and air account for the remaining share of concrete²⁵⁵.

Concrete waste is produced in different types and quantities throughout the life cycle of a building with the bulk of the waste being produced during the demolition phase. Figure 41 schematically represents the life cycle of a building and indicates the use of concrete materials and the waste generated.

9.1.2. Classification

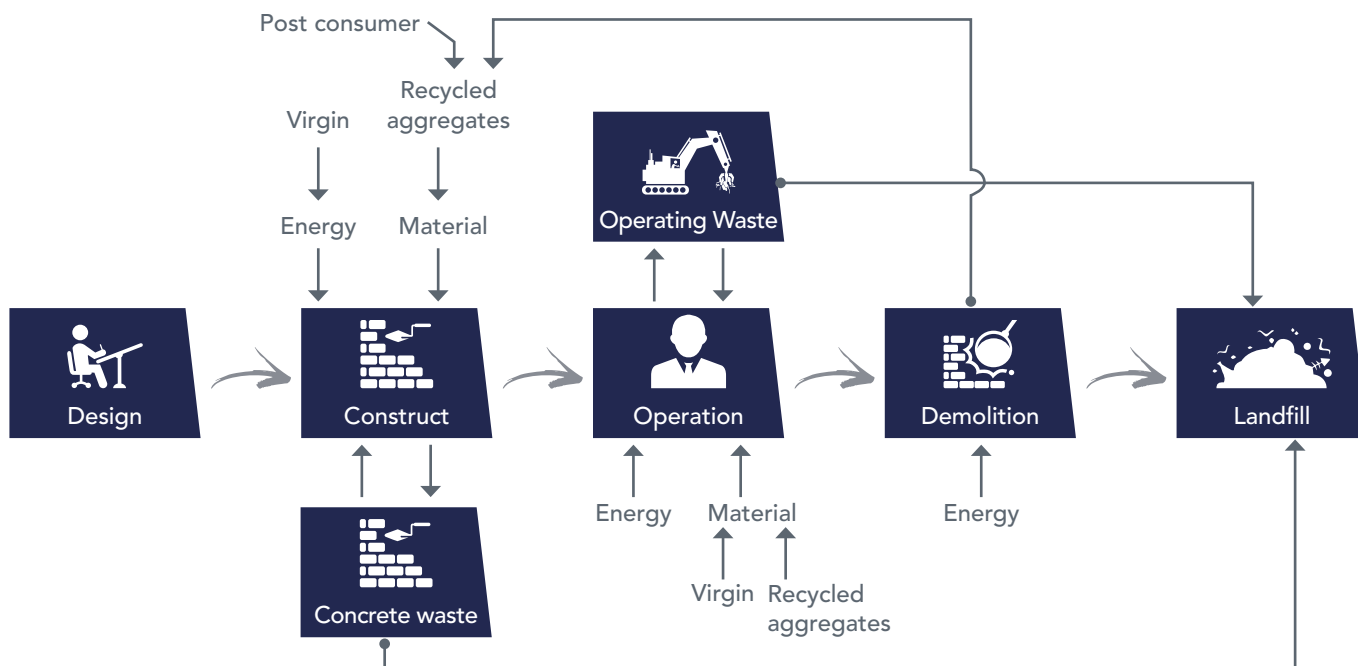
Concrete waste is classified into following categories depending upon the source of generation:

- Roadwork waste: Concrete waste generated due to rail, road or airport works.
- Demolition waste: Concrete waste generated because of building demolition. This waste may be complex in nature due to the presence of material, such as plastic and metal.
- Returned waste: Unused ready-mixed concrete that is returned to the plant in the concrete truck as excess material. This can be either small amount of concrete leftovers at the bottom of the drum in the truck or more significant quantities not used by customers at construction sites.

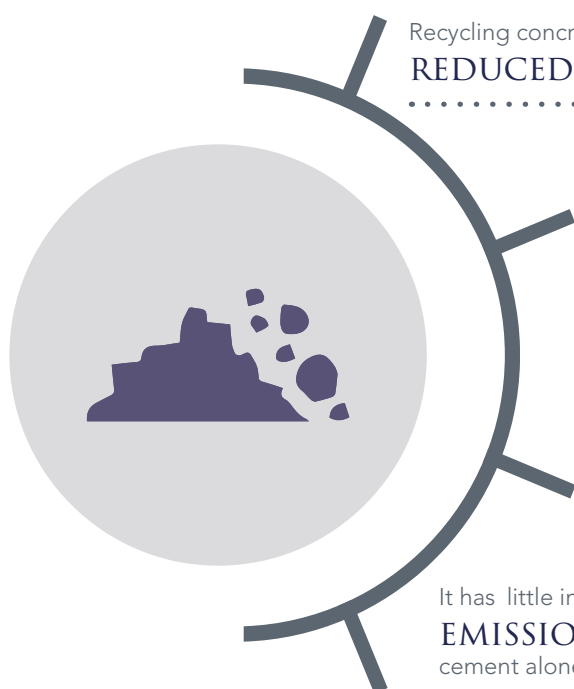
²⁵⁵ "Design and Control of Concrete Mixtures", cement.org



Figure 41: Life Cycle of a Building



9.1.3. Benefits of Recovered Aggregates



Recycling concrete reduces the **COST OF WASTE DISPOSAL**, and leads to **REDUCED USE OF LANDFILL**, preventing associated site degradation.

It provides substitutes for virgin concrete and thus reduces **NATURAL RESOURCE EXPLOITATION**. For structural operations, **15%-20% OF RCA** is mixed with virgin concrete.

Recycled concrete as aggregate has **HIGHER ABSORPTION** ability and **LOWER SPECIFIC GRAVITY** than natural aggregate.

It has little impact on **REDUCING GHG EMISSIONS** as **MOST EMISSIONS OCCUR WHEN CEMENT IS MADE**, and cement alone cannot be recycled²⁵⁶.

²⁵⁶ The Cement Sustainability Initiative

9.2. Aggregates Recovery Process

There are two approaches to recover concrete:

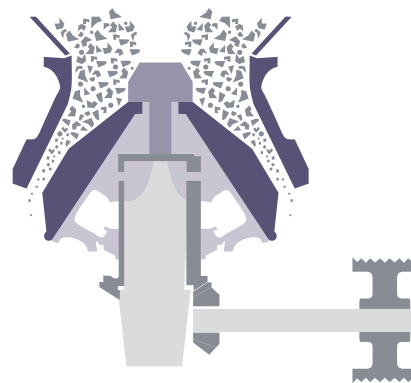
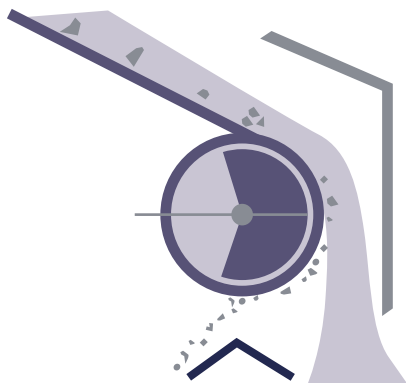
- Transporting the concrete debris to a permanent recycling facility for crushing and screening.
- The other approach is to do the crushing and screening at a demolition site where the aggregate is reused again for the new construction.

Figure 42: Aggregates Recovery Process



D. Screening and Crushing

The broken concrete then passes through two screens, which separate the aggregates depending on their sizes. Larger pieces (bigger than the specified size) are fed into the cone-crusher, which further breaks it into smaller pieces.

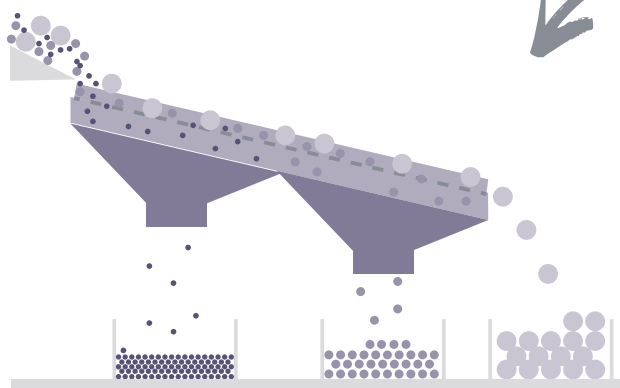
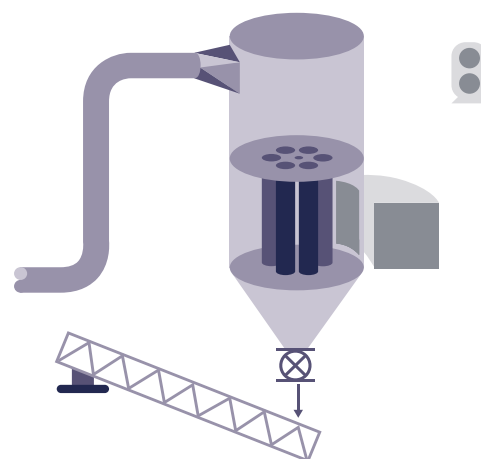


E. Metal Separation

In case metal is present along with concrete, it is separated using magnetic separator and the remaining aggregates are passed to the next stage of dust extraction.

F. Dust Extractor

The aggregates are then passed through a dust extractor, which removes unwanted substances, such as dust.



G. Vibration Screen

The aggregates are separated through a vibration screen. Aggregates having a size between 4.75mm and 19mm are collected in the coarse aggregate stockpile area, while aggregates with size less than 4.75mm are stocked in fine aggregate section.

9.3. Recovered Aggregates Applications

Recycled Aggregates can be used for different applications in the construction industry. Some of the applications include:

- **Aggregate Base Course:** It is used in the foundation layer of road construction. Recycled aggregates are the underlying layer that form a structural foundation for paving the road.
- **Soil Stabilization:** Recycled concrete is mixed with quality subgrade material that enhances the load-bearing capacity of that subgrade.
- **Pipe Bedding:** It is used for the foundation purposes, such as underground utilities.
- **Landscape Material:** Recycled concrete can be used in landscape settings for many purposes, such as boulder/stacked rock walls, underpass abutment structures, erosion structures, water features and retaining walls.
- **Roof Tiles:** Recycled concrete can be used for roof tiles to provide durable water shedding feature along with high durability at an economical cost.

9.4. Global Aggregates Recovery Market Overview

Construction activity involve material such as concrete, steel, brick, stone, glass, clay, mud, wood and plastic. However, concrete remains the main construction material used in construction industries. Within concrete, aggregates account for approximately 75%²⁵⁷. Within aggregates, 60–67% is coarse aggregate while fine aggregate account for 33–40%²⁵⁸.

As per the recent study by Fredonia Group²⁵⁹, the global construction aggregates market is expected to reach 51 billion metric tons in 2019 with the demand for crushed stone and alternative aggregates, such as recycled concrete, fly ash and slag and gravel, expected to double during the same period.

The composition of CDW varies across countries depending on the structure built, materials used and construction methods employed. For example, in Canada and the US, family homes are usually built with a wooden frame while in Europe clay bricks are used. In addition, less concrete may be available for recycling in newly developed regions while in areas undergoing reconstruction following war, significant unsorted demolition waste would exist.

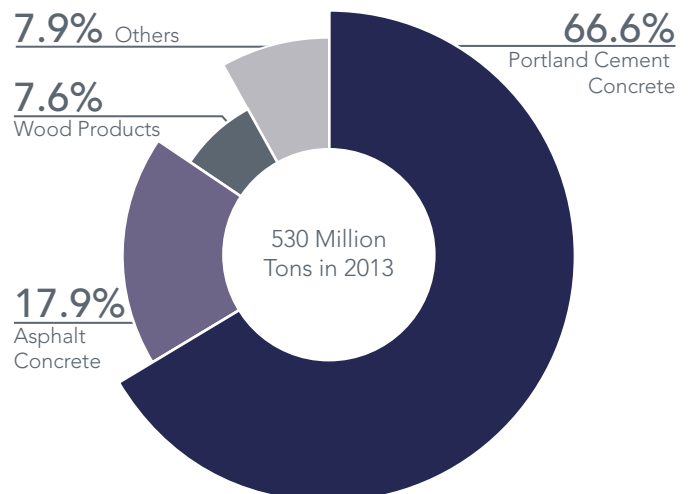
Most of the countries do not record the amount of CDW waste generated annually and thus, exact quantity of CDW waste generated globally cannot be estimated.

Historically, in 2006, Europe²⁶⁰ was estimated to have 510 million tons of CDW, while the US and Japan accounted for 317 million tons and 77 million tons, respectively.

In 2006, in the US, 155 million tons of concrete waste was generated and 127 million tons was recycled, achieving a recycling rate of 82%. In the same year, Europe reported a recycling rate of 30% for concrete, while Japan recycled 80% of the concrete waste.

During 2013, 530 million tons of CDW was generated in the US²⁶¹. Portland cement concrete accounted for 66.6% (352.9 million tons) followed by asphalt concrete and wood with 17.9% (95.1 million tons) and 7.6% (40.2 million tons) share, respectively. Others included brick and clay tile, asphalt shingles, steel, drywall and plaster with a combined share of 7.9% (Chart 162).

Chart 162: Composition of CDW in the US (2013)



Source: US-EPA-2013

Of the Portland cement concrete waste in the US, 95.1% (335.4 million tons) was generated by demolition activities while 4.9% (17.5 million tons) was generated as a part of construction waste. Asphalt concrete waste of 95.1 million tons was generated only through demolition activities.

As the amount of CDW waste is increasing around the globe, key initiatives are taken globally for recycling aggregates. Some of them are:

- **The US:** Within the US, 38 states use recycled concrete aggregate for road sub-base, while 11 states recycle it into new concrete.
- **Brazil:** There are legislations monitoring the CDW in Brazil. As a result, there are a few recycling facilities in the country. These recycled aggregates are used mainly for road sub-base.

²⁵⁷ "Use of RECYCLED AGGREGATES In CONCRETE – A Paradigm Shift", nbmcw.com

²⁵⁸ "Use of Recycled Aggregate Concrete," ISSN: 2278-1684, iosrjournals.org

²⁵⁹ "Global demand for aggregates to rise", pitandquarry.com

²⁶⁰ "The Cement Sustainability Initiative", Page 12, wbcscement.org

²⁶¹ "Advancing Sustainable Materials Management:2013 Fact Sheet", Page 17, epa.gov

- Japan: Almost 100% of the concrete waste is recycled and used in road sub-base.
- Europe²⁶²: Waste Framework Directives are issued to member states that aim to achieve a recycling rate of 70% for non-hazardous CDW by 2020.
 - The Netherlands: Legislations in the country ban the dumping of concrete waste and hence, most of the waste is recycled except for residual process waste.
 - Finland: Strong legislation and enforcements are applicable in Finland to make sure all recyclable material from a demolition site are recycled.

9.5. GCC Aggregates Recovery Market Overview

9.5.1. Market Overview

Owing to the increased infrastructural and real estate activities as well as increased rate for demolition of buildings reaching their end-of-life in the GCC region, large amount of CDW is generated.

Landfills in the region are running out of space due to this increased volume of CDW waste and hence, GCC countries have started opting for a sustainable solution to recover this waste.

In the UAE²⁶³, recycled CDW waste has been used by Etihad Rail to build Stage-I of the railway, which covers 264km of track between Shah and Al Ruwais in the Western Region of Abu Dhabi. As per estimates, almost a million cubic meters of recycled aggregates have been used in the railway project since 2011. Of this, 800,000 cubic meters have been used to make the track sub-ballast, replacing crushed rock aggregate or cement-stabilized material.

In Abu Dhabi, the government has set regulations that large construction project should use 40% of recycled aggregates in their construction.

Similarly, post the Gulf War, Kuwait²⁶⁴ saw a large amount of construction waste dumped in landfills, and thus legislative changes were made to encourage private players to enter the CDW waste recycling process. It is estimated that currently 4 million tons of CDW waste is generated annually in Kuwait.

9.5.2. Leading Companies in the GCC Market

Some of the leading companies operating in the recycled aggregates segment are:

Table 26: Recycled Aggregates Companies in the GCC Market

Company	Year of Establishment	Country	Activity	Annual Capacity (mn tons)
Be'aah	2007	UAE	Recovery	2.2
Al-Dafra Recycling Industries	2008	UAE	Recovery	NA
Emirates Recycling LLC	2006	UAE	Recovery	8
Environment Preservation Industrial Company	2001	Kuwait	Recovery	NA

9.6. Qatar Aggregates Recovery Market Overview

9.6.1. Historical and Current Waste Generation

Aggregate waste are generated through CDW activities that take place in the country. CDW in Qatar comprises concrete, bricks, sand, wood, steel and other material, such as glass and plastic.

Concrete, bricks and sand have a cumulative share²⁶⁵ of 85%, while steel generated due to CDW has a share of 5% and has been elaborated in Section 2.6.1.

²⁶² "From dust and debris", bq-magazine.com

²⁶³ "Extending life after use: UAE builds using recycled materials", thenational.ae

²⁶⁴ Recycling construction waste in the Middle East: commercial operation with environmental benefits", cleanmiddleeast.ae

²⁶⁵ MDPS

In 2010, approximately 7.82 million tons of aggregate waste was generated in Qatar that increased in 2013 to 7.95 million tons. The market witnessed a slowdown during 2014 due to decrease in oil prices that adversely affected the real estate sector and hence, CDW activities reduced in the country. Thus, approximately 6 million tons of aggregate waste was generated²⁶⁶. However, the market saw a speedy revival during 2015 with a year-on-year increase of 42.01%, with 8.52 million tons of waste getting generated and collected.

Real GDP of a country is directly linked to the construction activities happening in the country. Based on the real GDP and construction GDP in 2013, calculations suggest on an average 210 tons of CDW was generated per million QAR of construction GDP.

Thus, based on the construction GDP estimations (IMF) and CDW generation per million QAR of construction GDP in 2013, it is estimated that approximately 8.87 million tons of aggregate waste would be generated in Qatar in 2016 (Chart 163).

Chart 163: Aggregate Waste Generated from CDW in Qatar, 2010-2016E (Million Tons)



Source: MDPS Environment Statistics 2014, Team analysis

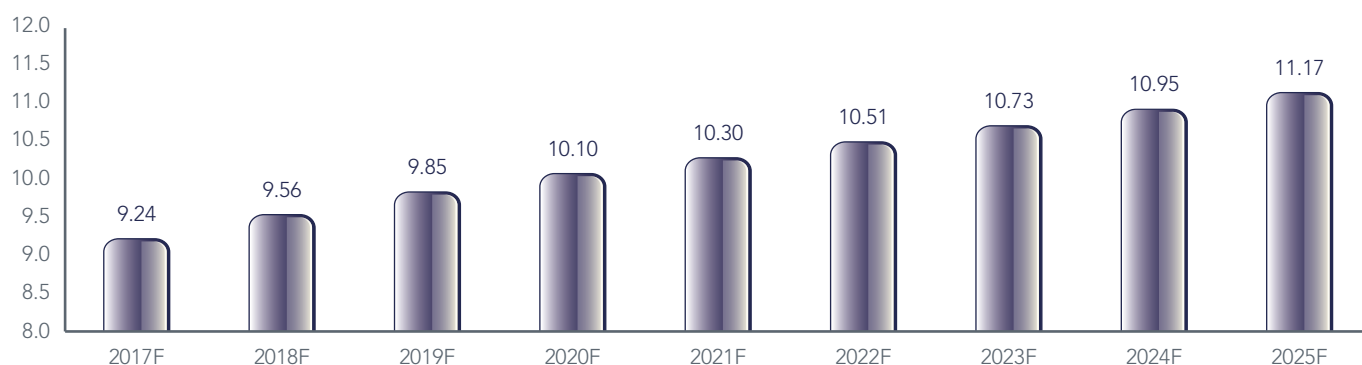
9.6.2. Waste Generation Forecast

The generation of aggregate waste during 2017 and 2025 has been estimated based on the aggregate waste generated per million riyal of construction GDP in 2013 i.e., 210 tons. This assumption has been made based on the primary interviews that suggest a revival in the real estate sector as the country approaches FIFA 2022.

CDW yields approximately 85% recovered aggregates. In 2016, about 8.87 million tons of aggregate scrap²⁶⁷ is estimated to be generated in Qatar.

Based on the construction GDP forecast (IMF) and CDW generation per million QAR of construction GDP in 2013, this is expected to reach 9.24 million tons in 2017 and increase to reach 11.17 million tons in 2025, witnessing a CAGR of 2.9% (Chart 164).

Chart 164: Aggregate Waste Generated from CDW in Qatar, 2017F-2025F (Million Tons)



Source: MDPS Environment Statistics 2014, Team analysis

9.6.3. Demand for Recovered Material

Local production: Qatar has restrictions on quarrying and thus, the complete demand of the country for Gabbro and Limestone aggregates is fulfilled through imports, majority of which originates from UAE and rest from Oman.

Imports: Qatar imported 21.1 million tons of gabbro and limestone in 2012 and this increased to 23.7 million tons in 2014.

After the initiation of Gabbro Berth Terminal, the capacity of port for handling import of Gabbro and limestone is expected to reach 30 million tons.

²⁶⁶ MDPS: Environment Statistics-2013 and 2014

²⁶⁷ MDPS, Primary research, Team analysis

Based on the primary research with aggregate importers in Qatar, the demand (imports) of aggregates in 2016 was approximately 24 million tons. Approximately 50% to 60% of aggregates is used in the construction of roads while the remaining is used in structural applications.

Replacement Opportunity for Recovered Aggregates

Qatar has a stockpile of 80 million tons of CDW waste in Rawdat Rasheed that can be recovered and can be used in place of fresh aggregates

Replacement/substitution of aggregate will vary with type of construction as per the QCS standards. For ex: In case of road sub-base, recovered aggregates can replace 100% of aggregates while in case of buildings, recovered aggregates should be mixed with the fresh aggregates in defined proportions.

Qatar requires 120 to 150 million tons of aggregates till 2022 for road construction (85% in expressways and 15% in internal roads and drainage) and in case recovery is done on a large scale, they can meet a major portion of demand in Qatar²⁶⁸.

Currently, the price of aggregates is in the range of QAR80 to QAR85 per ton while the price of recycled aggregates is estimated to be QAR40 to 50 per ton. This presents a huge opportunity for recycled aggregates, especially in a country like Qatar which is importing the entire demand.

9.6.4. Assessment of Supply Landscape

Based on the primary interviews with leading waste management companies, Qatar currently has only one aggregates recycling facility while one recycling facility is expected to start operations in 2017.

1. LafargeHolcim²⁶⁹, which started the operations for recycling aggregates in 2015 is situated in Rawdat Rasheed. The company had a contract to deliver 1.1 million tons of recycled aggregates, based on 100% of their current production capacity. However, based on primary research, it is understood that the operation of the facility has come to a halt as their contract with government has expired.
2. Qatar Primary Material Company²⁷⁰ and Transport Research Laboratory (TRL) have recently signed an agreement for recycling 5 million tons of aggregates in Qatar. The operations for this facility is expected to start in 2017. These recycled aggregates will be consumed in various construction applications including concrete buildings and road layers.

9.6.5. Pricing Analysis

Based on the primary interviews with recovery facility in Qatar and validated web-based research, the recovered aggregates in Qatar are priced at QAR40 to 50 per ton²⁷¹. However, as there are no imports/exports of aggregate waste, and recovery has started in 2015, the historical prices for recycled aggregates is not available.

²⁶⁸ Primary research

²⁶⁹ Company website

²⁷⁰ QPMC Website

²⁷¹ Trash to treasure: Recycling construction waste in Qatar, qatarconstructionnews.com

9.6.6. Analysis of Business Model and Presence/Absence of Key Synergies

Qatar provided permission for the use of recycled aggregates in 2014 and hence, the first recycling company was set up in 2015. Based on the primary interviews, there is one model operational for recycling aggregates in Qatar.

Business Model 1: Recovery of Aggregates – there are two ways to source waste aggregates:

- By Waste Management Companies: Waste management companies are involved in the transportation of CDW from the demolition site to landfills and are not involved in any segregation or value addition.

Example: Seashore Waste Management Company and Averda.

Figure 43: Business Model 1: Recovery of Aggregates



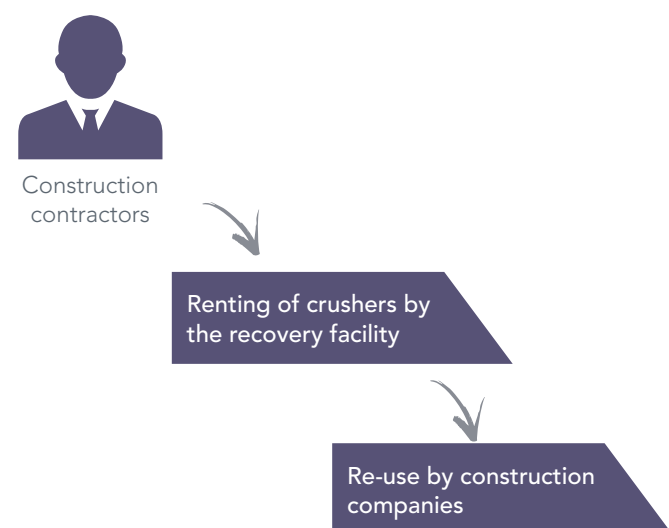
- By Construction Contractors: In some cases, the construction contractor by using their own vehicle dispose the CDW waste in Rawdat Rasheed.

The recovery facility, i.e., Lafarge, sources the waste material from the stockpile available at Rawdat Rasheed landfill and segregates concrete aggregates from other waste. They recover coarse and fine aggregates that are either used for in-house production or sold to domestic and international ready-mix companies.

Potential Business Model: Based on practices around the globe, a few potential business models can be easily replicated in Qatar.

- A. **On-Site Recovery:** In this model, recovery facilities can rent their crushers to the construction contractors who recover the aggregates at the construction site and reuse in the process. Recovery facilities can also carry out the process for a pre-determined fees at the demolition site. This model helps minimize transportation costs and reduce carbon footprints.

Figure 44: Potential Business Model (B): On-site Recovery



- B. **Recovery of the Complete CDW:** When recovery facilities source waste from landfills, they use the concrete aggregate waste while other waste, such as paper, rubber, plastic and metal, are not recycled and dumped in landfills. In this model, CDW waste can be sorted at source and then collected by waste management companies. This segregated waste is directed to the respective recovery firm e.g., metal scrap to metal recovery facility, plastic scrap to plastic recovery facility and so on, while concrete aggregates can be directed to aggregates recovery facility.

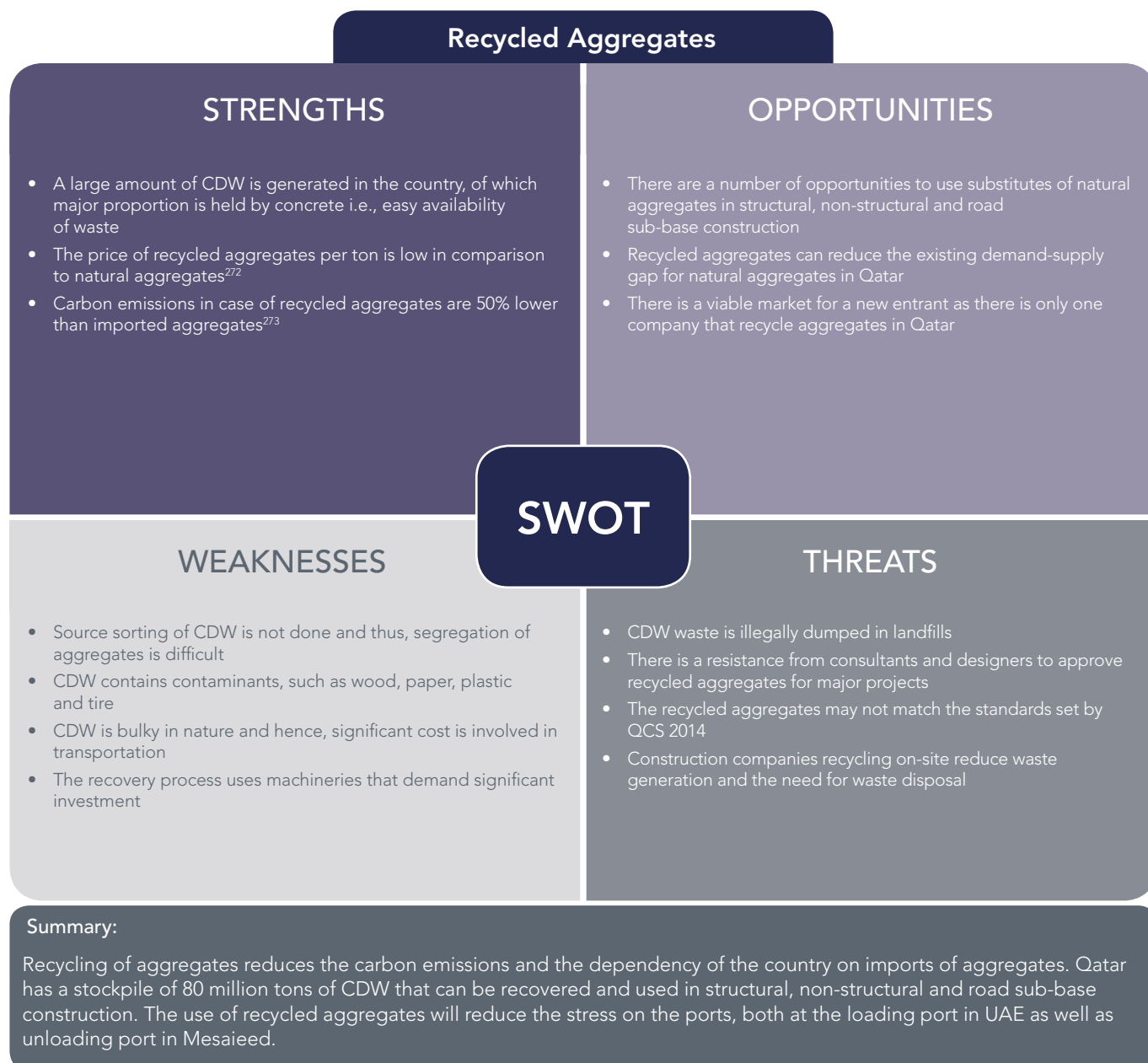
The aggregate recovery facilities use the waste and produce coarse and fine aggregates that can either be used for captive consumption or sold in the international/domestic market.

Figure 45: Potential Business Model (B): Recovery of Complete CDW



9.6.7. SWOT Analysis

Figure 46: SWOT Analysis- Recycled Aggregates



9.6.8. Regulations

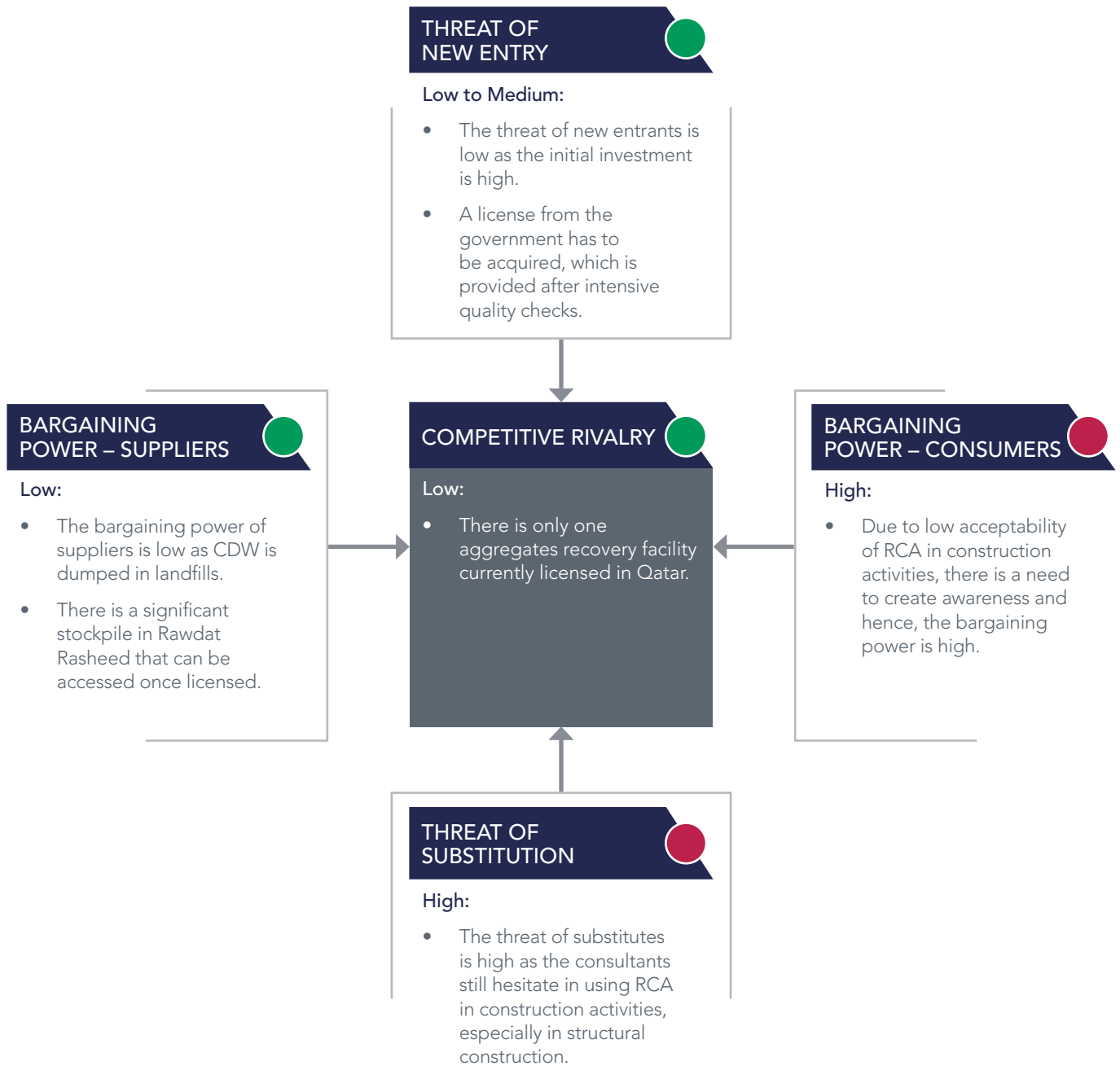
- Recycled aggregates have to comply with the requirements of the Qatar Construction Specification similar for limestone and imported aggregates.
- Qatar Standards audit all recycled aggregate production units and facilities regularly, and those meeting the requirements of the Qatar Construction Specification are permitted to supply aggregates to construction projects.
- The level of contamination allowed in recycled aggregates is restricted and cannot exceed the level as specified in the Qatar Construction Specifications 2014.

²⁷² "Trash to treasure: Recycling construction waste in Qatar ", qatarconstructionnews.com

²⁷³ BQ Magazine: "From dust and debris"

9.6.9. Michael Porter's Five Forces Model

Figure 47: Michael Porter's Five Forces Model – Recycled Aggregates



9.6.10. Key Takeaways and Potential Opportunities

- Qatar is undergoing a large number of construction and demolition activities currently because of commitments such as FIFA 2022.
- Historically, there has been no recovery of CDW generated and the waste has been dumped in landfills without segregation. As per industry experts, it is estimated that 80 million tons of CDW is stockpiled in Rawdat Rasheed.
- In 2016, it is estimated that 8.87 million tons of aggregate waste will be generated in Qatar and by 2025, annual aggregate waste generation will increase to 11.17 million tons.
- Qatar has restrictions on quarrying and thus, the complete demand of the country for aggregates is fulfilled through imports, majority of which originates from the UAE and the rest from Oman.
- The recovered aggregates in Qatar are priced at QAR40 to 50 per ton while virgin aggregates are priced currently at QAR80 to 85 per ton.
- As per the industry estimates, Qatar requires 120 to 150 million tons of aggregates till 2022 and thus recovery facilities have huge potential to meet a sufficient portion of this demand. They can avail the stockpile of CDW in Qatar along with the annual waste generated.
- Qatar currently has only one aggregates recycling facility i.e. LafargeHolcim while QPMC is expected to start its recycling operations in 2017.





CONCLUSION

- While Qatar generates ample waste per day i.e., about 2,800 tons of MSW and almost 20,000 tons of CDW, the country still lacks the infrastructure required for the proper management of waste.
- A major portion of MSW generated in Qatar is organic waste, which accounts for 57%. Moreover, due to lack of awareness, this is mixed with other recyclable waste, such as plastic and paper, making it contaminated and unfit for recovery.
- Public awareness needs to be created about source segregation and its implications on the recovery process. Initiatives can be taken by the leading companies to educate people about the benefits of recycling. Placing bins in public places for every product type can reduce the amount of contaminated waste.
- Proper collection channels need to be established for hazardous waste, such as waste oil, e-waste and batteries. Take-back units, similar to that existing in the European nations can be established in Qatar.
- Incentives/discounts can be provided to the recovery facilities (as some companies in Qatar are closing down due to high operational costs) to encourage them to continue their operations. This will help Qatar achieve its vision of 38% recycling.
- The government regulations pertaining to export and import of waste also require revision as, currently, they hinder in the trans-boundary material flow. For example, although there is a high demand for scrap in the international market, no licenses are provided for the export of paper bails from Qatar.
- Qatar lacks the end-consumption industries that can utilize the recovered materials for segments such as e-waste, glass and WCO while there is limited demand for paper and rubber.
- In addition, the shipping of recovered material from Qatar is an expensive and time-consuming process, as ports have a high waiting time. Thus, establishment of SMEs within Qatar and development of hassle-free shipping routes could open the market for recovered products.



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About Qatar Development Bank

Qatar Development Bank (QDB) is a fully owned government developmental and financial entity set up by an Emiri Decree in 1997 to invest in and develop local industries by supporting SMEs in Qatar. In line with Qatar's National Vision 2030, QDB aims to facilitate the development and growth of SME's that will result in long-term socio-economic benefits.

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