Confidential Report

Rubber Chemical Consultants Ltd

Tire Tread Performance Resins & RPOs 2021

Page 1 of 140	
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Tire Tread Performance Resins & RPOs 2021

1 CONTENTS

List of Figures

List of Tables

2 EXECUTIVE SUMMARY

TPR & RPO volumes in thousands of metric tonnes (kMT), tire units in millions (MM). Market prices in United States Dollars (USD) per metric tonne ($/MT) and market values in millions of USD ($MM).

2.1 SCOPE

Market Segment: Tire segment focusing on resins and RPOs used to enhance the performance of **tread compounds**, specifically traction, handling, rolling resistance and wear for the **Products** below.

Tread Performance Resin (TPR): Resin used to enhance the end performance of a **tread compound**. This excludes tack resins. Examples and categorisation are provided in the **Table 2.1**.

Table 2.1 - TPR Categorisation & Examples

Resin Type	Resin Derivation	Examples
AMS	Alpha Methyl Styrene Types	Sylvatraxx (Kraton), Impera (Eastman)
C5	Aliphatic Hydrocarbons	Escorez (ExxonMobil)
C9	Aromatic Hydrocarbons	Novares C (Rütgers)
C5C9[1]	Blend of C5 and C9	Struktol 40MS
H-DCPD	Hydrogenated DCPD	Oppera (ExxonMobil)
Terpene	Terpene Derivatives	Sylvares (Kraton), Dercolyte (DRT)
LP	Liquid polymers	Polyvest
LP STY	Liquid styrene polymer	Ricon

[1] C5 or C9 resins modified by C9 or C5 are included in the C5 and C9 volumes.

Rubber Process Oil (RPO): Oils used to enhance the processability and end performance of a **tread compound**. Examples and categorisation are provided in **Table 2.2**.

Table 2.2 - Tire Tread RPO Categorisation and Examples

RPO Type	Derivation	Examples
DAE	Distillate Aromatic Extract	Panoil
TDAE	Treated DAE	Vivatec
HN	Heavy naphthenes and treated naphthenes	HyPrene
MES	Mild Extraction Solvate	Plaxolene
PAR	Paraffinic Oil	Sunpar
RAE	Residual Aromatic Extract (Including treated)	Flavex
VO	Vegetable Oil	Agripure

Products: Car, SUV, Motorcycle and Scooter tires and associated subtypes.

Geographies: Global market split into 10 regions: Africa, China, CIS, Europe, India, Middle East, North America, North Asia, South America and South Asia.

Time Frame: 2015 to 2050 for market volumes. Market pricing by type for APAC, EMEA and USMCA for the years 2017 to 2020.

2.2 OBJECTIVES

The key report objectives are as follows:

- Determine the current TPR and RPO manufacturing landscapes
- Understand tire types, subtypes and product requirements
- Determine the market drivers for TPRs and TPOs
- Review impact of changing compounding technologies
- Implement long-term forecasts and assumptions
- Determine global and regional splits for TPR and TPOs
- Determine global and regional market values for TPR and TPOs
- Provide an outlook for TPR and TPO manufacturers

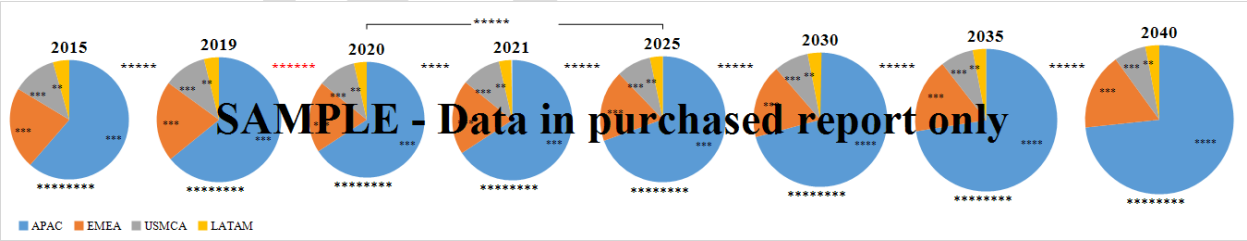
2.3 MARKET DRIVERS

The combination of RPOs and TPRs in a single market report may appear confusing. It is however completely necessary to view these two groups of tire chemicals collectively due to changing tire market requirements and their increasingly inter-related nature. This section looks at quantitative tire production growth drivers which apply to both groups and follows with qualitative drivers which discuss the interactions and divergences between the two groups.

2.3.1 Quantitative

Increased ******* is * key ****** for *** adoption ** both ****** because ********* tire ****** should **** to ********* rubber ******** demand. **Figure *.*** presents ********* tire ********** growth *** PC **** SUV **** types ***** by **** and ******. It ** clear **** tire ********** will ******** substantially* with **** year ***** ranging ***** *.* to *.*% globally. APAC ** forecast ** have ********** production ****** to ***** increasing ******** parcs ** well ** export *******.

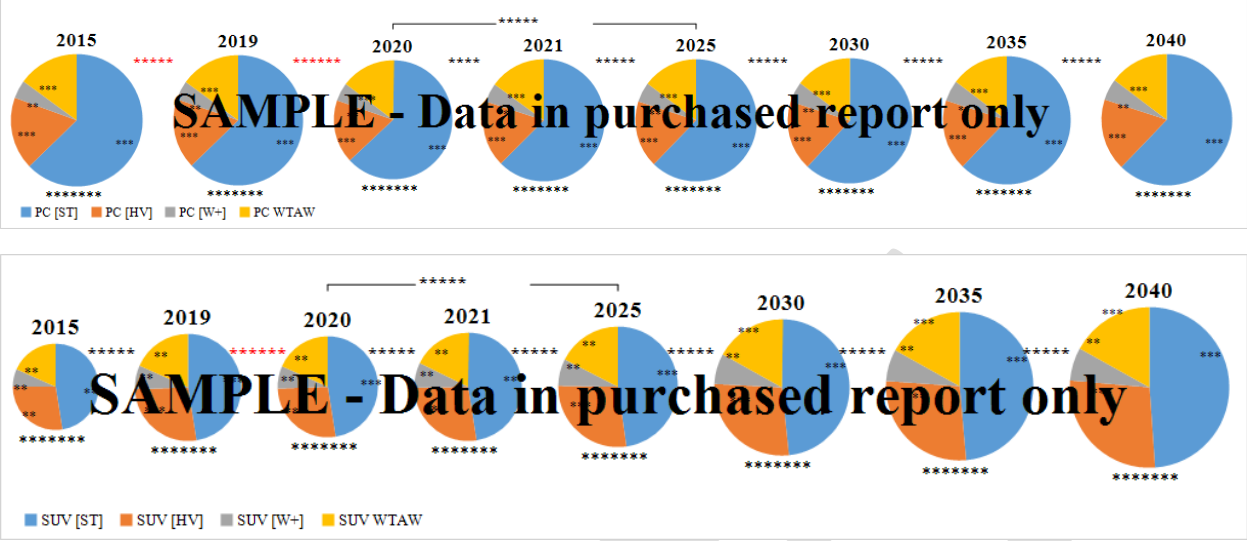
Figure 2.1 - PC + SUV Regional Tire Production Growth 2015 to 2040



There ** a ***** trend ** **high ***** added *HVA* goods**. **Figure *.*** presents **** production ********* split ** main **** type *** subtypes. Two *** points **** this **** are* *) *** tires *** increasing ** a **** faster **** versus **: *) *** types* typically ********** with ****** speed ******, larger ******** lower ****** ratio* is ********** for **** SUV *** PC. Both ** these ******* drive ********* use *** both ****** due ** average ********* tire *** tread ****.

It ****** be ********** that ********** regional *********** and ******* mixes **** have ** influence ** individual ***** demand* this ** explored ** the ********** section *****.

Figure 2.2 - PC and SUV Tire Production Growth by Subtype 2015 to 2040



2.3.2 Qualitative

Changing ***** Mix** ** a ****** driver *** differences ** group *** patterns. Examples ** this ******* the ***** from ********** of * and * rated ***** in ****** to *** products. TPR *** typically ********* as *** move ** the ***** chain* often ** the ******* of **** RPO ******.

The ********** of ***** tire ******** ** influences ******** choices* for ******* AW ***** typically ******** use ** VOs *** TPRs **** limited *** of ********** fossil ***** RPOs.

Market ***** ** of **** products ** a ******** factor. Original ********* (**) tires have * significantly ****** proportion ** TPR ******* versus ********** (**) tires often ** the ******* of *** types. In ******* to ****, there **** significant ****** in *** use ******* tire ***** of ********* tier ******.

Geographical ******** ** are **** a ******, these ****** to ********* tire ********** drivers ******* regions. Regions ***** wet **** is * key ********* (*.g. Europe* have ********* underlying ***** technologies ****** regions ***** this ** not **** a **** priority **** influences *** amount *** type ** both **** and ****. Regional ********** in ****** chemical ****** availability **** impact *** and **** compound ******.

External ***** ** such ** environment *sustainability** tire *********, legislation *** automotive ********** have * substantial ******.

Sustainable ****** is ******* the ****** of **** TPRs *** RPOs* this ** impacting **/AW*AS ***** at ******* rates. Regions ***** tire ********* is ******* have ****** TPR ******* due ** property ******* requirements. Legislative ******** such ** low *** oil ****** in ****** have ****** increased *** of **** to ******** property *******. Increased *** of *** PAH **** in **** is * strong ****** for *** adoption ** TPRs* even **** lower ********** tire *******. The ******** focus ** larger *e.g. SUV* electric ***** vehicles ** placing ********* emphasis ** RR *** wear ********. These ******* requirements *** being ******* with ***** tread ***** with ****** use ** specific *** types *esp. liquid ******) and ***** RPO ***.

2.4 Market Demand

This section looks at market demand determined by combining all the factors discussed in **Section 2.3** to provide demands for TPR and RPO. Two different scenarios are used to estimate future use. The current scenario assumes changes based on current and short-term technologies without reference to tire company sustainability targets. The vision scenario assumes elimination of fossil based materials using RCCL estimates of rate of change based on tire company vision targets and tire subtypes. This **does not** determine how this demand is replaced, and is therefore a measure for the potential rate of change for manufacturers currently producing fossil based products.

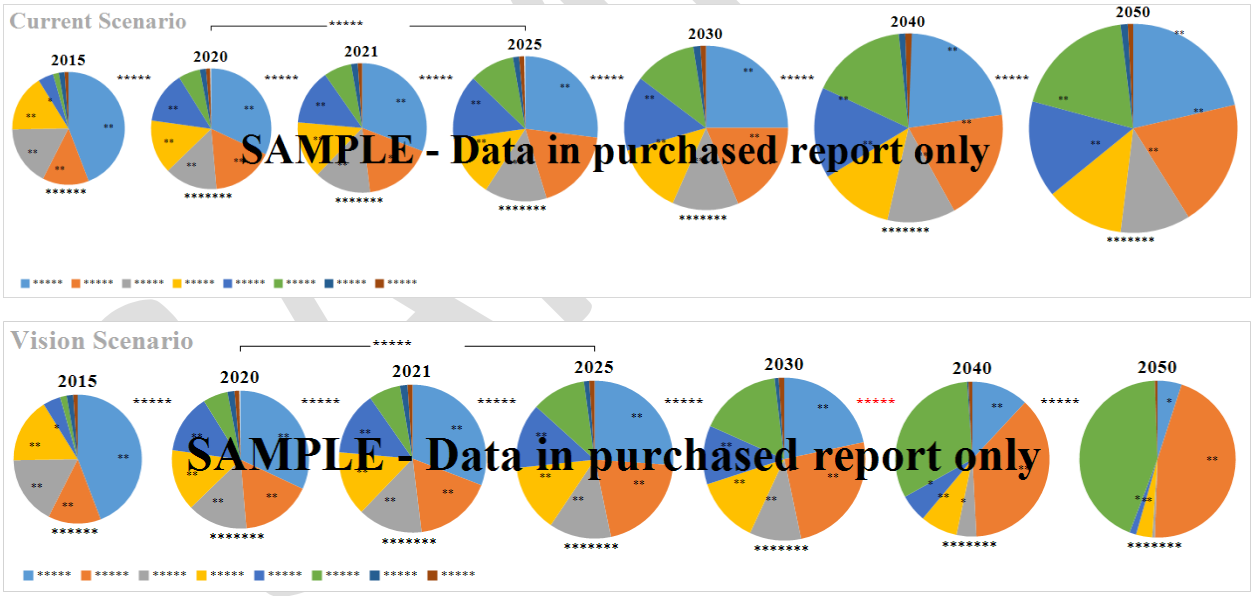
2.4.1 TPRs

Total market demand and splits by TPR type are presented in **Figure 2.3**.

Current ******: AMS ***** maintain *** largest ******, however ***** share ** forecast ** drop **** **% ** **** ** **% ** ****. C* and ** types ****** in ***** with ***** types *******, most ******* LP *** HDCPD *****.

Vision ******: Terpene *** LP ***** are ******** to ****. Fossil ***** products ***** share **** around **** with ********** drops ** demand **** ****. Please **** RCCL ********** for **** interpretation.

Figure 2.3 - Global TPR Market Demand by Type and Scenario 2015 to 2050



SAMPLE - Data in purchased report only

Total ****** demand *** **** ** **** ** presented ** **Table *.***. The **** market ****** was ********* at ***.* kMT *** is ******** to ******** to ***.* kMT ** ****. The ******* scenario ******** substantial ****** through ** ****, *** vision ******** is **** flatter **** the ******* of ****** based ********* and ***** for ** and ** types.

Table 2.3 - Global TPR Market Demand All Types by Scenario 2015 to 2050

kMT								Δ	CAGR			
Scenario	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Current	**.*	***.*	***.*	***.*	***.*	***.*	***.*	**%	*.*%	*.*%	*.*%	*.*%
Vision	**.*	***.*	***.*	***.*	***.*	***.*	***.*	**%	*.*%	*.*%	**.0%	*.*%

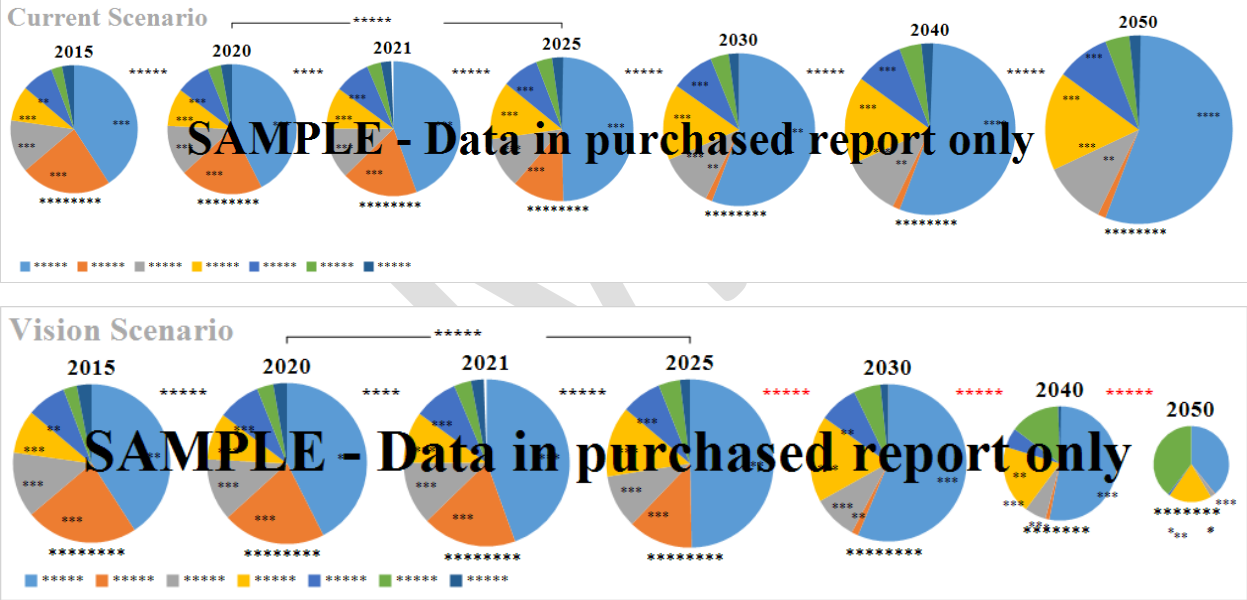
2.4.2 RPOs

Total market demand and splits by RPO type are presented in **Figure 2.4**.

Current ******: TDAE ***** maintain *** largest ****** with ***** share ********** from **% in **** to **% by ****. RAE *** VO ***** increase ***** market *****. DAE ***** reduce ***** in ******.

Vision ******: TDAE *** RAE **** share ***** **** ******** by ********** declines. DAE ******** rapidly **** ****. Please **** RCCL ********** for **** interpretation.

Figure 2.4 - Global RPO Market Demand by Type and Scenario 2015 to 2050



Total ****** demand *** **** ** **** ** presented ** **Table *.***. The **** market ****** was ********* at **** kMT *** is ******** to ******** to **** kMT ** ****. The ******* scenario ******** substantial ****** through ** ****, *** vision ******** predicts * substantial *******.

Table 2.4 - Global RPO Market Demand for All Types by Scenario 2015 to 2050

kMT								Δ	CAGR			
Scenario	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Current	****	****	****	****	****	****	****	*%	*.*%	*.*%	*.*%	*.*%
Vision	****	****	****	****	****	***	***	*%	*.*%	**.4%	**.2%	**.6%

2.5 Market Price & Market Values

This section looks at market price and value determined by combining all the factors discussed in **Sections 2.3 & 2.4** to provide demands for TPR and RPO. Future market values use unadjusted 2019 pricing.

2.5.1 TPRs

Total market values were estimated from averaged delivered prices which are presented in **Table 2.5**.

Table 2.5 – TPR Average 2019 and 2020 Delivered Regional Pricing by Type, $/MT

TPR Type	APAC		EMEA		USMCA	
	2019	2020	2019	2020	2019	2020
AMS	****	****	****	****	****	****
C5	****	****	****	****	****	****
C9	****	****	****	****	****	****
C5C9	****	****	****	****	****	***
HDCPD	****	****	****	****	****	****
LP	*****	****	*****	****	*****	****
LP STY	*****	****	*****	****	*****	****
TP	****	****	****	****	****	****

Regional pricing may be impacted by volume differences. Prices reflect modified resins with differentiated performance, therefore the true regional average will be lower. RCCL assumptions apply see Section 9.

Global ****** values *** all *** types *** presented ** **Table *.***. The **** market ***** was ********* at **** MM* this ** predicted ** rise ** $*** MM by **** using *** current ******** and **** MM ** **** ***** the ****** scenario.

Table 2.6 - Global Market Value for All TPR Types by Scenario 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
	2020	2030	2040	2050	2020	2030	2040	2050
Global	***	***	****	****	***	***	***	***

Regional ****** values *** presented ** **Table *.***. Europe *** the ******* current ***** which ** surpassed ** China ** ****. Values *** lower *** the ****** scenario *** are ********* by *** high ****** pricing *** LP *****.

Table 2.7 - Regional TPR Market Value for All TPR Types by Scenario 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	**	***	***	***	**	***	***	***
CIS	**	**	**	**	**	**	**	**
Europe	***	***	***	***	***	***	***	***
India	*	**	**	**	*	**	*	*
M. East	*	**	**	**	*	*	*	*
USMCA	**	**	***	***	**	**	**	***
N. Asia	**	***	***	***	**	***	***	***
S. Am.	*	**	**	**	*	**	**	**
S. Asia	*	**	**	**	*	*	*	*

2.5.2 RPOs

Total market values were estimated from averaged delivered prices which are presented in **Table 2.8**.

Table 2.8 - RPO Average 2020 Regional Delivered Pricing by Type, $/MT

RPO Type	APAC		EMEA		USMCA	
	2019	2020	2019	2020	2019	2020
DAE	***	***	*	*	****	***
TDAE	****	***	****	***	****	***
HN	****	***	****	***	***	***
MES	****	****	****	***	****	***
PAR	****	****	****	****	****	****
RAE	****	***	****	***	****	****
VO	****	****	****	****	****	****

Regional pricing may be impacted by volume differences. RCCL assumptions apply see Section 9.

Global ****** values *** all *** types *** presented ** **Table *.***. The **** market ***** was ********* at ***** MM. This ** predicted ** rise ** $**** MM by **** using *** current ******** and ** rise ** $**** MM by ***** using *** vision ********.

Table 2.9 - Global Market Value for All RPO Types by Scenario 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
	2020	2030	2040	2050	2020	2030	2040	2050
Global	****	****	****	****	****	****	***	***

Regional ****** values *** presented ** **Table *.****. China *** the ******* **** ***** and *** highest ********* current ******** growth. The ****** scenario ********* growth ** **** *** China* India *** North ****, with ***** regions ****** flat ** showing ****** declines ** ****.

Table 2.10 - Regional Market Value for All RPO Types by Scenario 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	**	**	**	*	*	*	*
China	***	***	****	****	***	***	***	***
CIS	**	**	**	**	**	**	**	*
Europe	***	***	***	***	***	***	**	**
India	**	**	***	***	**	**	**	**
M. East	**	**	**	**	**	**	*	*
USMCA	**	**	**	**	**	**	**	**
N. Asia	***	***	***	***	***	***	***	**
S. Am.	**	**	**	**	**	**	**	*
S. Asia	**	**	**	**	**	**	**	*

2.6 INDUSTRY OUTLOOK

2.6.1 Tire Industry

Tire ********** organic ****** in **** is * key ****** for **** chemical ******. Changing ******* mix *** compounding ********** as * result ** regional *** global ****** is **** a ********** factor. Regional ******* include *** transition ** '****** technologies in ***** and ********* growth ** HVA **** manufacturing ** Europe *** USMCA. Global ****** include ******* electrification *** sustainability ***** is ******* tire ***** technology ********. Tire ******* initiatives ** reduced **** weight *** equivalent ********** may ***** to ********** the ******* trend ** increased **** sizes ** the ****** continues ** transition **** PC ** SUV. The ****** term ****** of ********** driving ** unclear* but **** have ** impact ** tire ***** compound ******. The ********** of ******* tires ****** in ********* not ****** tire ***** compounds* however* future ******** requirements *** this ********** may ******.

2.6.2 TPR Industry

The ***** term ****** prospects *** TPR ****** demand *** good* with * current ******** ****/** CAGR of *.*% and ****/** of *.*%. Longer **** current ******** growth ***** reduce* but *** above **** industry **** growth *****. This ** a ********* of ******** tire ******* mix ** HVA ***** with ********* types *** differentiation ** well ** larger ******* sizes. Development ** liquid **** and*or ********** solutions ** particularly **** growth *** shows * lot ** potential *** tire ***** compounding ******.

The ****** scenario ***** at ********* in ****** based *********, this ********* a ********** reduction ** long*term ****** unless ********** feedstocks *** sourced.

Demand ** region ** dependent **** current *** future **** product *** as **** as ********** measures **** as **** labelling *** PAH ********** in ******* oils. APAC ***** potential *** additional *** demand *** to *** elimination ** well ** changing **** product ***. This ***** itself ** development *** tire ******* competency *tier *****) with ******** products *** lower **** level **********.

Resin ********** typically **** highly ********** manufacturing ********* and ******* ranges ***** span * variety ** industrial ********. TPR ******** represent * small* but ***** added ***-segment *** these **********. Established ******* in **** market **** been **** to ******** tire ******** knowledge *** a ***** pool ** technical ********* to **** market *********. Competition ** this **** is ******** to ******** with ******** from **** and ***** in **********, this **** almost ********* lead ** downward ******* pressures ** the ****** (*+ years) ****. Longer **** advantages **** be ****** from ********** that **** invested ** sustainable ******** and ******* development. Due ** the ********* requirements ** tire ******** it ** envisaged **** additional *********** will ** gained *** manufacturers **** can ****** the ********** versus ********** gap *** HP*UHP ** subtypes.

2.6.3 RPO Industry

The *****-term ****** prospects *** RPO ****** demand *** good **** current *** vision ******** ****/** CAGRs of *.*% and *.*%. Tire ********** sustainability ********** will **** an ****** from **** shown ** the ********** in *** current *** vision ******** ****/** CAGRs of *.*% vs **.7%.

Regional ********** are **********. China *** India **** high ******* growth **** a ***** overall ********** mix **** influenced ** transitions **** highly ******** types ** non*labelled *****. This ***** to ******, especially ** DAE ********** prior ** the ****** of **********. In ****** the ********** mix ** high *** DAE *** been **********, the ********* sustainability ****** is ******.

Long*term ****** for ****** related **** will **** significantly. The ****** outlook ** RPO **** for *** vision ******** is ********* in ****** *.*. This ***** the ********* percentage ****** change ** RPO **** from *** **** ******. TDAE *** RAE ***** are **** to ******** and **** drop *********, whereas ******** in ***** types *** more ********* but ** a ****** rate. DAE ******* substantially ****** primarily ** legislative **********. VO ********* substantially* this **** of ******** has *** been ******** to ********** for ******** in ****** based **** and ********** current ****** seen ** WT* AW *** AS *****. As ******* noted* there *** significant ******** differences* therefore ******** by ****** is ********** using *** associated ***** spreadsheet *** data ** **Section ***.

Figure 2.5 - Vision Scenario Change from 2021 Market Demand by RPO Type to 2050

These *** only ******** elimination ** fossil ***** oils* they ** not ******* for ********* changes ** sustainable ********** or ****** for *** respective ****.***

3 INTRODUCTION

This section provides the framework for this market research report. Definitions and scope provide critical components necessary for a clear understanding of the report and conclusions. The objectives provide the building blocks for the market report. Information sources allow the user to understand the level of detail and reliability of the data.

3.1 DEFINITIONS, ABBREVIATIONS AND NOMENCLATURE

Definitions, abbreviations and nomenclature are provided in **Table 3.1.**

Table 3.1 - Definitions, Abbreviations and Nomenclature (A to H)

Item	Definition/Description
3PMSF	The Three Peak Mountain Snowflake label found on winter tires and all weather tires.
Africa	The African region – all countries on the African continent.
AFO	Alternative fuel vehicle (not electric).
AMS	Alpha Methyl Styrene type tread performance resin.
APAC	Asia Pacific Region. (All countries east of Pakistan).
AS	All Season tire type. This covers tires with M+S tire labelling.
AW	All Weather tire type. This covers tires designed for all weathers which includes snow performance. These tires have the 3PMSF label indicating measurable and standardised snow and low temperature performance.
BEV	Battery electric vehicle (100% electric drive).
CARB	California Air Resource Board Regulation.
CIS	CIS Countries plus countries outside of the Europe and EFTA. (Albania, Armenia, Azerbaijan, Belarus, Bosnia, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Montenegro, Russia, Serbia, Tajikistan, Ukraine, Uzbekistan)
CMB	Combustion engine driven vehicles.
DAE	Distillate Aromatic Extract.
Eco	Eco tires represent tires manufactured in energy and resource efficient factories. These tires typically incorporate a proportion of sustainable materials and also provide environmental credentials through low rolling resistance. In the case of truck tires there is also significant importance placed on retreading and case life.
EFTA	European Free Trade Association.
EPA	USA Environmental Protection Agency.
Europe	Countries of the European union plus EFTA.
EMEA	Europe, Middle East and Africa (Including CIS countries).
GTRCDB©	RCCL's Global Tire & Rubber Chemicals Database.
HC	Hydrocarbon type tread performance resin.
HEV	Hybrid electric vehicle.
HN	Heavy naphthenes and treated naphthenes.
HP	High Performance tire. These are tires with speed ratings of H and V.
HVA	High Value Goods.

Table 3.2 - Definitions, Abbreviations and Nomenclature (I to S)

Item	Definition/Description
India	Mainland India.
LATAM	Latin America (South America, Central America) Excluding Mexico.
LFY	Last full completed year. For market reports this is the last full year which can be benchmarked against RCCL's range of confidential market volume information.
LP	Liquid polymer
LP STY	Liquid polymer styrene based
LRR	Low rolling resistance
LT	Light Truck tire. Tires for commercial vehicles <3.5MT.
MES	Mild Extraction Solvate (mild extraction of vacuum distillate plus dewaxing).
Middle East	Countries around the Persian Gulf. (Afghanistan, Bahrain, Iran, Iraq, Israel, Jordon, Kuwait, Lebanon, Oman, Pakistan, Palestine, Qatar, Saudi Arabia, Sudan, Syria, Turkey, Turkmenistan, United Arab Emirates, Yemen)
MT	Metric Tonne.
M + S	Mud and snow label. This label is not a rigorous performance standard and only applies within a manufacturer and range of tires. It is typically indicative of a tread design allowing for better handling in adverse conditions, it does not necessarily indicate low temperature performance.
MW	Molecular Weight.
MM$	Millions of United States dollars.
NAFTA	See USMCA.
N. Asia	Countries around mainland Asia. (Bangladesh, Bhutan, Cambodia, Japan, Laos, Mongolia, Myanmar, Nepal, North Korea, South Korea, Taiwan, Thailand, Vietnam)
NR	Natural Rubber.
OE	Original equipment (new vehicle production).
pa	Per annum.
PC	Passenger car.
PHEV	Plug-in hybrid electric vehicle.
Precedence	RCCL's tire allocation method. AW > WT > UHP > HP > ECO > Others.
RAE	Residual Aromatic Extract (including treated versions TRAE and SRAE).
RCCL	Rubber Chemical Consultants Ltd.
PAR	Paraffinic Oil.
RP	Replacement market (components serving the used car market)
RPO	Rubber Process Oil including DAE, TDAE, RAE, NAP, PAR, MES and VEG.
S. America	Countries of central and South America.
S. Asia	Countries separate from mainland Asia. (Australia, Brunei, East Timor, Fiji Islands, Indonesia, Malaysia, New Zealand, Philippines, Samoa Islands, Singapore, Solomon Islands, Sri Lanka, Tonga, Vanuatu)
SUV	Sports utility vehicle or similar type.

Table 3.3 - Definitions, Abbreviations and Nomenclature (T to Z)

Item	Definition/Description
TD	Tangent delta. The ratio of dynamic loss modulus to dynamic elastic modulus.
TDAE	Treated Distillate Aromatic Extract (Process Oil)
TP	Terpene Resin
TPR	Tread Performance Resin
Touring	Touring tires are typically designed with comfort in mind. These tires cross a range of performances from budget (typically AS) through to UHP.
TR	Truck Radial. Tires for vehicles >3.5MT.
UHP	Ultra-High Performance tire. These are tires with speed ratings > V.
USMCA	United States, Mexico and Canada (formerly NAFTA).
VO	Vegetable oil including treated and untreated versions of sunflower, soybean, rapeseed, coconut and others.
WT	Winter tires. Winter tires are tires with the 3PMSF designation (Europe and North America) and also designated winter tires in North Asia (Japan and South Korea).
YoY	Year-on-year.

3.2 SCOPE

The following items are included in the scope:

Market Segment: Tire segment focusing on resins and RPOs used to enhance the performance of **tread compounds**, specifically traction, handling, rolling resistance and wear for the **Products** below.

Tread Performance Resin (TPR): Resin used to enhance the end performance of a **tread compound**. This excludes tack resins. Examples and categorisation are provided in the **Table 3.4**.

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[1] *C5 or C9 resins modified by C9 or C5 are included in the C5 and C9 volumes.*

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- Determine global and regional market values for TPR and TPOs
- Provide an outlook for TPR and TPO manufacturers

3.4 INFORMATION SOURCES

Primary Sources

Tire & rubber chemical company confidential contacts covering a broad range of disciplines (e.g. technical, commercial, marketing, production).

Knowledge gained via industry participation – no confidential information is presented.

Consultation for a range of clients on market and technical issues, enables extensive industry interaction and ensures up to date knowledge. Active consultations include carbon black companies, tire companies, rubber chemical companies, petrochemical companies, investment institutions and technology start-ups. While confidential information is not used directly in reports, information is used to benchmark and fine tune the reporting system providing realistic volume estimates via real life volume and technology benchmarking.

Secondary Sources

- Company annual reports & news feeds.
- Industry journals.
- Industry association journals and websites.
- Industry conferences and papers.
- Company web sites.
- Government websites.
- Patent reviews.

Global Tire & Rubber Chemicals Database (GTRCDB©)

The GTRCDB© is a proprietary database and reporting system designed specifically to gather and process market information relating to companies active in material compounding. This database is constantly fed information relating to tire, rubber and plastics compounding activities. Bespoke reporting tools allow flexible reporting of past, present and future market requirements for individual compounding ingredients. This is complimented by an extensive repository of chemical manufacturer information.

3.5 ASSUMPTIONS

RCCL tries wherever possible to rely on fact based analysis. Much of the underlying analysis via the **GTRCDB©** uses factual information gathered over many years from reliable sources. In order to provide a full market picture of a complex sector it is always necessary to make assumptions. **Wherever possible RCCL will make these clear by making a comment in bold red**.

RCCL's centrally controlled market analysis system allows alternative scenarios to be run. Clients wishing to adjust any of the stated assumptions can arrange for further analysis at an additional agreed fee.

4 TPR MANUFACTURING LANDSCAPE

This section focuses on manufacturers of tire tread performance resins. **Section 4.1** provides an industry overview giving some context with respect to the broader resin manufacturing segment and markets and that of tire tread performance resins. **Section 4.2** discusses raw materials used for tire tread performance resins. **Section 4.3** looks at the different types of tire tread performance resins. **Section 4.4** takes a closer look at the key manufacturers and their product offerings and provides some high level financial analysis.

4.1 INDUSTRY OVERVIEW

Many ** the *** manufacturers *** tire ****** are **** active ****** a ***** range ** industry ******** and ******** groups. Eastman ******** Company* ExxonMobil* Kolon ********** and **** Corporation *** examples ** these ***** of ************ for ***** tire ****** are * small ***-set ** one ** their ********** market ********. The ***** mentioned ********* also ***** the **** industry ****** a ***** of ********** product *********, this ****** spread ** resources *** shared ********** between ********* product ********* with ****** customers.

Manufacturers ******** in ***** products *** derivatives ***** companies **** as *** and ******** Chemical* in **** instance *** tire ******* forms * small ***-set ** the ***** product *********.

Figure 4.1 - Simplified Schematic for Raw Material to Resin Type

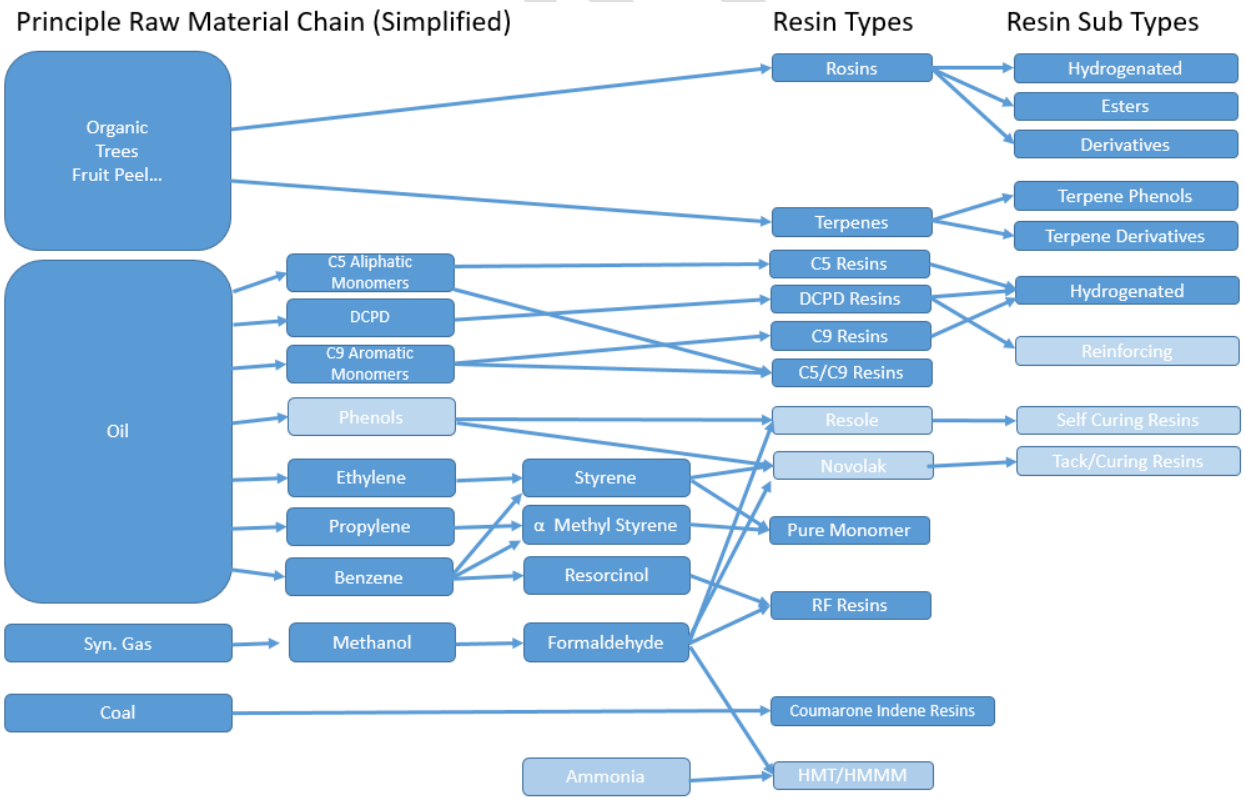


Figure *.* shows * simplified ****** for *** materials ******* to ***** types *** sub *****. This

********** the ********** of *** resin ******** and *** huge ***** of ******* offerings *** potential ******* variants. Each ** the ***** groups *** sub ***** has * natural *** with ******** target ******** due ** chemistries *** performances* the ********* to ****** materials **** leads ** cross*overs ** target *******. The ***** categorisation ** this ****** denotes *** primary *********, however ** is ******** possible **** the **** resin ** modified ** other ****** to *** in ************ with ****** polymers *** applications.

4.2 RAW MATERIALS

The *** starting ********* for *** main ***** types *** oil* coal *** organic *********. Oil ***** resins *** typically ******** to ** petroleum ******. Trees *** the ********* feedstock *** organic ***** resins* although ***** are ******** exceptions ** this. **Figure *.*** shows * simplified ********* for *** principle *** materials *** the ***** to ********* for ********* resin *****. It ****** be ***** that **** resin **** can ** subject ** many ********* types ** modification *** this *** sometimes **** to ********* of **********. The ***** groups ********* in **** report *** produced **** coal* oil *** organic **********.

Distinction *** made ******* sustainable ******* and ***** consisting ** oil ** coal ***** derivatives* this ***** to **** differentiation ** the **** resin ****** on *** grounds ** sustainability. The ******* driver *** individual *** use ** tire **********, with ***** premiums *** products **** to ********** themselves ** final ******** enhancement *** also ******* in ********** performance. Sustainability ** becoming * more ********* factor ** material ****** for *** tier **** manufacturers *see **** *.***). This **** impact ******** choices ** the ******-long **** in ***** for ***** manufacturers ** meet ***** sustainable ******** targets. This **** complexity ** the ******* mix **** sustainable ********* modified **** fossil ***** chemicals ** provide * balance ** performance *** sustainability.

4.3 RESIN TYPES

The ***** types ******* by **** report *** detailed ** the ***** (******* **3.* Table *.***). There *** wide ******* claims *** resin ********** and *** within *** tire ********. This *** lead ** a ******** picture **** respect ** actual ********* use ** tire **********. The ********* sections **** with **** resin ****, providing *** range ** use *** tread ********** and *** in ***** tire **********. This ********** is ******** in ******* * ***** looks ** the ********** requirements ** treads ** specific **** types *** sub *****.

The ********** of ****** by **** is ********** for ********* purposes. It ****** be ********** that **** resins *** hybrids ** two ** more ********** types* the ***** '***** in this ******** is ********* defined ** the ***** component. For *******, a ******* resin *** be ******** with ****** and*or ***** aromatic **********, it ** referred ** as * terpene ***** if **** is *** major *********. This ********** can ****** tenuous ** some **********.

Review ** tire ******** resin *** via ********** contacts* patent ********** research *** brand ******** indicates ** increasingly ******* landscape. Development ****** and ********** considerations *** presented ** **Section *.***.

4.4 KEY MANUFACTURERS

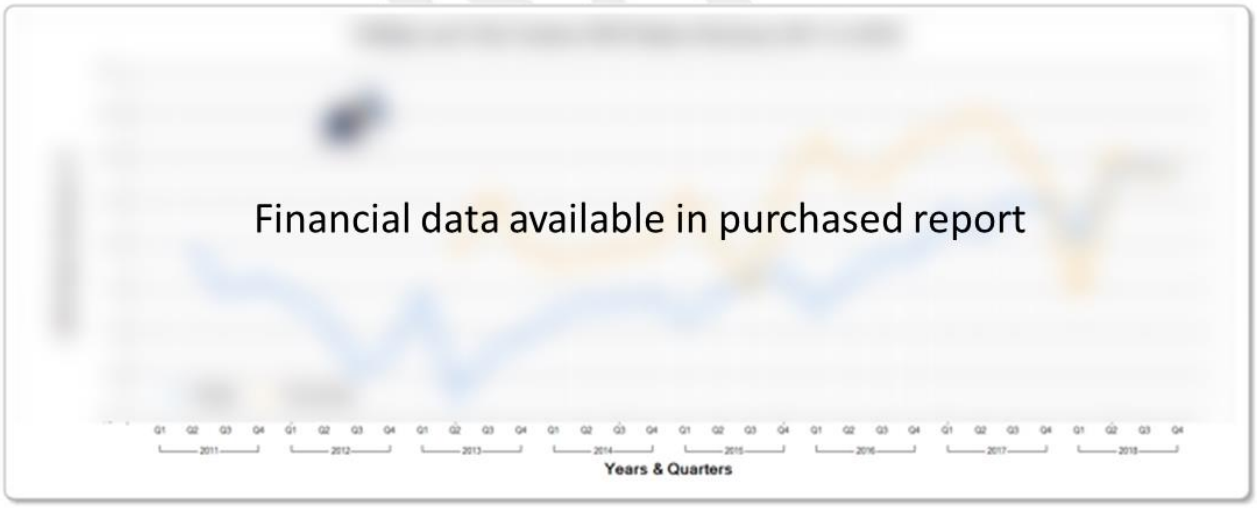
This section focuses on key TPR manufacturers. The patent literature research provides the names of some additional manufacturers, these can be found in **Section 7.4**.

4.4.1 Financial Performance

Many ** the ********** listed *** active ****** a ***** range ** market ******* (** discussed in ******* *.*) covering a **** range ** products* both ***** and ***-resin *******. This ***** financial ******** of **** resin ******* operations **********. **Figure *.*** shows ********* margin ** a ********** of ***** revenue *** selected ***** manufacturers *** reporting ******** including *** activities. The **** ratio *** Eastman ** due ** the ***** of ********* included ** their ********** products *******. The ***** three ********** segments *** more ******** to ***** production ******** a **** range ** market *******. Trends ******** from ***** ratios ***:

- ********** ***** *** **** * ****** **** **** **** ** ****. ********* *** ******* ******* ** **** **** *** ****** ** *** ***** **** ** *****-** pandemic.
- ******* *** *** ***** ***** ********** **** ****** **% *** **** ** ****.
- ********* ********** ** **** **** ** ****.

Figure 4.2 - EBIT/Sales Revenue for Selected TPR Manufacturers & Business Segments 2015 to 2021



Kraton ********** financial ********** allow ********** breakdown ** resin ******* product ********** volume. This ** presented ** **Figure *.*** showing ***** revenue* gross ****** and **** divided ** total ***** volume *** Kraton's ******** reporting ******* (******** Arizona Chemical*. Average ******* price ** about *****/MT **** average **** of ********** $***/MT. Average ******* price ******* from ** **** ********** in ****.

Kraton ****** quarterly ***** for *** Tire *******. Using *** reported ****** changes *** an ********* **** ****** price* the **** to **** values *** market ***** and ***** volume **** estimated. This ** provided ** **Figure *.***. This ********* that ****** sell *** products ** prices **** above *** average ******* reporting *****.

Figure 4.3 - Kraton Corporation's Chemical Segment Financials 2016 to 2021

Figure 4.4 - RCCL Estimates for Kraton TPR Sales & Volumes

4.4.2 Arakawa

Arakawa ********** in ******** using ********** raw ********* and *** multiple ********** locations ** Japan. TPRs ****** to **** a ***** part ** their ******* offering.

Table 4.1 - Arakawa's TPR Products

Trade Name	Type	Description
ARKON	H-HC	Hydrogenated petroleum resin
TAMANOL	******* ********	

4.4.3 Cheeshine Chemicals

Cheeshine ********* have *** manufacturing ******** in ******* Province* China. They ********** a **** range ** rubber ******** products ********* silane ******** agents* multifunctional ************ agents* performance ******, fillers* process **** and ***. Cheeshine **** a ******* TPR ******** and *** technology *********.

Table 4.2 - Cheeshine Chemical's TPR Products

Trade Name	Type	Examples	Target Properties
LUKATOTAC	AMS	CSR6009	WG [RR]
LUKATOTAC	******* ** ******* *** ******** ******	*******	** ***]

4.4.4 Cray Valley (Total)

Total **** Valley ** a ****** manufacturer ** low ********* weight ********** additives. Cray ****** produce ***** hydrocarbon ****** at ***** plant ** Beaumont* Texas* USA *** also ******* functionalised ************* resins ** their ***** in ***** Junction* Colorado* USA. Cray ****** have * broad ******* range *** customer ****.

Table 4.3 - Cray Valley's TPR Products

Trade Name	Type	Description
Ricon Series	LP-BR LP-BR-FX LP-SBR	Low MW Polymer
Norsolene Series	** **** *******	** ****** **** *******

4.4.5 DRT

DRT ********** in ***** and ******* products. After *** acquisition ** Pinova ** **** **** have ********** bases ** three ********* regions* Georgia* North *******: France* Europe *** Wuxi* China. DRT **** a ***** range ** terpene *** modified ******* products *** appear ** have ** increasing ***** on *** Tire ******.

DRT ** building * new ******* phenolic ***** at *** existing ******** in ********, France. The ***** is *** for ********** end ** **** *** will ***** the ***** terpene **** capacity ** **%. They *** also ******** a *** hydrogenated ***** plant ** Vielle *****-Girons* France* due *** completion ** ****.

Table 4.4 - DRT's TPR Products

Trade Name	Type	Examples
Dercolyte	Terpene Limonene	L120
Dercolyte	******* ********	*****
Dertophene	******* ********	****

4.4.6 Eastman

Eastman ******** Company **** entered *June ****) into * definitive ********* to ****** its **** additives ******** with *** exception ** its **** performance ****** products ***** it **** retain. Eastman **** four ***** manufacturing ********** in *** USA *Pennsylvania* Texas** Europe *Netherlands* and ***** (*******).

Eastman ***** annual ******) announced ********* for *** Impera **** performance ******. The ********** will ** at ***** Middelburg ***** in *** Netherlands *** at ***** Jefferson ***** in **, USA. The ******** increases **** stated ** be ******* ** *** ** *******, this ******* to ************ * ***** based ** RCCL's *********.

Eastman ****** to * wide ***** of **** companies ****** the *****. Their ********** based *** product ***** is *********.

Table 4.5 - Eastman's TPR Products

Trade Name	Type	Examples	Target Improvements
Impera	AMS	P1504	WG/RR/WR
Impera	**	*****	
Impera	**/**	*****	**/**/WR
Impera	*-*********	*****	
Impera	*-********	*****	
Piccotac	**/**	****	

4.4.7 ENEOS

The ***** brand ***** from *** amalgamation ** Tonnen ******** and ** Nippon ***. Prior ** this ***** were ******* agreements **** ExxonMobil. It ** not ***** if *** resin ********* are ******* from ********** technology.

Table 4.6 - ENEOS' TPR Products

Trade Name	Type	Examples	Target Improvements
T-REZ	C5	RA100	Tack
T-REZ (Premium)	*-****/C9	*****	**/** High *** **********
T-REZ (Premium)	**/**	*****	**/** High *** **********
Neopolymer	**	***	******* *******
Neopolymer Premium	****/**	**-***	*** *** * ****

4.4.8 Evonik

Evonik **** a ****** position ** tire *** rubber ********** supplying ********** silica* silanes *** specialist ********* including ****** BR ** functionalised *silane **********) or ***-functionalised *****. The ****** BR ******** are ******** in ****, Germany.

Table 4.7 - Evonik's TPR Products

Trade Name	Type	Examples
Polyvest ST	Silane Terminated LP	Polyvest ST
Polyvest 130 S	********** **-**	******** *** *

4.4.9 ExxonMobil

ExxonMobil ******* elastomers *** resins *** the **** industry. ExxonMobil **** resin ********** locations ** the *** (*********), Europe (******) and Singapore. While **** are * small **** of ***** business **** have ** established ****** customer ****.

Table 4.8 - ExxonMobil's TPR Products

Trade Name	Type	Examples
Escorez	C5	1102
Oppera	**/**	******
Oppera	*-****	

4.4.10 Kolon Industries

Kolon ********** manufacture **** cord* adhesion ****** and ********** resins. Kolon ********** resin ********** plants *** located ** Daesan* Ulsan *** Yeosu* South *****. TPRs ****** to ** a ***** part ** their *********.

Table 4.9 - Kolon Industries' TPR Products

Trade Name	Type	Example
Hikorez Series	C5	
Sukorez Series	****, *-****, DCPD***	
Hikotack	** *** **/********	*-**

4.4.11 Kraton Corporation

Kraton ********** acquired ******* Chemical ** the *** of ****. Arizona ********** operations *** form *** chemical ******* of ******** operations. Kraton *** tire ***** manufacturing ********* in ******, France *** Panama ****, USA.

Kraton ********* (*** 2018) *** intention ** increase ******** for ***** enhancement ********* at *** Niorit ***** by **% with *** capacity ******** scheduled *** completion ** Q* ****. Based ** RCCL's ********* this ********* an ******** of ********** * *****.

Kraton **** a ***** range ** products ********** targeting *** Tire *******. In **** Kraton ********* its ****** generation ********** product* Sylvatraxx* ****. This ** a **** based *******

(********* limonene due ** pricing **********) with * high ******** content. The ******* is ******** at **-AS ***** for **** and **.

Table 4.10 - Kraton's TPR Products

Trade Name	Type	Examples
Sylvares	AMS	SA85
Sylvares	******* ********	** ****
Sylvares	*******	** ****
Sylvares	******* ********	** ****
Sylvatraxx	*******+*** ******* ******* ********	**** ****

4.4.12 Kuraray

Kuraray ********** their ****** resins ** Kashima* Japan **** supporting ***** offices ** all ****** regions.

Table 4.11 - Kuraray's TPR Products

Trade Name	Type	Examples
LIR	Liquid Isoprene	LIR-50
LBR	****** *********	***-***
L-SBR	****** ******* *********	*-*** 841

4.4.13 Rütgers Novares (Rain Carbon)

Rutgers **** two ***** manufacturing ********** in ******, the **** plant ** located ** Duisberg* Germany *** the ***** in ********, Netherlands. Rutgers **** a **** history ** supply ** the **** industry* particularly ** Europe *** recently ****** a *****-of*the*art ****** laboratory ** its ********** site ** Duisberg.

Rutgers ******* production ** a *** ***** hydrogenated hydrocarbon ******** in *******-Rauxel* Germany ** Q* ****.

Table 4.12 - Rutger Novares' TPR Products

Trade Name	Type	Examples
Novares C Series	C9 (Coal)	C30
Novares TM Series	*******+***	** ** *
Novares TL Series	** ****)	

4.4.14 Yasuhara Chemical

Yasuhara ******** are ******* on ******* chemistry *** have *** resin ********** plants ** Japan ******* in ********* and *****. Yasuhara's *** offerings ****** to ** mainly *** customers ** APAC.

Table 4.13 - Yasuhara Chemical's TPR Products

Trade Name	Type	Examples
YS Resin PX Series	Terpene	TO125
YS Resin TO Series	*******/**	****
YS Polyster Series	******* ******	****

4.4.15 Zeon Corporation

Zeon ********** have *** resin ********** plants. The **** plant ** located ** Okayama* Japan *** the ***** is ******* in ******, Thailand. TPRs ****** to ** a ***** part ** their ******** base.

Table 4.14 - Zeon Corporation's TPR Products

Trade Name	Type	Examples	Description
Quintone 100 Series	C5/C9	G100B	HC resin made from high purity 1,3-pentadiene from C5 fraction
Quintone 1000 Series	****	****	**** *** ****/*** resistance

4.4.16 Other Manufacturers

There *** numerous ***** resin ********** claiming ** sell **** the **** market. Many ** these *** supply ********** rather **** TPRs. Additional ********** which **** some ******** in *** TPR ****** are* Daelim* Mitsui *********, Sadara ********, Songwon *** Ube. Orgkhim **** terpene **** resins ** upcoming ********.

4.4.17 Key TPR Resin Manufacturer Trends

Two trends in suppliers are clear:

- ******** **** ****** *********
  - ******* ** *** ******* *** ********* ******** ***** ********* **** ****** ******* ********** ** ******* **** ***** ** *** ******. ***** ********* ******* ******* *** **********.
- **** ****** *****
  - ********* **** * ***** ********** ** *** **** ****** **** **** ********** ** ******* ** ********** ********** *** *****. ***** ********* ******* ****** ******** Chemical** *** *** ********.

4.5 INDUSTRY DEVELOPMENTS

This section comments on developments from a supplier perspective. Market driven developments are discussed in **Section 7**.

Leading *** producers *** increasing ***** focus ** specific **** type *** subtype ********** in **** with **** market ********** and **********. This ** leading ** increased ***** on ******** for **/AW ********** which **** balanced ********** characteristics.

Tire ******** manufacturers *** favourable ****** conditions ******* ****, *******, market ********** deteriorated ******* ****, ******** by ********** COVID*** disruption ******** in ****. While ********** TPR ******** have **** immunity ** general ****** fluctuation* pricing ********* were ******** by *** main *********. Kraton **** also ********** a *** material ****** for ***** terpene ***** which *** also ** an ********* of ******* pricing *********.

5 RPO MANUFACTURING LANDSCAPE

This section focuses on manufacturers of RPOs. **Section 5.1** provides an industry overview giving some context for the RPO industry and market within the broader base oil & vegetable oil industries. **Section 5.2** discusses raw materials and RPO types. **Section 5.3** takes a look at the key manufacturers and their product offerings. **Section 5.4** highlights key developments in the manufacturing and development of RPOs.

5.1 INDUSTRY OVERVIEW

Historically *** majority ** RPOs **** based ****** DAE ***** derived **** Group * base *** production ***** were *** cost* readily ********* byproducts **** the ******** industry. Due ** changing ************ and ********** developments ** the ******** and **** industries* the *** and ************ of **** has ******* significantly.

The ******** industry *** developed **** expensive ******** methods ** produce ***** II **** stocks ***** are ********** to ** higher ******* products *** many ***** applications. This *** lowered *** price ** Group ** products ** become *********** with ***** I *****. In ******** to ****, the ********** industry's ************ for ****** oil **** changed **** modern ******* requiring **** quality **** oils. The ********** changes **** occurred **** the **** two *******. An ********** disrupter* IMO ****, was ********** in **** by *** International ****** Organisation. This ********** that ****** fuel **** in ******* zones **** be ***** *.*% sulphur, **** from * previous *** of *.*%. This ****** is *********** the ****** and ****** of ***** I **** stocks. It ****** be ***** that ***** Group * volumes **** declined **********, they ***** hold * substantial ****** share ******** a ********* mix ** product ********** (*.g. greases* waxes ***.).

The **** RPO ****** is **** small ******** to *** overall ******** and **** base *** markets. It ********* has ******* influence ** the ********* of ****** of *** refining ********. One *********** factor ********** in **** by *** EU *** a *********** on *** level ** polycyclic ********* (***) in RPOs *** tire *** in *** EU. This *** implemented *** to *** carcinogenic ****** of ***** compounds. This *** to *********** of * number ** low *** aromatic ***** from ***** I **** oil ********** as **** as *** introduction ** treated ********** types.

More ******** sustainability *** environmental ****** have ****** more ********* for **** companies. The **** five ***** has **** a ****** increase ** aspirational ***** towards *********** development ** the ******** including * focus ** renewable *** recycled *********. Current *********** of ****** based **** in **** formulations ** driven ** advantages ** performance *** is ********** to ********** small *******. Replacement **** accelerate ****** forwards ** order *** tire ********* to **** specific *******, the **** stringent ** which ** ***% *********** materials ** ****.

Vegetable *** developments **** accelerated ** the **** ** *****, with **** of *** leading **** companies ***** these ***** of **** for ******* replacement ** fossil ***** RPOs ** winter ***** and **** recently ** all*weather *****. These ********* oils *** typically ******** for *** in ******

compounds. It ** anticipated **** these ***** of *** will ** further ********* for *** in * wider ***** of **** types.

The ***** factors **** reduced *** number ** fossil ***** RPO ********* over *** last ****** of *******. Those ********* have *** to **** a ********** to *** RPO ****** as **** of ***** overall ********** efficiency *** technology. While *** fossil ***** suppliers **** decreased ** number* the ***** of ********* oil ***** and ********* have **********.

5.2 Raw Materials and RPO Types

The ******** of **** are ******* from *** refining ** mineral ***. Aromatic ***** (***, TDAE, ***, TRAE* are ********* from *** same ********** flow **** for ***** I **** base **** as ***** in ****** *.* with appropriate *** lube *** definitions ******** in ****** *.? Other ***** such ** MES *** HPD *** the **** production **** as ***** II*III **** oils. Naphthenic ***** fall **** the ***** V ********** and *** typically ************ for ****** applications.

HPD: hydrotreated paraffinic distillate.

Figure 5.1 - Lube Base Oil Production and RPO Streams

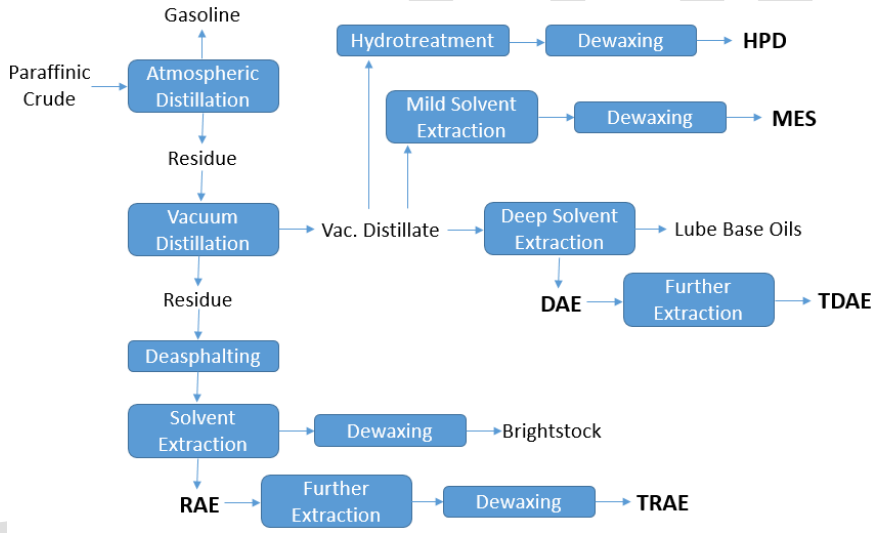


Figure 5.2 - API Base Oil Categorisation

	API BASE OIL CATEGORIES				
	Base Oil Category	Sulfur (%)		Saturates (%)	Viscosity Index
Mineral	**Group I (solvent refined)**	>0.03	and/or	<90	80 to 120
Mineral	**Group II (hydrotreated)**	<0.03	and	>90	80 to 120
Mineral	**Group III (hydrocracked)**	<0.03	and	>90	>120
Synthetic	**Group IV**	PAO Synthetic Lubricants			
Synthetic	**Group V**	All other base oils not included in Groups I, II, III or IV			

Sustainable **** are *********/plant ***** with * wide ***** of ******** used ** the *** tire ********** including *********, soybean *** rape ****. The **** are ********* modified *** have * controlled *** high ********** Oleic **** content.

Other ********** RPOs *** falling **** the ***** two ********** include ********* esters *** specialist ********** products *** specific ********** such * racing.

5.3 KEY MANUFACTURERS

Key manufacturers are summarised by region and RPO type in **Table 5.**? Entries in light grey are tentative.

Table 5.1 - Key Manufacturers in APAC, CIS and Europe

Region	Country	Manufacturer	RPO Types
APAC	China	*****	**** *****
		********** *****)	**
		******** ********	** *** ****
		****** ******	***
	*****	**** **********	** ***
		** **********	** *** *** * ****** *****
		***** **********	*** ** ***
		****** *********	*** *** ** *** *** ****
		*** ***** **********	*** ** ***
	*********	*********	**** ***
	*****	***** *****	***
	***** *****	** **********	***
	********	*******	****
		********** *********	***
	*********	*****	***
		********	*** *** **** ****
	******	*** ****	*** ****
	********	*&*	****
		****	****
		**** **** ****	****
CIS	******	*******	****
		******	**
		*******	*** *** *** **** ****
EU	*******	*******	***
	*******	***** *********	*** ***
	******	*****	*** *** *** ****
		*******/*****	***
		******	***
	*******	*&* Grouop	****
		*******	***
		*****	** ***
	*****	***	*** *** ****
	**********	*****	***
		*******	***
	*****	******	*** *** *** ****
	******	*****	**

Table 5.2 - Key Manufacturers in M. East, USMCA and LATAM

Region	Country	Manufacturer	RPO Types
MEAST	Iran	**** Co	**** *** **** ****
USMCA	******	******** ***	***
	***	*******	**
		*******	***
		******* ********	***
		*****	***
		***** ***	**
		*****	*** **
		**********	*** *** ***
		**********	**
		*** *******	*** **
		******* *****	***
		*****	**** *** **** ****
LATAM	******	******	*** ** *** ****
		*********	*** ***
	*****	**********	**
	********	*******_*_ Disolventes	**

5.4 RPO Industry Developments

This section comments on developments from a supplier perspective. Market driven developments are discussed in **Section 7**.

Moving ******* **** *** tire ******** was ******** to **** down* particularly ** APAC. This ********** other ******* such ** Europe ***** witnessed ********** pricing ******** for *** products. COVID*** impacted *** tire ******** in **** in ***** **** ** top ** an ******* softening ******. More ********* effects **** felt ** Europe *** the ******** from **** Q* onwards.

Tire ******* recovered ******* in ***** and **** slowly ** the ****. The ***** for ****, and ***** in **********, is ******* low *** oils ** green **** technology ** adopted *** domestic ** well ** export **********. The ****** term *****, driven ** developments ** Europe *** USMCA ** towards ********** sustainable *********.

6 QUANTITATIVE TIRE MARKET DRIVERS

This section focuses on the tire market from a quantitative viewpoint. Tire types and their respective subtypes are discussed in relation to regional tire market trends. The tire types and subtypes provided give the best compromise for differentiation of material requirements versus the availability of reliable production and market information.

Note: All commentary relates to tire types and subtypes included in the report scope (**Section 3.3**). Also review **Section 11.3** for a comprehensive list of tire types and subtypes.

RCCL has estimated USMCA SUV content from reported PC and LT data, this is due to variation in vehicle definitions and reporting across regions.

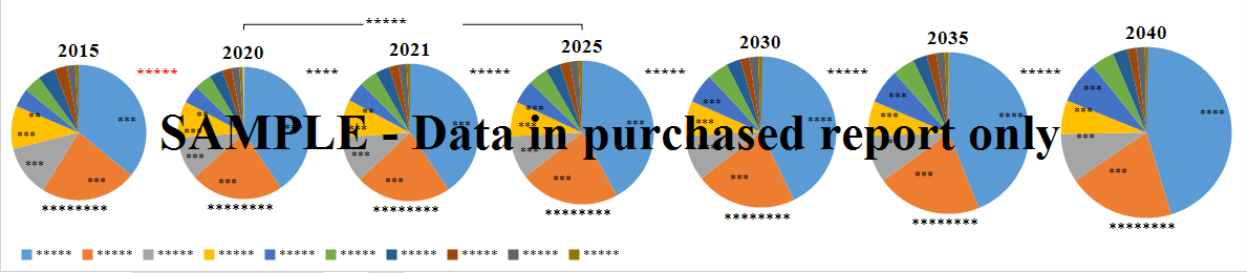
6.1 TIRE TYPES

In ***** to ******* TPRs * RPOs ** is ********* to ***** the ****** into ******** units **** similar **********. The ********* reasons *** this *** discussed ** **Section *.** This ******* looks ** quantitative **** market ****** and ******* for *** trends ** each **** type *** subtype.

The ****** summary *** tire **** evolution ** presented ** **Figure *.***. This ***** global *** regional **** unit ********* for *** types *PC* SUV* MCSCTR* indicating ****** growth ********* COVID*** reduction ** ****. The ****** in *****, North **** and ***** is **** significant ** unit ****** giving *** following ******* for **** to **** unit ****** (**):

China (627) >> North Asia (196) > India (158)

Figure 6.1 - Tire Unit Evolution by Region All Tire Types 2015 to 2040

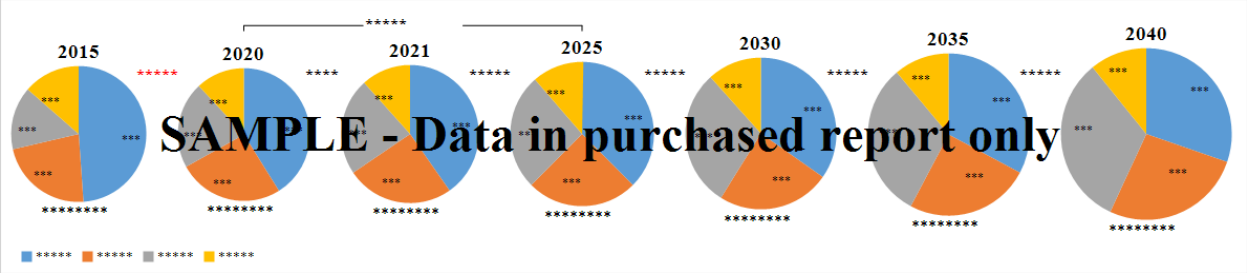


Tire **** growth ** tire **** is ********* in ****** *.***. This ***** the ****** ****/** ranking (**):

SUV ****) > ****** (***) > PC ****) > ** (***)

The **** growth ** SUV ***** is ********** as **** represents ***** of ****** average ****. Caution ****** be **** in *** interpretation ** this **** as ***** is ** allowance *** differences ** TPR ********** requirements ******* tire ***** and **** importantly **** subtypes. This ** the ****** why **** breaks **** production **** tire ********.

Figure 6.2 - Tire Unit Evolution by Tire Type 2015 to 2040



Manufacturing Location versus Market Requirements

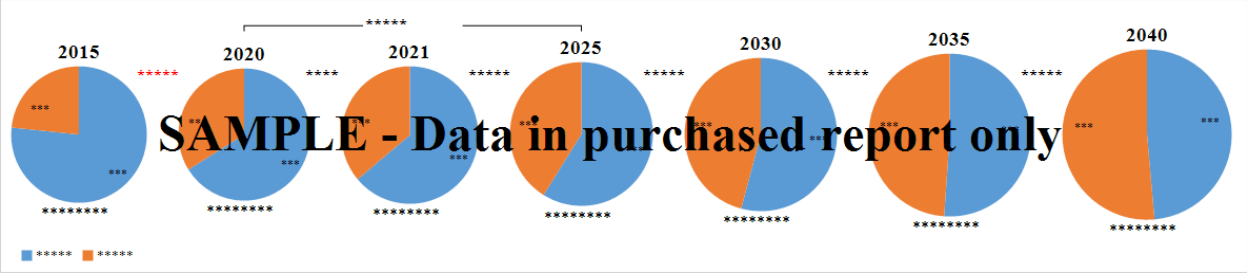
RCCL's *** tracks *** benchmarks ******* tire **********. This ********* means ***** may ** a ********** between * region's ****** requirements *** material ***** relative ** the ****** mix. This *** be ********* by ********** for ****** which ** done ****** to ******** centres ** competence *e.g. winter **** production* run **** or ****-seal ***.) or *** economic ******* such ** manufacture ** Thailand *** export ********.***

6.1.1 PC and SUV

From * material ********** it ** convenient ** combine ** and *** tire ***** and ******** since *** underlying ***/RPO ********** are *******. RCCL's ******** system ***** a ********** between ***** tire ***** to ******* for ********** and **** differences ***** impact **** material **********. For *******, both ** and *** AS ***** will ******* similar ***/RPOs* the **** difference ***** that *** tire ****** will ******* more ******** due ** their ****.

Figure *.* shows *** historic *** future ****** potential ** PC *** SUV **** types. The ***** growth ** SUV ** projected ** continue **** the ****** period* this ** a ********** of ********* OE ********** with * corresponding ****** in ** offset **** that ** OE. There *** some **** subtle ******* behind *** main **** types ** PC *** SUV* these *** explored ** the ********* sections ***Sections *.*.1.* to *.*.1.***).

Figure 6.3 - PC and SUV Tire Unit Evolution 2015 to 2040



6.1.1.1 Standard Tires (S, T rated)

Tire ********** evolution *** these ***** is ********* in ***** *.*. Standard * and * speed ***** tires *** considered *** low *** of *** value ***** by ********** proficient **** manufacturers. Growth ** manufacture ** these ***** is ****** in **** driven ** organic ****** growth *** exports. EMEA *** USMCA **** see ****** declines ** production ** these **** types. The ********** nature ** tires ** this ******** means **** are ******** on * cost ***** and *** not ******* for ****.

One ********* is **/AS *** types ******** for **-off ** off*road **********. These ***** typically ******* reinforcing ****** for ******** cut*chip **********.

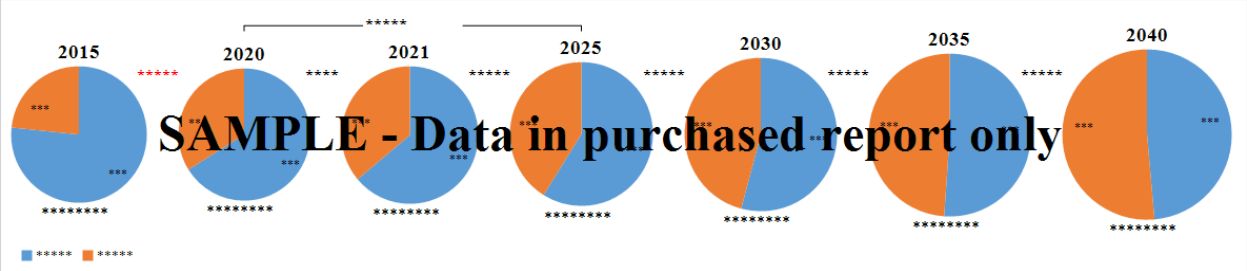
Table 6.1 – PC and SUV Standard Tire Unit Evolution 2015 to 2040

Tire Type	Year							Change	CAGR			
	2015	2020	2021	2025	2030	2035	2040	20/21	15/20	20/25	25/30	30/40
PC	***	***	***	***	***	***	***	*.*%	**.3%	*.*%	*.*%	*.*%
SUV	***	***	***	***	***	***	***	**.*%	*.*%	*.*%	*.*%	*.*%
Total	***	***	***	***	***	***	****	*.*%	**.9%	*.*%	*.*%	*.*%

6.1.1.2 High Performance Tires (H, V rated)

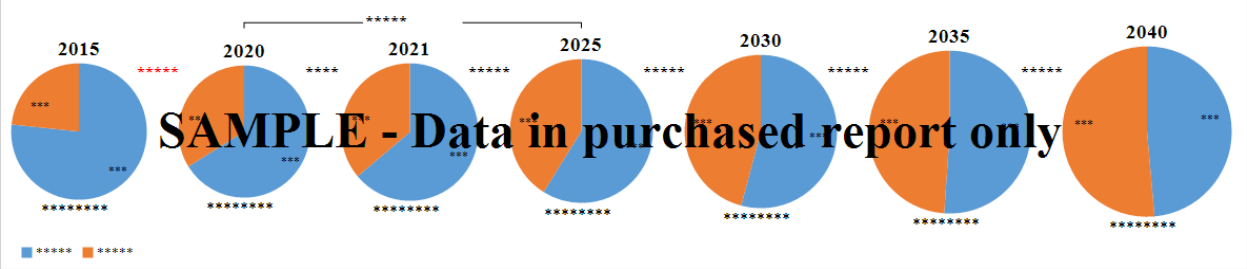
HP ** tire ********** growth ** presented ** **Figure *.***. These ***** represent ********* differentiation **** standard ***** and *** more ********** targets *** TPRs *** also ********* a ****** target *** VO *** types. The **** indicates ********** growth *** SUV ***** in **********.

Figure 6.4 – PC and SUV HP AS Tire Unit Evolution 2015 to 2040



HP ** tire ********** growth ** presented ** **Figure *.***. These ***** represent ********* differentiation **** standard ***** and *** more ********** targets *** TPRs. The **** indicates ****** unit ****** versus ** AS ***** with ******* growth *********. These **** types ********* more ** a ********* for ********** development **** respect ** performance ******* traditionally ******* on *** types **** high **********.

Figure 6.5 - PC and SUV HP SM Tire Unit Evolution 2015 to 2040

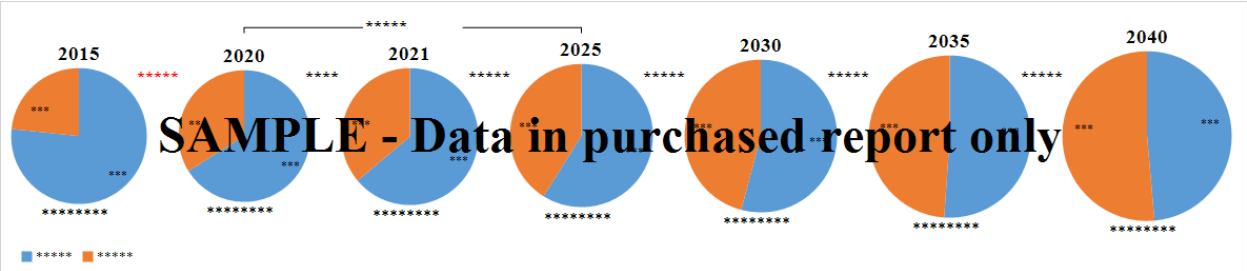


Note* The *** potential *** HP ** types *** be ********** versus ** types. Market ********* sees * shift ** AS ***** which *** happen ****** than **** has *********. This ********* may **** be ******** by *** recent ******** for ** tire *****, which *** sometimes ****** AS *****. There ** a ***** distinction ******* the ********** of ***** types* RCCL ********** AW ***** as ***** meeting *** ***** requirements.***

6.1.1.3 Ultra-High Performance Tires (W+ rated)

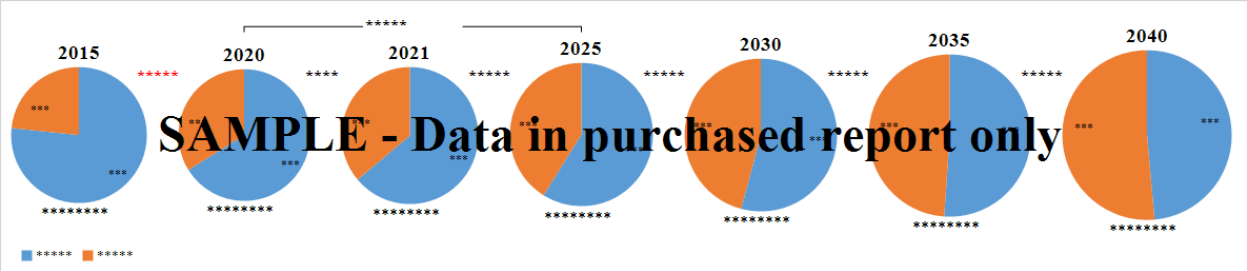
UHP ** tire ****** is ********* in ****** *.*. These ***** have ********* differentiation **** HP ***** and ********* high ********* for ****. Unit ******* are ***** than **, however *** technical ******* is ******. These ***** pose * significant ********* for ********** balance *** replacement ** traditional ****.

Figure 6.6 - PC and SUV UHP AS Tire Unit Evolution 2015 to 2040



UHP ** tire ****** is ********* in ****** *.*. These ***** have ********* differentiation **** HP ***** and ********* high ********* for ****. These ***** represent *** ultimate ********* with ******* to ****** replacement ******* heavily ** aromatic **** TPRs *** RPOs.

Figure 6.7 - PC and SUV UHP SM Tire Unit Evolution 2015 to 2040



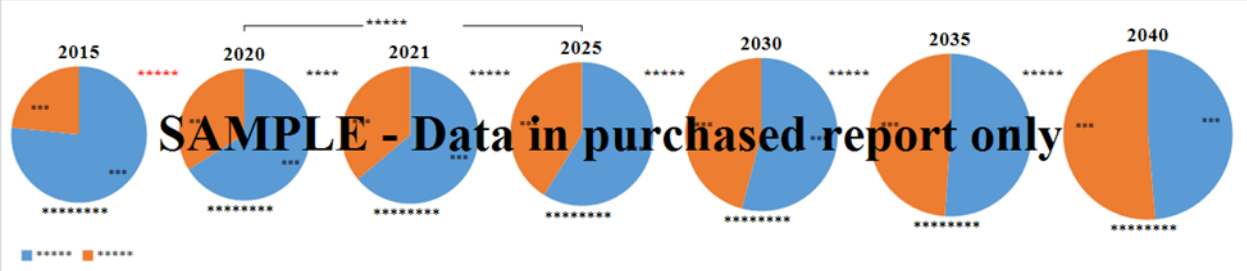
Note: See comments for Figure 6.5.

6.1.1.4 Specialist Variants: Winter and All Weather

WT *** AW **** production ********* is ********* in ****** *.*. This ***** good *** lower ***** versus ** and *** tires. There *** several ********** complications *** these *****. AW ***** were ******** for **** round *** in ******* with **** severe ******* and ********* will **** some ** tire *****. Some ************* mix ************** of ** and ** tires* RCCL's ********** is **** a **** AW **** will **** the ***** requirement. Some ** units *** therefore ****** to ****** in ***** AS **** subtypes.

Both ** and ** tires ********* good ************* for ****, and ** explained *****, this **** extends ** some **/UHP ** tires ******* AW ********. The ******* of ********** required *** WT *** AW ***** is ***** met ** TPRs *especially ** and **) and *** as **** as * more ********** polymer ****** (*.g. NR*BR*SBR*.

Figure 6.8 - PC and SUV WT and AW Tire Unit Evolution 2015 to 2040



6.1.2 Motorcycle and Scooter Tires

MC *** SCTR **** production ********* is ********* in ****** *.*. There ** some ******* in ************ categorisation *** these *****. From * TPR ********** the ********** in *** radial ** market ** the **** important ** this ** a ****** differentiated ******* with **** scope *** TPR **********. Development ** MC*R ***** is ********* in ***** *.*. The **** grip ********** for **-R ********* demand **** aromaticity ** both *** and *** types ***** presents * significant ********* to ********** of ********** solutions.

Figure 6.9 - Motorcycle and Scooter Tire Unit Evolution 2015 to 2040

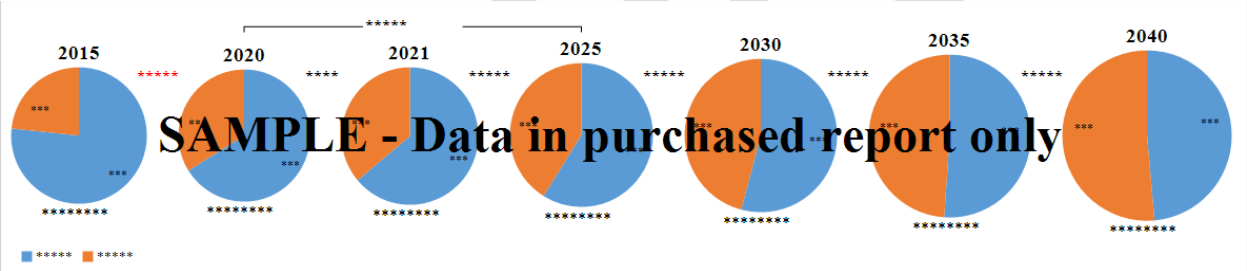


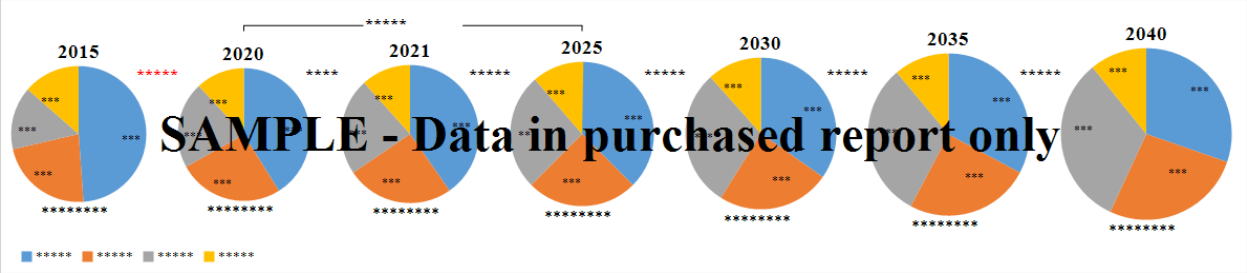
Table 6.2 - Motorcycle Radial Tire Unit Evolution 2015 to 2040

Tire Type	Year							Change	CAGR			
	2015	2020	2021	2025	2030	2035	2040	20/21	15/20	20/25	25/30	30/40
MC-R	**	**	**	**	**	**	**	*.*%	**.*%	*.*%	*.*%	*.*%

6.1.3 Light Truck Tires

RCCL *** estimated *** split*out *** types **** LT ***** for *****. Definition ** other ******* is **** consistent. The ********** for ** types *** generally ********* versus ***/PC ***** due ** different ***** depths *** designs. There ** typically * higher ********** for ********* performance ** these **** treads ***** is ******** in **** by ********** resins * these *** not ********* in **** report ***** focuses ** TPRs. There ** growth ** LT ** tires ***** may *** similar ********** to *** AW *****.

Figure 6.10 - Light Truck Sub Type Unit Evolution 2015 to 2040



6.2 Changing Vehicle Technologies (Drivetrain)

The ***** industry ** currently ******* a ******* to ****** drive ******* (****** combustion). The ********* adoption ** electric ***** vehicles ** likely ** impact **** design *** performance *********. From * tread ******** perspective ***** is * desire ** have ********* durability ** well ** lower ******* resistance ** accommodate ******* drive ***. TPRs ***** flexibility ** compound ****** approach *** are ****** to ****** a **** of *** total ***** performance ***** in *** short*medium ****. Longer **** indications *** that ******* materials *** replace * portion ** TPRs.

RCCL * used ******** and ******* based *****-term ******** to ***** electric ******* production **********. These ******* are ******** aspirational *** may ********* an **********, however* recent ******** sentiment ******** a ****** desire ** implement *** technology *******.**

Figure *.** presents ** tire ****** by ********** type ** to ****. BEV ***** are * small ********** of *** OE *** up ***** **** ***** demand ** expected ** accelerate. By **** BEV ***** are *** to ******* for ************ **% ** total ******.

Figure 6.11 – PC and SUV OE Tire Demand by Vehicle Drivetrain 2011 to 2040, millions

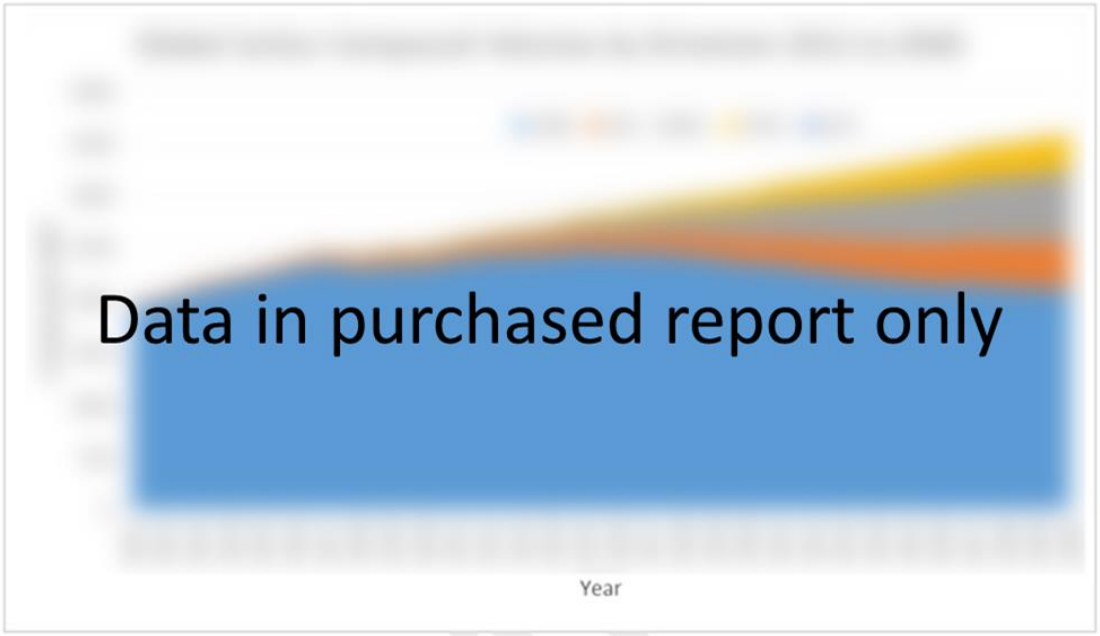
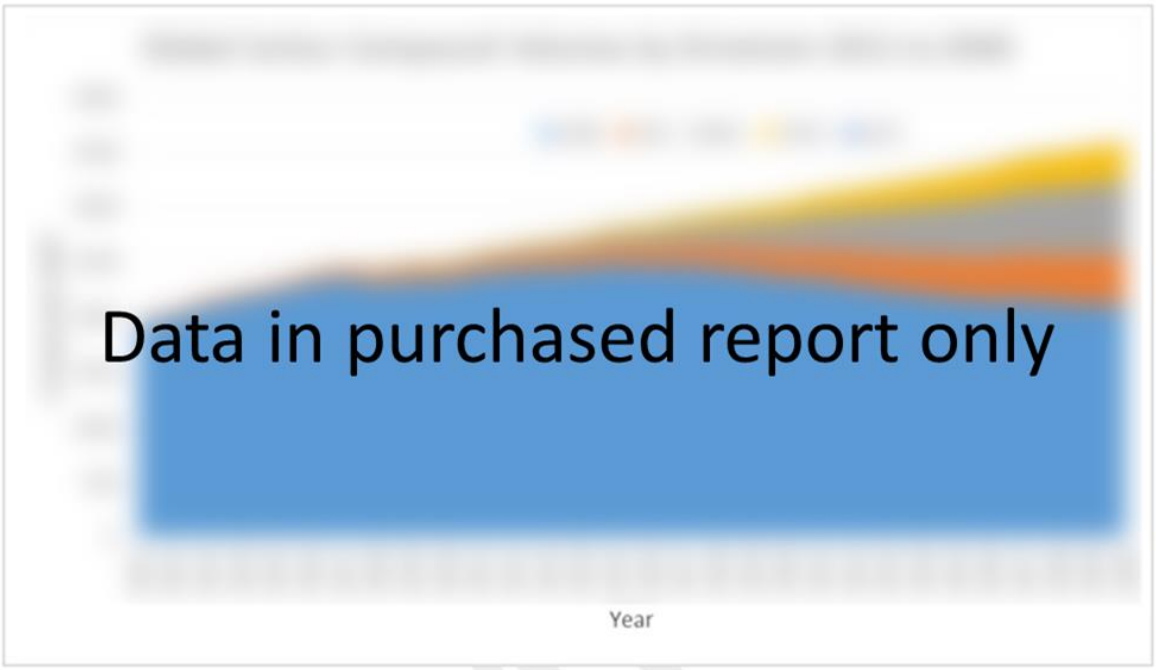


Figure *.** presents ** tire ****** by ********** up ** ****. Demand **** behind ** as ** expected* with * **** *** market ***** of **%.

Figure 6.12 – PC and SUV RP Tire Demand by Vehicle Drivetrain 2011 to 2040, millions



Drive ********** places ********** requirements ** tires *** to ********** vehicle ****** and ********** torque **********. Key ********** are ******** for **** durability *especially ****) and ******* resistance *for ******* range*.

These ******* have **** considered ** part ** the ********** materials **********. **See ******* *.*.**

A ****** term ********** for **** design *** performance ** autonomous *******. This *** significant ********* impacts *** tire ********** where ******* is ******** electronically. Under ***** circumstances *** compounding ********** may ** quite *********. This ****** has *** been ********** in *** time ****** analysed.

7 QUALITATIVE TIRE MARKET DRIVERS

This section deals with tire market drivers influencing adoption and use of TPRs and RPOs.

7.1 TIRE TECHNOLOGY

7.1.1 Historical Perspective

Resins **** been **** in **** treads *** many *******. Early *** was ******** at ****** durability *chip*chunk* of ***** and ***-road ***** using ********** resins* while ********* and **** derivatives **** used *** improving **** performance ** HP ** tires. Resins ** all ***** types **** also **** used *** tack ********** in *** tire ******** process. This ******** use *** typically ** very ****** loading ***** (****** 3-****) with the ******* of ****** only *** performance ** processing ********.

Development ** silica ***** compounds ** Europe **** the *** **** led to ****** performance ******* with **** being ******* to **** fine **** RR *** WG ** particular. European ***** to ****** PAHs **** tire ***** oils* fully ******* in ****, increased *** use ** TPRs. This *** required ** balance ** and ****** which *** compromised ** the **** to ******* process ****. Adoption ** tire ****** in ****** followed ** Japan *** South ***** led ** additional ***** on ** and ** again **** the ** of **.

RPOs *** used ** tire ****** to ******* processability *** improve ********. The ******** and **** was ********* linked ** the ******** availability *** requirements. For ******* in ***** HN ***** were ****** used ** relatively *** loadings ********* tire ****** designed *** durability *** comfort* whereas ** Europe *** types **** typically **** at **** higher ******** to ******* WG *** wear. The ********** of ****** treads* legislation *** PAH ******* as **** as **** subtype ********** have ******** the **** and ******** which *** also ********** use ** TPRs ** discussed *****.

The **** ten ***** has **** a ******** increase ** tire ******** as **** as *****-overs ** subtypes ****** speed ******* as **** companies **** moved ** the ***** chain. This *** expanded *** market ** terms ** TPR *** RPO **********, with ******* performance ******** and ******** required *** these ****** value ********. This ** explored ** the **** section ******* at **** value ***** products.

7.1.2 Evolution of High Value Added Products

The **** industry *** traditionally ******* a ******** approach ** developments *** changes ** a ****** critical *******. Safety ******* a ******** principle* however* the **** few ******* have **** substantial ********* in ******* developments *** product *********. This **** of ********** is **********. A ******* driver ** product ********* allowing ********* to **** up *** value ***** in ***** to ****** market ***** and ****** margin. The ****** for **** has **** the **** influx ** low ****** Tier *** type ********** products *mainly **** China* and ********** developments ** other **** manufacturers ******* to **** themselves ** the ***** recognition ******.

RCCL's **** has ***** tire ***** and ** particular **** subtypes ***** on **** value ***** goods ** be * strong **** for *** and *** use* both ** terms ** type ** TPR*RPO ** quantity ****. In ******* the ***** of ***/RPO ** filler ** kept *****, therefore ***** of *** necessitates * reduction ** RPO.***

7.1.2.1 PC and SUV

These *** tire ***** can ** treated ********* from * tread ******** viewpoint. The ******** trend *** these ***** is ** higher *********, lower ******** and ****** speed *******. This ***** has **** significant **** the ***** ****** in the **** developed *******, especially ****** and ***** America. The ********* regions ******** to *** market ********** along ***** lines* the **** dramatic ******* are *** occurring ** the ****** economies* in ********** China *** India.

The three key drivers from a TPR/RPO perspective are:

- **** ***** **** *********
  - **** *** ****, *** ********* ** **, ****** ** ******** ******* *** **** ** ** *** ***** ***** ***** ** ******* ******** ** **** **** *** ***** ****.
  - ** ******** ** **** ***** ** **** * ********** ***** **** ***** ***** ***** ***** ** ****** ***** ***** *****, ********* ****** ****** ** ** *** **** ***** ***** ** * ***** ** ****** ********, ***** ****** ****** *** ****** ***** *******.
- ********* **** ********
  - ** ***** ** ***** ************** ******** ***** ** *** * ***** ***** ** **** ******** ** *****, ************ ** ******* ******** ****** ******* *******.
  - ******** **** ********** ******** ************ *** *********** *******.
  - **** *** ***** *** ** *** *** **** ***** **** *** *** *** ***** ** ******* *** ****.
- ********** *****-*****
  - ************ ***** *** **** **** ********* **** *** ***** ****** ** *** ****. *** *******, * ****** **** ***** ******** **** **** * *, * ** * ***** ******. ****** ************ **** *** ** ******** *****-***** in ***** ******* *** **** *****, ********* ** ** *** **** ** *** *** * ****** **** **** ** * ** * ****** *** ********* **** ******. ***** ******* *****-***** lead ** ************ *** ******** ***/**** or ************ ***/**** to ******* ** *** ***** ****** ********* **********

The **** to **** value ***** products ** summarised ** **Figure *.*.** It ** assumed **** AW ***** conform ** the ***** standard* whereas ** tires ** not. There *** many ********** dimensions ***** can *** to ********** tire **** and ******* value* these *** include ***-road ********** (******* for SUV*LT *****) as **** as **** technologies **** as ***** reduction* run **** systems ***.

Figure 7.1 - PC and SUV Subtype Differentiation Overview

7.1.2.2 Motorcycle and Scooter

Within *** two ***** segment* radial ********** tires *** seen ** value*added ********. This ****** distinguishes ******* motorcycle *** scooter ***** as **** as ******* radial *** bias ********** for *** two *****.

RCCL ******* that **** are **** in ********** radial ***** and *** in *** lower ***** products.

7.1.2.3 LT

RCCL *** split *** SUV *** LT *** the ***** production* the ********** in ***** regions ** consistent. The ******** of *** development ******* in *** types.

New ******** such ** LT ** are ********** to *** TPRs *** alternative ****. The *** of ********** resins ********* found ** LT **/AS *****, especially ***-road ** not **********.

7.1.3 Market Positioning

The ****** positioning ** tires ** an ********* factor **** considering *&D ****** and ********** material **********.

RCCL's ***** for ***/RPO *** indicated * very ****** relationship **** tire ****** positioning.***

This is explained in the following sections:

7.1.3.1 Manufacturer's Tier Level

Tire ********** can ** defined ** tiers* this ** typically **** via ***** positioning *e.g. premium ***** versus ******* brand). For *** purposes ** this ******, tier ***** is ***** upon *** tire ********* ability ** supply ***** with ** tires ** well ** the ******* technology ***** of *** company. There ** some ********* between **** I *** tier ** companies. In ***** cases *** tier ** company ** allocated * specific ***** of ** and **** I ** volume* this ** done ****** to *** plant *** tire ***** (* tier I ***** may **** budget ***** which *** also ****** accordingly*. Please **** review *** *.*.

From a technological viewpoint tier I companies are the most important and are fully defined, examples of tier II and tier III companies are provided but are too numerous to be given in full.

Table 7.1 - Manufacturer's Tier Level

Tier	Definition	Companies	
I	Provide significant quantities of OE tires to leading automotive brands in a wide range of tire types and sub types. **and/or** Are recognised as technology leaders in their field of expertise (e.g. high performance).	Bridgestone Michelin Goodyear Continental Pirelli Hankook	Kumho Sumitomo Toyo Yokohama Nokian
II	Provide limited OE tires to targeted sub types and have brand recognition in the replacement sector.	Cooper Apollo	…
III	Don't provide OE tires and fulfil budget performance in the replacement sector.	TVS Srichakra Shandong Sanli Tire	…

7.1.3.2 OE Market

A ******* driver *** TPR *** is ***** manufactured *** the ******** Equipment ******. These ***** are ********* optimised *** performance ** meet *** exacting ********* of ********** manufacturers. TPR *** is ************* higher *** manufacturers ********* into *** OE ****** segment. This ******* a ********* in *** for ***** tires *** manufacturers.

The ** segment ** also * strong ****** for ********* complexity ** use ********. This ********* means **** specific ********* and ***/RPOs *** used *** designated **** subtypes *** brands. This ***** of ********** is ********* highest ******* the ****** manufacturers.

7.1.3.3 RP Market

The *********** tire ****** represents * more ******* segment **** a ************* viewpoint. TPR *** in **** segment *** significantly ****** for **** manufacturers ****** in *** OE *******. The ****** for **** is *** cascade ****** effect ***** technology *** be ******** down ******* ranges.

TPR *** was **** found ** be **** substantial *** tire ************* with * broad ***** of ******* offerings ***** allows ********** transfer ****** product ******. Examples ** this *** tire ************* active ** racing **** development ***** transfer *** be **** to *** tires.

Manufactures **** limited ******* ranges ***/or ****** reach ********* utilise **** little ***. It ** important ** note **** changing *********** practices ** China* with *********** of ***/RAE **** high *** content* will **** to ********* TPR ************ if ******* performance ** to ** maintained. This **** also ********* lead ** opportunities *** TDAE*TRAE *****.

7.1.4 Geographical Influences

Tire ***** composition *** vary **** region ** region* even ****** similar **** types *** subtypes.

RCCL's research found strong geographical influences relating to TPR/RPO use.

The ******* for ***** differences *** explained ** the ********* sections*

7.1.4.1 Performance Requirements

Regional differences in performance requirements are related to a number of factors including:

- *******/********** conditions
- ******* ******
- ******* *****
- **** ***** *** *********

Examples ** regional *********** include *** high ******** on *** grip ** Europe ***** contrasts **** comfort *** wear ******** in ***** America. These *** of ****** generalisations ***** also ****** upon ******** tire *** types* however **** are ******** when ****** similar **** sub *****.

7.1.4.2 Compounding Differences

From * tread *********** these ******* can ********* lead ** significant *********** in ********** tread ******** technology. An ******* of **** is *** premium ****** on **/SUV *** grip *********** in ****** relative ** some ***** regions. This *** led ** tread ********* in ****** with **** filler *** plasticiser ********. These ********* offer **** opportunity *** plasticiser ************ by ******.

A ******** to **** is *** PC*SUV ******* tire ***** in ***** America ***** have ********** had **** lower ****** loadings **** correspondingly ******* plasticiser ******* and ********* reduced ********** for ********** by ******.

When ********** light ***** and ***** tires *** relatively *** filler ******* typically ***** in ***** types ******* the ********** with ******* to ***** use. The ***** performance ******* are **** significantly ********* with **** emphasis ** wear *** durability ***** regional ********** in ******* temperatures *** also **** a ***** impact ** compound ******.

7.1.5 Compounding Requirements for TPRs

TPR ********** performance ***** to **** individual **** company ********** for ******* types *** subtypes* typically **** differing ********** methods* formulations* tire ****** and *** goals.

Key properties of interest to tire manufacturers include:

- ********** ********** *** and ***** *****)
- ********* *****
- ********* **********/**********
- ********* ******
- **** **** ********** ******)
- ********** *******
- ********** ********** at **** ********)

The ***** considerations **** to **** individual **** company ********** for ******* types *** subtypes* typically **** differing ********** methods* formulations* tire ****** and *** goals. The ********* summarises ******* tire ******* requirements*

- ********** ** ********* **********/********** property**********
  - *********: *** ******** ********** ** * ********* ******** *** ** ******* ********** **** *** ***** ********** ****** ** ***** *** ****
- **********
  - **********, *********, **********, ******* ********* ********
- ********** **********[*] *** and ***** ** *** ******* ******** *****)
  - **/**
    - ******** ***, ******, **** ********** ********* *** ****
  - **
    - ********** ** ******, **** ****** ********* *** **** **********
  - **
    - ********** ** ***, ****** ******* ********* *** **** **********
- ****
  - ** ********* ** **** ********** improvement*
- **********
  - ** ********* ** ***-**** resistance
- *****
  - ********** ********** **** *** **** ******* *********

*[*] **** compounders ******* viscoelastic ********** as **** performance **********. For ** there ** an ****** understandable ********** with ********* energy ****** at ******* tire ********* temperatures *** rotational *********, usually ******** by ******* delta *TD* at ****** **[*]* at ****. Grip ********** utilises ****-temperature ********** principles *WLF *********), measuring ********** at * low ********** as ** indication ** equivalent ********** at **** frequencies. WG ** usually ********** by ** around *[*]*, with ** and ** being ********** at ***** temperatures ** to ***[o]C* and ** determined ** higher ********** (********* 30[o]C). Grip ********** is **** dependent **** compound *********, therefore *** elastic ****** at ***** temperatures ** equally *********. Other ********* considerations *** testing *** prediction *** strain ********* and *** nature ** the **** surface ***** predicted. Required ********** is ********* a ********** between ********** of ********.*

7.1.6 Compounding Requirements for RPOs

The properties of interest and key tire company considerations are similar to TPRs as discussed above.

Historically *** replacement ** highly ******** (***) types with ***** alternatives *** the ******** market *** to ********** drops ** grip *** cut*chip ********** which *** addressed **** addition ** C* resins ** suitable **********. This ***** is ********** for **** (***. China* with *** introduction ** clean ****.

RPO ****** is ******** by **********, region *** cost. Performance ** based ** the **** type *** subtype **** higher ********** favoured *** summer ** and *** types. VO ***** are ********* increasing ******* for ****** and ***-weather ******** due ** the ******** operational ********** ranges *** retention ** properties **** aging.

Sustainability ********** will ***** significant ******** on ****** based ****, which *** now ****** increased ********** with ****.

7.2 External Drivers

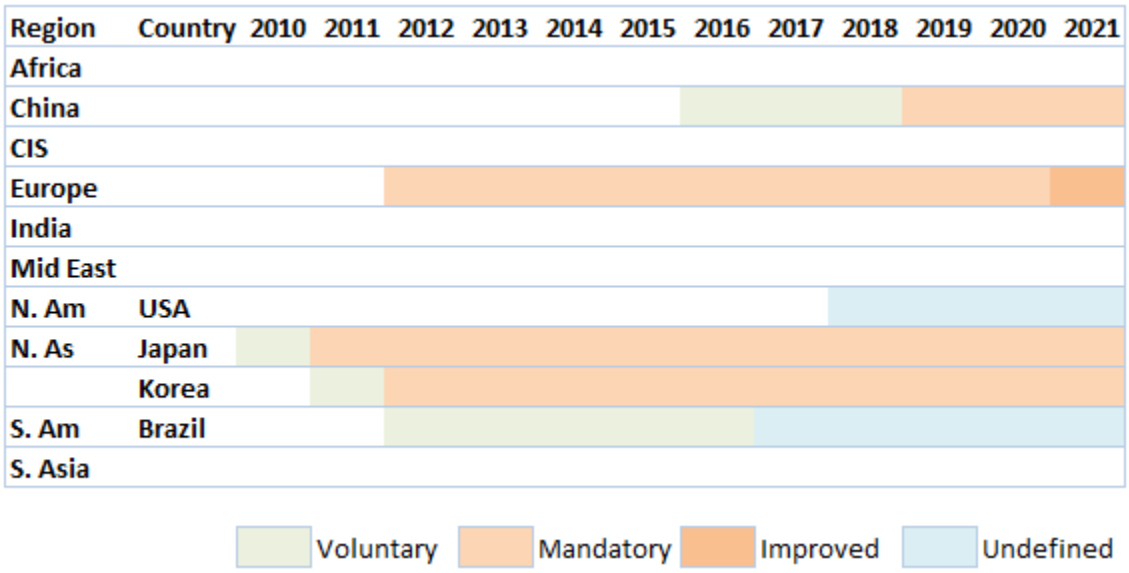
A ****** of ******** factors *** influence *** use *** development. These ***** material **********, including *** use ** low *** oils* tire ********* and **********/sustainable **********. The *** of *** PAH **** was ********* in ********* *.***, the other ***** are ******* in **** section.

RCCL's research found strong external driver influence on current and potential TPR use.

7.2.1 Tire Labelling

The ******* status ** consumer **** labelling ** region ** presented ** **Figure *.***. This ***** that ****** and ***** Asia *specifically ***** and ***** Korea* have ****** tire ********* schemes. The ******* upcoming ****** is *** implementation ***** in ***** and ******** legislation ** the ***. The *** implementation ** by ** means *** in ***** and *** already **** pushed **** several *****.

Figure 7.2 - Tire Labelling Status by Region



The ******** and ***** Asian ****** give ****** emphasis ** both ******* resistance *** wet ****. The ******* version **** have ******* emphasis ** these **********. These ********** provide ********** for ***/RPOs ** optimise *** grip ***** maintaining ** reducing ******* resistance. TPRs **** allow ********** in ********** approach* allowing **** manufacturers ********* formulation *** performance *******.

These influences should be considered in parallel to the drivers already discussed in **Sections 7.1 to 7.4**.

7.2.2 Sustainable Developments

From a raw material perspective there are three key points to company sustainability targets:

- *********
  - **** ** ***** ** ***** **** ******** *** **** **********. ********** ****** ******* ***** ** ********** ********** **** ********** **.g. *******).
- *******
  - **** ******** **** ******** ** ** ******** **** **** *** ****/******* production.
- *****
  - **** ** *** ********** *********, ***** *********[*] ********* *** ****.

[*] ********* natural ******** are ******* resources ****, after **********, can ****** to ***** previous ***** levels ** natural ******** of ****** or **********.

The ***** factors ***** are ********** into ******* targets. A ****** of **** of *** top ** tire ********* and ******* is ********* in ***** *.*.

Review ** **Table *.*** reveals **** each ******* has ******* goal ***** based ** reduction ** material ***, sustainable ******* and *********. The ********** company ******* differ ******, from ******** target ******, to ********** levels ** undefined ******* with ******* developments. It ** clear* however* that ********** development ** gaining ******** and ** likely ** accelerate **

the *****-medium **** in ***** for ********* like ********** and ******** to ******* their *******/vision.

Table 7.2 - Tire Company Sustainable Targets (Most Recent Publication)

Company	Targets	Notes
Bridgestone	Vision 2050: 100% Sustainable Materials Half-weight & long life technology	
Michelin	**% ********** ******* ** **** ***% ** ***** ******** ****** ****** * ****** ****	****: **% ********** ******* ** ***** **% ** ** * ********* ***, *% ********
Goodyear	********* *** ********** ** **** ******* *** **** **** ****** ********* ******	********** ****** ********** *** ******* *** ** ****
Continental	**** ********** **** ******* *** ************* ** **** ********: ***% ********** **** ********* ****** ****** ******* ******	
Pirelli[2]	***% renewable ** **** ***% renewable ** **** ***% fossil ***** ** **** ***% fossil ***** ** **** ****** ***% by **** **** ***% by ****	*******: ********* ** **% ********, *% ******** ********* ** **** *****) **% ********, *% ********

[2] It is not clear if these targets are for all product lines. Cinturato is premium eco tire.

The ***** factors ******* impact ** future *** & *** prospects. Tire ****** have ******* focused ** the ******* volume ********* to **** maximum ********. RPOs * TPRs **** high ****** loadings ****** to ***** tire *********, therefore **** are ******* attracting ********* for ******* content.

Many ** the *** tier **** companies **** strategically ****** '**** products. These ******** primarily ******** to ******* the ********** via ******* energy ********** during ***. Several ** the *** tire ********* have ******** the ******* of *Eco' ** incorporate ***** own ******* values* this ******** low ********* manufacturing* use ** non*oil ******* materials* use ** ingredients **** low *** levels **** numerous ***** options.

These *** products ********* a ***** but ********** significant ********* of *** level ********** product *********. This ** an ******* area *** naturally *******, sustainable ******** such ** TP *** VO **********. A ********* of ********** and ****** fitting **** category *** displayed ** **Table *.***. It ****** be ***** that **** tire ********** also ***** brand*

therefore * particular ***** will **** a ***** of ********** which **** include *Eco' ********** indicated ** a ******* manufacturer *****.

Table 7.3 - Top Tier Manufacturers' Eco Labelled Tire Examples (non-exhaustive)

Manufacturer	Brand	Description
Bridgestone	Ecopia	ECOPIA ******** eco*friendly ********** through ****** fuel ********** and ******. It ****** for ******* rolling **********, which ** turn ******** fuel **********. ECOPIA also reduces the production of harmful carbon dioxide emissions that contribute to global warming.
Pirelli	*******	******** ** ***** ** ******** **** *********, *** *****, **** **** *** *** ************ ******.
Sumitomo	******	******* *** ******* **********.
	*******	****** ******** **** ***** Enasave *** *******)
Toyo	**********	**** *********.
	***** ***	******* *** ******* ********** ****.
Yokohama	********	********** ******** ****** ** ***** **** *** ******** ** ******* ********** *****, ***** *** ******** ******** ********* *** ******* *** ***** ********.

7.3 COMPETING TECHNOLOGIES

Tire ***** compound ********* is ******* an ******** in **********. Development ******* the ********* of **** properties *** performance *******, some ** which **** opposite ********. The **** known ** these ** the ** called *magic ********* of ****, rolling ********** and *** grip. Legacy ********** for **/SUV ******** carbon ***** compounds ***** only *** of ***** three ********** could ** improved ** any *** time. The ****** of ****** reinforced ***** compounds *** to *** possibility ** optimising *** three ** these ****** (******** wear was ******* problematical*.

Currently ***** are ******** options ********* to *** tire ********** to **** the ********** balance ** properties. Consideration **** clearly ** given ** the ***** design* compound ****** and ********** technologies. A ****** of ***** options *** well ******* synergistically **** other *******, therefore *** permutations *** combinations ****** almost *******. Primary ******* include *** following *no ********** order**

- ***** ******
  - ** ***** ********
    - ******** ******* ********** ** * **********
  - ******** *******
    - ******** *********
    - ****** **********
  - ***** **********
    - *****-**** (**********)
    - ********** *********)
  - ***** ************

        - *****-*****
        - *****-****
- ****** **********
    - ********
    - ******
    - ******** *****
    - ***** ********** ************)
- ******* **********
    - **********
        - ********** **
        - ********** ***** **********
    - **** **
- ********** *******
    - ******** * ************)
    - ***** *** ********** *****)
- ******* ****
    - ***********
    - ************
    - ***********
- *******
    - **** ******* ******
    - ********** ******* ******
        - ******
        - ****** *****
        - ******

Because ** the ********* of ******* available ** is *** easy ** determine ***** that *** directly ** competition. Those ***** may ********* affect ****** use ** TPRs ** RPOs ***:

- ***** ************, ****** *****-***** or *****-****. **** ****** *** ***** ************* ****** ** *** *****.
- ****** ********** ************ **** ****** ************ *** ** ******** ********** *** *********** ******* *** ********** ******* ******** **********.
- ******* **** *** ******** *** ************ *** ****** ** *** ************ *** ** ************ ** *** ***** *******

7.4 TPR TECHNOLOGY DEVELOPMENTS

This section reviews TPR technology developments. Recent developments from TPR manufactures are reviewed in **Section 7.4.1**. This is followed by developments from a tire company's perspective through patent review in **Section 7.4.2** and tire brand analysis in **Section 7.4.3**.

7.4.1 TPR Manufacturer Developments

Some ** the ********** within *** resin ********** sector *** indirectly ****** opportunities ** the *** market. An ******* of **** is ********** resins ********* for ******** performance ** other ****** markets *e.g. adhesives). The **** type **** is *****, however ********** versions ** other ***** types *** also *** increasingly ******. Generally* modifications ***** provide ******** with ** adjusted ********** envelope *** be ** interest ** tire ********** who *** looking *** the **** approach ** tire ********** optimisation.

Another ******* of ******** development ** functionalised ****** butadiene ******* used ** adhesives **** specific ***** (*.g. Evonik's ******** ST* enabling **** manufacturers ** adjust ********** envelopes. Development ** functionalised *** non*functionalised ****** rubbers ** a ********** area ** interest *** resin ********** with ***** products ******* tire ****** share *** to ******** compounding **********.

Phenolic ******** terpene ****** appear ** be * growth ****. Patent ********** suggests **** these ******* types **** use ** formulations **** very **** precipitated ****** loadings **** reference ** hydrogen ******* capability. It *** well ** that ***** types ******* both ******* response ********** as **** as ********** related ****** such ** filler ********** and ******** tack.

Recent manufacturer specific developments are detailed in the table below:

Year	Manufacturer	Product
2020	Kraton	********* ********** ***** ********* ********* ********
2017	*******	****** ********* ***-developed **** ****** ***.) *** ***** **** ***** ****

7.4.2 TPR Tire Related Patent Review

RCCL ******** recent ****** literature ***** TPR ******* materials *** the ***** or **** of *** application **********. The ********** year ** provided* which ****** that *** technology *** already **** been ******* by *** company ** question. Additional ********** was ****** on ****** applications ***** tire ******* was *********, this ** indicated ** '** in the ** column. It ****** be ***** that ****** patents ** not ****** indicate ******* tire ******* has **** completed* this *** be ****** by ********** use ** AI ** compound **********, especially *** the ********* stages. Tire ********* typically ***** a ***** of ******, those ********* below *** based ** preferred ******* in *** patents. Cases ***** no ***** resin ********** is ****** are ********* by *Multiple'. Patents **** referenced *** RPOs *** highlighted ** bold.

Abbreviations **** for ********** characteristics *** presented ** **Table *.***. While *** a ********** attribute* sustainability *SUS* has **** added ** this *****. It ** assumed **** where *** is ********* the **** company *** achieved ** least ** equivalent ******* of ********** versus *** original ***** (**** is the ******** requirement ** any ******** proficient **** company*.

Table 7.4 - Tire Performance Abbreviations for Patent Activity

Key	Description	Key	Description
AGE	Maintains performance with age	**STB**	Steering stability/handling
DG	Dry grip	**SUS**	Sustainability Increased
DUR	Durability including chip/cut/tear resistance	**TR**	Temperature range increased
GRP	Grip generic term (covering WG, DG and possibly IG, SG)	**WG**	Wet grip
IG	Ice grip	**WR**	Wear resistance (abrasion resistance)
PRO	Processability (viscosity, workability, flocculation)	**[]**	Property should not be affected
SG	Snow grip		

The following abbreviations are used for TPRs and Modifiers

Table 7.5 - TPR Abbreviations for Patent Activity

Key	Description	Key	Description
APH	Alkyl Phenol	**H**	Hydrogenated
AMS	Alpha Methyl Styrene	**LP**	Low MW Liquid Polymer
C5	Aliphatic	**M**	Modified
C9	Aromatic (Incl. Coumarone-Indene)	**PH**	Phenolic
C5/9	Aliphatic/Aromatic Combination	**PHF**	Phenol Formaldehyde
DCPD	Dicyclopentadiene	**ST**	Styrene
FX	Functionalised	**TP**	Terpene

Tire ******** development ********* requires *** improvement ** one ** more **********. It ** generally ********** understood **** all ***** important ********** should ****** equal ****** these ********. Certain ****** of **********, for ******* WG* DG* IG* SG *** particularly ****** to *******, therefore ******* developments *** require ********** in ** while ** remains ********, this ** indicated ** DG *WG** but **** not ***** that ***** key ****** characteristics *** be *****.

The following summaries are not exhaustive, they are intended to show typical activities.

Bridgestone's *** related ******* are ********* in ***** *.*. These ******* cover **/SUV ***** and * wide ***** of ********. The **** recent ******* are ******* on **** performance ******* balancing **, RR* DG *** STB ** well ** total ******* of ********** for ** tires. Patent ********** suggests *** of ************ HC ***** resins.

Table 7.6 - Bridgestone TPR Related Patents

Year	Patent	TT	Tread	TPRs	Target Properties
2007	JP2007277307A	N	UHP	PH/C9	WG
2008	**********	*	***	** ****/*-PH	** ***]
2009	**********	*	**	**	**/**/WG
2011	**********	*	*/*	****/*-PH	**/***/PRO
2014	**********	*	*/*	*-**	** ***]
2015	**********	*	*/*	**/****	**/***
2016	**********	*	*/*	**/*/TP****	***/**
2017	**********	*	*/*	**/*, C5* **, ***	** ***]
	**********	*	*/*	**, ****, **/*, C5	**/**
2018	**********	*	*/*	**, **/**	**/**/STB
2019	**********	*	*/*	**, ***, **, **/*	**/** [**]
	**********	*	*/*	**/*, C9* ****, **	**/**/RR
	**********	*	*/*	**, **/*	**/**/RR
	**********	*	**	**, ***	****]
	**********	*	**	********	**/**/IG***/STB
	**********	*	**	********	**/**
2020	**********	*	*/*	**-**	**/**/STB****
	**********	*	*/*	**	**,**,DG
2021	**********	*	**/**	**/*	**/**/WR
	**********	*	*/*	**-**, DCPD	***/**

Continental's *** related ******** is ********* in ***** *.*. Specific **** types *** tire ******* were *** generally ******* in *** patents. Patent ********** suggests *** of ** based ******.

Table 7.7 - Continental's TPR Related Patents

Year	Patent	TT	Tread	TPRs	Target Properties
2007	US20070167557A1	N	N/A	C9	DUR
2011	**********	*	*/*	**-**	**,**,WG
2013	**********	*	*/*	**	** ***][WG*
	**********	*	*/*	**-**	**/**[DG*
2014	**********	*	*/*	***	**/**/DUR****]
2015	**********	*	*/*	***	**/**/PRO
2016	**********	*	**	**/*, LP***	***/** [**]
	**********	*	*/*	**/*	**/**[RR*
	**********	*	*/*	**	**/**
2017	**********	*	*/*	**-**, TPE**	**[**]
2018	**********	*	*/*	**/*	**/**[All*
2019	**********	*	*/*	***, **-**-BR	**/**[All*
	**********	*	*/*	****	**/**/RR
	**********	*	*/*	**-**-BR	**/**/RR***
2020	**********	*	*/*	********	**/**/SG***
	**********	*	*/*	********-**	**/**/WR
2021	**********	*	*/*	**-**	***
	**********	*	*/*	********	**/**
	**********	*	*/*	**-**-BR	**[**][DG*
	**********	*	*/*	********-**	**/**/WG

Goodyear's *** related ******** is ********* in ***** *.*. There ** a ****** emphasis ** AW ********** with ** increasing ***** of ***** type ***.

Table 7.8 - Goodyear's TPR Related Patents

Year	Patent	TT	Tread	TPRs	Target Properties
2012	EP2468815A1	N	N/A	AMS, LP-SBR/BR	WG/WR/RR
2016	**********	*	**	***	****]
2017	**********	*	**	**-**/BR	**/**
2018	**********	*	**	***	**/**/RR
2019	**********	*	*/*	**, **-**/BR	**[**][WG*
	**********	*	**	***/***	***/**/WG***]
	**********	*	*/*	********	**/**/RR
	**********	*	*/*	********	**/**/WG***
2020	**********	*	**	***	**
2021	**********	*	*/*	**/*	**

Hankook's *** related ******** is ********* in ***** *.*. The ***** is ** UHP *** HP **** performance **** Terpene ***** materials ********* most **********.

Table 7.9 - Hankook's TPR Related Patents

Year	Patent	TT	Tread	TPRs	Target Properties
2014	KR101457866B1	Y	UHP	PH	WG/STB[RR]
2019	**********	*	***	****, **	***/**/IG****
	**********	*	***	****	**/**/IG
	**********	*	**	**-*********	**/**/SG****
	**********	*	** **	**	****]
2020	**********	*	*/*	***, **	**/**
	**********	*	**	**, **	**
2021	**********	*	**	********	**/**/WG
	**********	*	*/*	**-**	**/**/WG

Kumho's *** related ******** is ********* in ***** *.**. The ******* show * wide ***** of ***** types **** a **** frequency ** sustainable *******.

Table 7.10 - Kumho's TPR Related Patents

Year	Patent	TT	Tread	TPRs	Target Properties
2007	KR20070004255A	N	N/A	DCPD/C5/ST	WG/DG
2009	**********	*	***	********	***
2010	**********	*	**	**	**/**/RR
2011	**********	*	*/*	****** *******	**/**/RR
2012	**********	*	*/*	**/*****	**
2016	**********	*	*/*	****	**/**[PRO*
	**********	*	*/*	**	**/**
2017	**********	*	***	**-**	**/**
2018	**********	*	**	**	**/**/WR***/IG
	**********	*	*/*	**-**	**/***
2021	**********	*	**	**	**[**]

Michelin's *** related ******** is ********* in ***** *.**. Michelin's ******** has * high ********* of ******* related ****.

Table 7.11 - Michelin's TPR Related Patents

Year	Patent	TT	Tread	TPRs	Target Properties
2006	**WO2006061064A1**	**Y**	**N/A**	**C5/ST**	**DUR/WR**
2007	**********	*	*/*	**/**	***/**
2011	**********	*	***	**/**	***/**
	**********	*	**	** *********)	**
2012	**********	*	*/*	**/*, TP *********)	** ***]
2013	**********	*	**/**	** *********)	**/**/WR
	**********	*	***	**	**/**/DG***
2014	**********	*	*/*	****-**	****]
2016	**********	*	**	********	****]
2017	**********	*	*/*	*-****	**/**
	**********	*	*/*	**/*	**/**
2018	**********	*	*/*	**-**	**/**
	**********	*	**	**-**	**
	**********	*	*/*	********	**[**]
	**********	*	*/*	**, ********	**/**/STB
	**********	*	*/*	** ******-pinene*	**/**/RR
2019	**********	*	*/*	*******-***** Extension	***
	**********	*	*/*	**-**-BR	***
	**********	*	*/*	*-****	**/**[WG*
	**********	*	**/***	********	***
	**********	*	*/*	**-**	****]
2020	**********	*	*/*	**-**-BR	***[**]

Pirelli's *** related ******** is ********* in ***** *.**. Pirelli's ******** is *** transparent. There **** a ****** of ******* related ** special ****** processes **** TPRs.

Table 7.12 - Pirelli's TPR Related Patents

Year	Patent	TT	Tread	TPRs	Target Properties
2017	WO2017046771A1	N	WT	LP-BR, Multiple	SG/WG/DG
2018	**********	*	**	********, **-**	**/**/DG***
	**********	*	**/**	**-**, LP	**/**/SG

Sumitomo's *** related ******** is ********* in ***** *.**. Sumitomo *** prolific ****** publishers. Terpene ****** have ** increasing ********* in **** recent *******.

Table 7.13 - Sumitomo's TPR Related Patents

Year	Patent	TT	Tread	TPRs	Target Properties
2012	US20120016056A1	Y	N/A	C9	RR/WG/WR/STB
	**********	*	*/*	********	***/**/WR****
2013	**********	*	*/*	********	**/**/RR****
2014	**********	*	***	**/**	**/**/RR****
	**********	*	*/*	**	**/**/WR****
	**********	*	*/*	**, ***	**/**/WR
	**********	*	*/*	**	**/**/WR
2015	**********	*	*/*	**, ***	**/**/STB
2016	**********	*	*/*	** **** extended*	**/**/IG***/DUR
2017	**********	*	*/*	*-**, C9	**/**/DUR
2018	**********	*	**	**	**/**/WR****
	**********	*	**/**	********	**/**/DUR***/SG
	**********	*	*/*	**	**/**
	**********	*	***	********	**/***
2019	**********	*	*/*	***	**/***/RR***
	**********	*	*/*	**-*********	***
	**********	*	*/*	*-**	**/**
	**********	*	***	***, **/*	**/**
	**********	*	*/*	**-**	**/**
	**********	*	**	***, *-**	***/**/WG***
	**********	*	**	*-**	**/**
	**********	*	**-**	***, **	**/**/WR
	**********	*	***	********	**/**/STB****
	**********	*	*/*	**, **	**/**/WR
	**********	*	**-**	**	**/**/DG
2020	**********	*	*/*	**	***/**/DUR
	**********	*	*/*	**, ***	**/**/WR
	**********	*	***	**	**/**/WR
	**********	*	**/***	***	***/**/DG***/WR
2021	**********	*	*/*	**, ********	***
	**********	*	*/*	****/*-DCPD	**/**/EB
	**********	*	***	**, *-****	***
	**********	*	***	****/*-DCPD	***
	**********	*	***	***, **	**/**

Toyo's *** related ******** is ********* in ***** *.**. Toyo *** a ****** focus ** mixing **** TPRs ***** development ** less **********.

Table 7.14 - Toyo's TPR Related Patents

Year	Patent	TT	Tread	TPRs	Target Properties
2008	JP2008120940A	N	N/A	LP-FX	AGE/RR
2013	**********	*	*/*	**-*, TP***	**/**
2017	**********	*	*/*	**, **	**/***
2018	**********	*	*/*	**	**/**/AGE
2019	**********	*	*/*	**-*	**/**
2020	**********	*	*/*	********	***/**/[DUR*
	**********	*	**	**	**/**/SG***

Yokohama's *** related ******** is ********* in ***** *.**. Yokohama **** a **** frequency ** terpene ******* patents.

Table 7.15 - Yokohama's TPR Related Patents

Year	Patent	TT	Tread	TPRs	Target Properties
2007	JP2007246622A	N	N/A	TP-C9	WG [WR] [STB]
2013	**********	*	*/*	**-**	**/**/WR
	**********	*	***	**	**/***/PRO
2014	**********	*	*/*	**	**/***/WR
2015	**********	*	**	**-**, LP***	**/**/WR
	**********	*	*/*	**-**	**/**/PRO
2016	**********	*	*/*	**-**	** ****]
2017	**********	*	***	**, **/***	**/***/WR
2019	**********	*	**	**	**/**/SG
	**********	*	*/*	**-**	***/**/RR
	**********	*	**	**-**	**/** [**][WG*
	**********	*	***	**-**/AMS	**/**/TR
	**********	*	*/*	**-**	**/**/WR
	**********	*	**	**-**	**/**/SG
	**********	*	***	**-**,AMS***	**/**
	**********	*	*/*	**-**	**/**/WR
	**********	*	*/*	**-**	**/**/STB
2020	**********	*	*/*	***, **	**/[***]

Additional *** trends ** patent ********** include ******* mixing ******* where *** is ******* with *** prior ** mixing. There **** also * number ** investigations ***** resins **** grafted **** polymers. One ****** area ** concern **** to ** handling ** compounds **** high **** contents.

Table *.** presents * summary ** resins ********* by **** company *******. This **** is ***-exhaustive *** should ** used *** directional ******** only.

Table 7.16 - Resins Mentioned by Tire Company Patents (Non-exhaustive)

Tire Company	Resin Company	Type	Tradename
Bridgestone	Tonen Chemical	C5/C9	T-Rez RD104
	***** ********	**	*-*** RA100
	** ****** ***	**	******* ********** ***
	**** **********	****	******* ****
	**** **********	**	****** *****
	**********	**/**	******
	****** **********	**	*** ******* ***
	** *****	**********	*******
	****** ****** ***	*****	******* **
	******** ********	******* ******	** ******** ****
	**********	**	******* ****
	****** *********	***	*******
	**** ******	**-**	***** ***
	**** ******	**-**	**-****
Michelin	****** ******** **	**/*******	***** ****** **
	***	******* *******	********* ** ***
	***	******* ********	********* ****
	*******	******* *******	*** ****
	*******	******* *******	******
	*******	******* ********	******** **-****
	*******	*******	******** ** ****
	*******	*********-******	******* ***
	***	******* ********	********** ****
	*******	******* ********	******** ******
	*******	******* ********	******** ******
	**********	****/**	******* ****
	*******	**-**	***-***
	******	**-**-FX	******** **, ** **-*-100
Goodyear	*******	***	***** ****
	*******	***	****** *****
	*******	***	******** ****
	***	*******	********* ****
	**** ******	**-**-FX	****** ***-*
Continental	*******	** *** mod*	******** ****
	**** ******	**-**	***** ***
	**** ******	**-**	********* ***
	********	**-**	*******
	*******	**-**	***-**
Kumho	*******	**-**	******
	******	**-**	**-****
	*******	**-***	*-***-841
Pirelli	***	******* *******	********* *****
	******	**-**-FX	******** ***

Sumitomo	*******	*********-******	***, ***, ***, ****
	******* **********	**	******** ***** *-*** AS
	*******	***	******** ****
	*******	*******	******** *** **
	*******	******* ********	******** ** ****
	*******	******* ********	******** *****
	******** ********	*******-**	** **-**
	*******		******* ***** **
	** *** * ****** ****	**	********** *******
	******* ********	*********-******	***
	******** ********	*******	*****
	** ****** ***	*********-******	********** ****
	*******	***	********* ****
	**** ******	**-**-C9	***** ***
	**** ******	**-*-BR	***** ******
	*******	**-**-M	***-***
	**** ******	**-**-BR* **-**	***** ***, ***
Yokohama	******** ********	*******-**	**-***, TO****
	*******	**-******	****
	*******	**-******	***
	****** *********	******-***	*******
	******	**-**, LP***-FX	******** ***, **** **
Toyo	******** ********	******-************	******** **-*****, PR12686
	****** ********	**********	****** ****
	*******	******* ******	*****
	*******	**-**	*****
	******** **********	**-**-FX	**-**
	*** **********	**-**-FX	*******
	******	**-**-AMS	********, ****
Kumho	***** ****	**	*-**

7.4.3 TPR Brand Analysis

This ******* focuses ** RCCL's ******** tying ****** to ******** usage. This ** done ** assessing **** company ********, annual *******, product ********** and **** outlet *********. Brands **** direct ********** links ** TPRs *** included ****, **no ********** are ****, the ********** TPR *** is ********** more ******** and *******. Tire ********* generally ******* technologies ***** are ********** into * brand *** are **** expanded ** the ****** with ********** brands *** technology **********. Technologies **** evolved ** be *****-faceted* using * range ** materials*processes*designs ** combination.

Bridgestone's *** related ****** are ***** in ***** *.**. Bridgestone's ********* compounds **** developed ** eliminate ***** from *** tire ******* patch **** travelling **** ice. The ********* technology ******** C* resin ***** with ***** materials. This *** been ******** across * wide ***** of ****** since ***** adoption. An *Improved **** Adhesion' ********** was ******* in **** stipulating ***** usage* this *** been ******* across ******** brands.

Table 7.17 - Bridgestone's TPR Related Brands

Year	Technology	Brand Association
2005	********* ******** ** ***** *** ****** ******	****** *****), Blizzak* ****, ******
2017	******** **** ******** * *****	*****-***** Technology
	********* ******** *	*******

Continental's *** related ****** are ***** in ***** *.**. Continental's ****** technology **** resins ***** with ***** materials ********* specialist ********** and ********** aids* these *** incorporated **** multiple ******. They **** specify ****** performance ***** use ** their **** AllSeasonContact *****.

Table 7.18 - Continental's TPR Related Brands

Year	Technology	Brand Association
2010	***** ****** ********	**********, **********, **********
2014	***** ****** ********	********
2016	**** ****** ********	**********
2017	****** ********** ******	**********
2018	***** ****** *.*	**********

Goodyear's *** related ****** are ***** in ***** *.**. Goodyear ******** resin *** across * broad ***** of ****** and **** subtypes.

Table 7.19 - Goodyear's TPR Related Brands

Year	Technology	Brand Association
2014	******* *****	*****, *******
	*******	*****
2015	**********	*********
2016	**** ******** ******	** ***** ****
	********_*********	*****
2017	********* **********	*********
2019	******** ******	*****
2020	****_********	****** ******* *****
2021	******** *****	*********

Hankook's *** related ****** are ***** in ***** *.**. Hankook ******** adopted *Aqua **** Compound' ** their ****** and ******* brands.

Table 7.20 - Hankook's TPR Related Brands

Year	Technology	Brand Association
2007	**** ** ******* * ******** *****	******
2018	**** **** ********	******, *******
2021	***** ****	*******

Kumho's *** related ****** are ***** in ***** *.** Kumho specify ****** for ***** Ecsta *****.

Table 7.21 - Kumho's TPR Related Brands

Year	Technology	Brand Association
2012	**** **** ********* *****	*****
2015	*** ********** ********** *****	*****

Michelin's *** related ****** are ***** in ***** *.**. Michelin ** not ********* resins **** brands.

Table 7.22 - Michelin's TPR Related Brands

Year	Technology	Brand Association
	No brand info tied to resin use	

Pirelli's *** related ****** are ***** in ***** *.**. Pirelli ********* use ** resins ** their **** Scorpion ***** for ******** performance.

Table 7.23 - Pirelli's TPR Related Brands

Year	Technology	Brand Association
2019	***** *** ******** **********	********

Sumitomo's *** related ****** are ***** in ***** *.**. Sumitomo ** not ********* resins **** brands.

Table 7.24 - Sumitomo's TPR Related Brands

Year	Technology	Brand Association
2017	****** ******** ******	****** ****** ****

Toyo's *** related ****** are ***** in ***** *.**. Toyo ********* resin ** natural ****** with ***** **** ******** brand.

Table 7.25 - Toyo's TPR Related Brands

Year	Technology	Brand Association
2013	******* ****** ******** **********	********

Yokohama's *** related ****** are ***** in ***** *.**. Yokohama ********* resins **** their ********** technology ***** has **** extended ****** a ****** of ******. They **** also **** terpene ***** resins **** ****, ********** use ** orange *** in * large ****** of ***** brands.

Table 7.26 - Yokohama's TPR Related Brands

Year	Technology	Brand Association
2013	****** ***	********
2014	********** ********	********, *********
2020	********** ******** **	********

7.5 RPO Technology Developments

This section reviews RPO technology developments. Recent developments from TPO manufactures are reviewed in **Section 7.5.1**. This is followed by developments from a tire company's perspective through patent review in **Section 7.5.2** and tire brand analysis in **Section 7.5.3**.

7.5.1 RPO Manufacturer Product Developments

A ******* progression *** fossil ***** RPO ********* is ******/seed **********. These *** beginning ** appear ** the ******. Resin ********* are **** looking ** capture ****** as ********* in ******* *.* above. Recent ********** specific ********** are ******** in *** table *****:

Year	Manufacturer	Product
2020	*******	********** ***/*** natural ***-********* based ********** *** ***/****
2019	*&* Group	******* ****/**** oil **** ********** ***
	*****	***** *** **** **** ****** **** ********* *********
2018	*****	***** *** * ********** ********** ******* *** *** **********
2017	**********	******** **** **: *** *** ******** *** ***

7.5.2 RPO Tire Related Patent Review

RCCL reviewed recent patent literature where RPO related materials are the focus or part of the application requirements. The publication year is provided, which infers that the technology may already have been adopted by the company in question. Additional importance was placed on patent applications where tire testing was completed, this is indicated by 'Y' in the TT column. It should be noted that recent patents do not always indicate whether tire testing has been completed, this may be driven by additional use of AI in compound development, especially for the screening stages. Tire companies typically state a range of RPOs, those specified below are based on preferred options in the patents. Cases where no clear RPO preference is stated are indicated by 'Multiple'. Patents also referenced for TPRs are highlighted in bold.

Please refer to **Table 7.27** for abbreviations used for performance characteristics.

Table 7.27 - RPO Abbreviations for Patent Activity

Key	Description	Key	Description
BIO	Algae Bio Oil	**TPO**	Tire Pyrolysis Oil
DAE	Distillate Aromatic Extract	**VG**	Vegetable Oil
H-	Hydrogenated	**VGCO**	Coconut Oil
HN	Heavy Naphthenes	**VGHP**	Hemp Oil
MES	Mild Extraction Solvate	**VGPO**	Palm Oil
PAR	Paraffinic Oil	**VGRP**	Rapeseed Oil
PES	Phosphoric Ester	**VGSB**	Soybean Oil
RAE	Residual Aromatic Extract	**VGSF**	Sunflower Oil
SRAE	Treated RAE (including TRAE)	**OTH**	Other
TDAE	Treated DAE		

The following summaries are not exhaustive, they are intended to show typical activities.

Bridgestone's RPO related patents are presented in **Table 7.28**.

Table 7.28 - Bridgestone RPO Related Patents

Year	Patent	TT	Tread	RPOs	Target Properties
2017	**********	*	*/*	*-**	**
	**********	*	*/*	****	***
2019	**********	*	******	****	****]
	**********	*	*/*	**	***
	**********	*	**	********	****]
	**********	*	**	********	****]
	**********	*	**	********	**/**/IG***/STB
	**********	*	*/*	***	***
	**********	*	**	********	**/**
2020	**********	*	*/*	**-**	**/**/STB****
	**********	*	*/*	**	**,**,DG
2021	**********	*	**/**	**/*	**/**/WR
	**********	*	*/*	**-**, DCPD	***/**

Continental's *** related ******** is ********* in ***** *.**. Specific **** types *** tire ******* were *** generally ******* in *** patents. Patent ********** suggests *** of ** based ******.

Table 7.29 - Continental's RPO Related Patents

Year	Patent	TT	Tread	RPOs	Target Properties
2010	**********	*	*/*	****	**/**
2011	**********	*	*/*	**	***
2013	**********	*	*/*	***	***
2015	**********	*	*/*	********	***/***
2016	**********	*	*/*	****	**/***
2017	**********	*	**	***	**/**/IG***/WG
2018	**********	*	*/*	********	***/***

Goodyear's *** related ******** is ********* in ***** *.**. There ** a ****** emphasis ** AW ********** with ** increasing ***** of ***** type ***.

Table 7.30 - Goodyear's RPO Related Patents

Year	Patent	TT	Tread	RPOs	Target Properties
2014	**********	*	*/*	****	**/**/WR****[RR*
2016	**********	*	*/*	***, **	**/**/WR
2017	**********	*	**	****	**/**
2018	**********	*	**/**	****	**/**/WG***/WR
	**********	*	**	****	**/**
	**********	*	*/*	***	**/**
2019	**********	*	*/*	****	**/**/WG
	**********	*	**	***	**/**/RR***
	**********	*	*/*	********	**/**/RR
	**********	*	***	**	**/**/WG***
2020	**********	*	**	****	**
2021	**********	*	*/*	**_**	***/***

Hankook's *** related ******** is ********* in ***** *.**. The ***** is ** UHP *** HP **** performance **** Terpene ***** materials ********* most **********.

Table 7.31 - Hankook's RPO Related Patents

Year	Patent	TT	Tread	RPOs	Target Properties
2018	**********	*	**	**	**/**/IG***/AGE
	**********	*	**	****	***/**/IG***
2019	**********	*	*/*	***	**
	**********	*	**	**	**/**/SG****
	**********	*	***	****	**/**/IG
	**********	*	*/*	**	**/**/WR****
	**********	*	**	**	**/**/WG***/RR
2020	**********	*	*/*	****	**/**
	**********	*	**	****	**/**
	**********	*	**	****	**
2021	**********	*	*/*	*_****	***
	**********	*	**	*_****	**/**/SG

Kumho's *** related ******** is ********* in ***** *.**. The ******* show * wide ***** of ***** types **** a **** frequency ** sustainable *******.

Table 7.32 - Kumho's RPO Related Patents

Year	Patent	TT	Tread	RPOs	Target Properties
2009	**********	*	*/*	**	**/***
	**********	*	*/*	**	
2013	**********	*	*/*	**, ***	***
2016	**********	*	******	********	**

Michelin's *** related ******** is ********* in ***** *.**. Michelin's ******** has * high ********* of ******* related ****.

Table 7.33 - Michelin's RPO Related Patents

Year	Patent	TT	Tread	RPOs	Target Properties
2004	**********	*	**	****	**/**/SG***
2005	**********	*	*/*	****, ***, ****	***
	**********	*	*/*	***/****	**/***
2006	**********	*	*/*	***/****	***/**
2007	**********	*	*/*	***/****	***/**
2008	**********	*	*/*	****	**/**/RR
2011	**********	*	***	***/****	***/**
2013	**********	*	**/**	**	**/**/WR
	**********	*	***	**	**/**/DG***
2014	**********	*	**_**	********	**/**
2015	**********	*	*/*	********	**/**
2016	**********	*	***	**	**/**[SG****]
	**********	*	**	**	**/**/SG
	**********	*	*/*	**	**/**/RR
2017	**********	*	**	***/***	***
	**********	*	**	***	**
	**********	*	**	**	**/**
2018	**********	*	*/*	**	**[**]
	**********	*	*/*	****	**/**/STB
2019	**********	*	**	**/***	***
	**********	*	**	***/***	**/**
	**********	*	**	***/***	**/**
	**********	*	**/***	****	***
	**********	*	*/*	**_**	****]
2020	**********	*	*/*	**	***[**]

Pirelli's *** related ******** is ********* in ***** *.**. Pirelli's ******** is *** transparent. There **** a ****** of ******* related ** special ****** processes **** TPRs.

Table 7.34 - Pirelli's RPO Related Patents

Year	Patent	TT	Tread	RPOs	Target Properties
2008	**********	*	*/*	***	**
2010	***************	*	**/***	***	**/**

Sumitomo's *** related ******** is ********* in ***** *.**. Sumitomo *** prolific ****** publishers. Terpene ****** have ** increasing ********* in **** recent *******.

Table 7.35 - Sumitomo's RPO Related Patents

Year	Patent	TT	Tread	RPOs	Target Properties
2014	***************	*	*/*	********	**/**/WR****
	*************	*	*/*	****	**/**
	*************	*	*/*	**	***/***
2017	***************	*	*/*	*-**, C9	**/**/DUR
2018	*************	*	***	********	**/***
2019	***************	*	*/*	**	**/***/RR***
	**************	*	**	**	**/**
2020	**********	*	**/***	***	***/**/DG***/WR

Toyo's *** related ******** is ********* in ***** *.**. Toyo *** a ****** focus ** mixing **** TPRs ***** development ** less **********.

Table 7.36 - Toyo's RPO Related Patents

Year	Patent	TT	Tread	RPOs	Target Properties
2012	************	*	*/*	********	***

Yokohama's *** related ******** is ********* in ***** *.**. Yokohama **** a **** frequency ** terpene ******* patents.

Table 7.37 - Yokohama's RPO Related Patents

Year	Patent	TT	Tread	RPOs	Target Properties
2004	**********	*	*/*	********	**/**
2006	**********	*	*/*	****	**/**
2007	**********	*	*/*	****/****	** ***] [***]
2008	**********	*	*/*	********	**/**
	**********	*	**/***	***	**[**]
2014	**********	*	*/*	****	***
2015	**********	*	*/*	****	**/***
2019	**********	*	**	***/***	**/**/SG

7.5.3 RPO Brand Analysis

This section focuses on RCCL's research tying brands to material usage. This is done by assessing tire company websites, annual reports, product literature and tire outlet materials. Brands with direct technology links to RPOs are included here, **no inferences are made, the underlying RPO usage is considerably more prolific**. Tire companies generally develop technologies which are incorporated into a brand and are then expanded in the future with additional brands and technology enhancements. Technologies have evolved to be multi-faceted, using a range of materials/processes/designs in combination.

Bridgestone does not have any brand technology directly attributable to RPOs.

Continental's RPO related brands are shown in **Table 7.38**.

Table 7.38 - Continental's RPO Related Brands

Year	Technology	Brand Association
2019	******** ***	******

Goodyear's RPO related brands are shown in **Table 7.39**.

Table 7.39 - Goodyear's RPO Related Brands

Year	Technology	Brand Association
2017	******* ***	********* **********
2018	******* ***	***** ******** *** *******
2019	******* ***	***** **********
2020	******* ***	********* ******* *****

Hankook's RPO related brands are shown in **Table 7.40**.

Table 7.40 - Hankook's RPO Related Brands

Year	Technology	Brand Association
2008	*** *** ********	********
2018	********* ***	*******
2019	********* ***	******

Kumho's RPO related brands are shown in **Table 7.41**. Kumho specify resins for their Ecsta brand.

Table 7.41 - Kumho's RPO Related Brands

Year	Technology	Brand Association
2012	*** *** ****	********

Michelin's RPO related brands are shown in **Table 7.42**.

Table 7.42 - Michelin's RPO Related Brands

Year	Technology	Brand Association
2007	***** ********	********, *****
2010	********* ***	*******
	***** ******** *	*****, *****
2012	***** ******** **	********, *****
2013	********* ***	*****
2014	********* ***	*******
	***** ******** **	*****, *****

Pirelli's RPO related brands are shown in **Table 7.43**.

Table 7.43 - Pirelli's RPO Related Brands

Year	Technology	Brand Association
2008	** ******** ****	********

Sumitomo's RPO related brands are shown in **Table 7.44**.

Table 7.44 - Sumitomo's RPO Related Brands

Year	Technology	Brand Association
2014	****** ******** ****	******* ***
2016	***** ***** **********	****** ****** **** **

Toyo's RPO related brands are shown in **Table 7.45**.

Table 7.45 - Toyo's ROI Related Brands

Year	Technology	Brand Association
2013	********* ** ******* ******	********

Yokohama's **** not **** any ***** technology ******** related ** RPOs. The ********* references ** orange *** technology *** assumed ** relate ** terpene ******* traction *****. This *** recently ********* due ** Kraton's ****** in ********* for *** terpene ******** resins.

8 MARKET DEMAND 2015 TO 2050

This section presents detailed TPR and RPO market demand.

Market demand is presented based on two scenarios:

1) **Current**
   This scenario uses market and material developments built into RCCL's market demand methodology as set out in **Appendices Section 11.1** and including the research outlined in this report. TPR and RPO values post 2040 are extrapolated from the 2035/40 figures for the respective TPR or RPO.

2) **Vision**
   This scenario adjusts the values derived from 1) above by reducing fossil based materials in-line with tire company's aspirational targets and visions. Reductions were based on the ease of replacement for tire types and were implemented according to the scheme in **Table 8.1**. Second order polynomial fits were used to model the reduction in fossil content. The reductions were applied based on tire company, production plant location and tire sub type.

   Reductions for TPRs excluded TP and LP types as these were considered the most likely candidates to be converted to sustainable raw materials. TP and LP values from 1) were used for this scenario and these values **were not** incremented for potential replacement of fossil based materials.

   Reductions for RPOs excluded VO types which used values from 1) and were not incremented for potential replacement of fossil based materials.

Table 8.1 - Reduction in Fossil Content based on Tire Company's Aspirations

Tire Company	Tire Type	% Reduction in fossil based content					
		2025	2030	2035	2040	2045	2050
Top Ten[1] including APAC	**/*** _ ** * **	**	**	**	**	**	**
	/* _ *** * **	**	**	**	**	**	**
	/* _ ** * **	**	**	**	**	**	**
	/* _ *** * **	*	**	**	**	**	**
	******	**	**	**	**	**	***
APAC (excluding top ten)	**/*** _ ** * **		**	**	**	**	**
	/* _ *** * **		**	**	**	**	**
	/* _ ** * **		**	**	**	**	**
	/* _ *** * **		**	**	**	**	**
	******		**	**	**	**	**

[1] *Bridgestone, Continental, Goodyear, Hankook, Kumho, Michelin, Pirelli, Sumitomo, Toyo, Yokohama*

All values are presented as thousands of metric tonnes (kMT).

8.1 TPRs

This section presents TPR demand in kMT.

8.1.1 Total Demand All Types

8.1.1.1 Global Demand

Global ****** demand *** all *** types ** presented ** **Table *.***. **** ****** is ********* at ***.* kMT. CAGR *** the **/** period ******* scenario ** estimated ** *.*% (****/5* *.*%, 2025/**: 5.*%), this reduces ********** over ********** ten **** periods. The ****** scenario ***** reduced ********* to **** followed ** some *******.

Table 8.2 - Global Market Demand All TPR Types by Scenario 2015 to 2050

kMT								Δ		CAGR		
Scenario	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
Current	**.*	***.*	***.*	***.*	***.*	***.*	***.*	**%	*.*%	*.*%	*.*%	*.*%
Vision	**.*	***.*	***.*	***.*	***.*	***.*	***.*	**%	*.*%	*.*%	**.0%	*.*%

8.1.1.2 Regional Demand

Regional market demand for all TPR groups for the current scenario are presented in **Table 8.3**

*** * ** **** ****** (***): Europe ***.2* > ***** (**.8) * N. Asia ***.1*

*** * ** **/** growth (***): China ***.9* > *. Asia ***.2* > ****** (**.1)

*** * ** **/** CAGR (%):*China (*.9) * S. Asia **.8* > ***** (*.2)

Table 8.3 - Regional Market Demand All TPR Types using Current Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
China	**.*	**.*	**.*	**.*	**.*	**.*	***.*	**%	*.*%	*.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
Europe	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
USMCA	*.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
N. Asia	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.5%	*.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%

Regional market demand for all TPR groups for the vision scenario are presented in **Table 8.4**

*** * ** **** ****** (***): Europe ***.2* > ***** (**.8) * N. Asia ***.1*

*** * ** **/** growth (***): China ***.1* > *. Asia **.0* > ***** (*.3)

*** * ** **/** CAGR (%):*China (*.7) * India **.8* > *. Asia **.2*

Table 8.4 - Regional Market Demand All TPR Types using Vision Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	**.3%	**.5%	*.*%
China	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	**.1%	**.6%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.5%	*.*%
Europe	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	**.1%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.6%	**.1%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.0%	**.2%
USMCA	*.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	**.0%	*.*%
N. Asia	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	**.4%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.5%	*.*%	**.7%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.6%	**.4%

8.1.2 Demand by TPR Type

This section provides totals for TPR types.

8.1.2.1 Global

Global market demand by TPR type for the current scenario is presented in **Table 8.5**.

Top * TPRs ** **** ****** (***): AMS ***.3* > ** (**.9) * C* (**.4)

Top * TPRs ** **/** growth (***): TP ***.3* > ** (**.1) * AMS ***.1*

Top * TPRs ** **/** CAGR (%):* LP ***.3* > ** (*.6) * HDCPD **.2*

Table 8.5 - Global Market Demand by TPR Type using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
TPR Type	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
AMS	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.5%	*.*%	*.*%	*.*%
C5	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	**.8%	*.*%	*.*%	*.*%
C5C9	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	*.*%	*.*%	*.*%
C9	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
HDCPD	*.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	**.*%	*.*%	*.*%	*.*%
LP	*.*	*.*	*.*	**.*	**.*	**.*	**.*	**%	**.*%	**.*%	*.*%	*.*%
LP STY	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
TP	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%

Global market demand by TPR type for the vision scenario is presented in **Table 8.6**.

Top * TPRs ** **** ****** (***): AMS ***.3* > ** (**.9) * C* (**.4)

Top * TPRs ** **/** growth (***): TP ***.3* > ** (**.1) * C* (*.0)

Top * TPRs ** **/** CAGR (%):* LP ***.3* > ** (*.6) * LP *** (*.8)

Table 8.6 - Global Market Demand by TPR Type using Vision Scenario 2015 to 2050

kMT								Δ	CAGR			
TPR Type	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
AMS	**.*	**.*	**.*	**.*	**.*	**.*	*.*	*%	**.5%	**.6%	**.7%	**.9%
C5	**.*	**.*	**.*	**.*	**.*	*.*	*.*	**%	**.8%	*.*%	**.8%	***%
C5C9	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	**.1%	***%	***%
C9	**.*	**.*	**.*	**.*	**.*	**.*	*.*	**%	*.*%	*.*%	**.0%	**.7%
HDCPD	*.*	**.*	**.*	**.*	**.*	*.*	*.*	**%	**.*%	*.*%	**.5%	***%
LP	*.*	*.*	*.*	**.*	**.*	**.*	**.*	**%	**.*%	**.*%	*.*%	*.*%
LP STY	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.0%	**.2%
TP	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%

8.1.2.2 Regional

Regional market demand for AMS types for the current scenario are presented in **Table 8.7**.

Top * Regions ** **** ****** (***): Europe ***.0* > ***** (*.4) * N. Asia **.9*

Top * Regions ** **/** growth (***): China **.3* > *. Asia **.8* > ***** (*.7)

Top * Regions ** **/** CAGR (%):*India (*.2) * China **.6* > ****** (*.9)

Table 8.7 - Regional Market Demand for AMS Types using Current Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
China	*.*	*.*	*.*	**.*	**.*	**.*	**.*	*%	*.*%	*.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.0%	*.*%	*.*%	**.7%
Europe	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.4%	*.*%	*.*%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.6%	*.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.3%	*.*%	*.*%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.5%	*.*%	**.7%	**.8%
N. Asia	**.*	*.*	**.*	**.*	**.*	**.*	**.*	**%	**.6%	*.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.8%	*.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%

Regional market demand for AMS types for the vision scenario are presented in **Table 8.8**.

Top * Regions ** **** ****** (***): Europe ***.0* > ***** (*.4) * N. Asia **.9*

Top * Regions ** **/** growth (***): China **.0* > ***** (*.4)

Top * Regions ** **/** CAGR (%):*India (*.6) * China **.6* > *. Asia ***.9*

Table 8.8 - Regional Market Demand for AMS Types using Vision Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	**.3%	**.4%	**.7%
China	*.*	*.*	*.*	**.*	**.*	*.*	*.*	*%	*.*%	*.*%	**.9%	**.4%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.0%	**.2%	***%	**.5%
Europe	**.*	**.*	**.*	*.*	*.*	*.*	*.*	*%	**.4%	**.6%	**.5%	**.7%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.6%	*.*%	**.7%	**.1%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.3%	**.2%	**.7%	**.7%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.5%	**.5%	**.5%	**.4%
N. Asia	**.*	*.*	**.*	**.*	*.*	*.*	*.*	**%	**.6%	**.9%	**.4%	**.3%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.8%	**.7%	**.8%	**.4%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	**.1%	**.9%	**.2%

Regional market demand for C5 types for the current scenario are presented in **Table 8.9**.

Top * Regions ** **** ****** (***): China **.0* > ****** (*.3) * N. Asia **.1*

Top * Regions ** **/** growth (***): China **.4* > ****** (*.3) * N. Asia **.5*

Top * Regions ** **/** CAGR (%):*China (*.6) * Europe **.9* > ***** (*.7)

Table 8.9 - Regional Market Demand for C5 Types using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.1%	*.*%	*.*%	*.*%
China	*.*	*.*	*.*	*.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.9%	*.*%	*.*%	*.*%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.7%	*.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.9%	*.*%	*.*%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.6%	**.1%	**.6%	*.*%
N. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.7%	*.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.0%	*.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.8%	*.*%	*.*%	*.*%

Regional market demand for C5 types for the vision scenario are presented in **Table 8.10**.

Top * Regions ** **** ****** (***): China **.0* > ****** (*.3) * N. Asia **.1*

Top * Regions ** **/** growth (***): China **.7* > ***** (*.1)

Top * Regions ** **/** CAGR (%):*China (*.4) * India **.5* > ****** (-*.9)

Table 8.10 - Regional Market Demand for C5 Types using Vision Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.1%	**.7%	***%	***%
China	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.7%	***%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.9%	**.8%	***%	***%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	**.9%	***%	***%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.7%	*.*%	**.1%	***%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.9%	**.5%	***%	***%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.6%	**.4%	***%	***%
N. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.7%	**.3%	***%	***%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.0%	**.2%	***%	***%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.8%	**.8%	***%	***%

Regional market demand for C5C9 types for the current scenario are presented in **Table 8.11**.

Top * Regions ** **** ****** (***): USMCA **.6* > *. Asia * Europe * China **.3*

Top * Regions ** **/** growth (***): USMCA * China **.2* > ****** = *. Asia **.1*

Top * Regions ** **/** CAGR (%):*China (*.3) * N. Asia **.1* > ***** = *. Am. (*.0)

Table 8.11 - Regional Market Demand for C5C9 Types using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.3%	*.*%	*.*%	*.*%
China	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	*.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.1%	*.*%	*.*%	*.*%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	*.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	*.*%	*.*%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	*.*%	*.*%	*.*%
N. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	*.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%

Regional market demand for C5C9 types for the vision scenario are presented in **Table 8.12**.

Top * Regions ** **** ****** (***): USMCA **.6* > *. Asia * Europe * China **.3*

Top * Regions ** **/** growth (***): China **.1*

Top * Regions ** **/** CAGR (%):*China (*.5) * India ***.5* > *. Asia ***.5*

Table 8.12 - Regional Market Demand for C5C9 Types using Vision Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.3%	**.1%	***%	*.*%
China	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	*.*%	**.4%	***%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.1%	**.3%	***%	*.*%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	**.7%	***%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	**.5%	***%	***%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	**.4%	***%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	**.7%	***%	*.*%
N. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	**.5%	***%	***%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	**.7%	***%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	**.4%	***%	*.*%

Regional market demand for C9 types for the current scenario are presented in **Table 8.13**.

Top * Regions ** **** ****** (***): China **.8* > *. Asia **.1* > ****** (*.6)

Top * Regions ** **/** growth (***): China *.*) > *. Asia **.2* > ****** (*.8)

Top * Regions ** **/** CAGR (%):*S. Asia ***.4* > ***** (**.5) * India **.1*

Table 8.13 - Regional Market Demand for C9 Types using Current Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	*.*%	*.*%	*.*%
China	*.*	*.*	*.*	*.*	**.*	**.*	**.*	**%	*.*%	**.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.7%	*.*%	*.*%	*.*%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.9%	*.*%	*.*%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.2%	*.*%	*.*%	**.1%
N. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.7%	*.*%	*.*%	**.3%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.8%	*.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.2%	**.*%	*.*%	*.*%

Regional market demand for C9 types for the current scenario are presented in **Table 8.14**.

Top * Regions ** **** ****** (***): China **.8* > *. Asia **.1* > ****** (*.6)

Top * Regions ** **/** growth (***): China **.6* > ***** (*.6) * S. Asia **.4*

Top * Regions ** **/** CAGR (%):*China (*.0) * S. Asia **.0* > ***** (*.5)

Table 8.14 - Regional Market Demand for C9 Types using Vision Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	**.5%	***%	***%
China	*.*	*.*	*.*	*.*	**.*	*.*	*.*	**%	*.*%	*.*%	**.6%	**.3%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.7%	**.6%	**.5%	**.8%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.9%	**.2%	**.4%	**.1%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.2%	**.0%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	**.5%	**.5%	**.2%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.2%	**.7%	**.1%	**.2%
N. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.7%	**.6%	**.8%	**.2%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.8%	**.0%	**.1%	**.8%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.2%	*.*%	***%	***%

Regional market demand for H-DCPD types for the current scenario are presented in **Table 8.15**.

Top * Regions ** **** ****** (***): N. Asia **.7* > ***** (*.2) * Europe **.0*

Top * Regions ** **/** growth (***): China **.7* > *. Asia **.9* > ****** (*.2)

Top * Regions ** **/** CAGR (%):*India (**.4) * S. Am. (**.3) * S. Asia ***.1*

Table 8.15 - Regional Market Demand for H-DCPD Types using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	*.*%	*.*%
China	*.*	*.*	*.*	*.*	*.*	**.*	**.*	**%	**.*%	*.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	*.*%	*.*%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	**.*	**%	**.*%	*.*%	*.*%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	*.*%	**.1%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	*.*%	**.4%
N. Asia	*.*	*.*	*.*	*.*	*.*	**.*	**.*	**%	**.*%	*.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.*%	*.*%	**.8%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.*%	*.*%	*.*%

Regional market demand for H-DCPD types for the vision scenario are presented in **Table 8.16**.

Top * Regions ** **** ****** (***): N. Asia **.7* > ***** (*.2) * Europe **.0*

Top * Regions ** **/** growth (***): China **.7* > *. Asia * USMCA **.3*

Top * Regions ** **/** CAGR (%):*India (*.0) * China **.2* > *. Asia * Africa **.3*

Table 8.16 - Regional Market Demand for H-DCPD Types using Vision Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	**.0%	**.3%
China	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	**.5%	***%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.5%	***%	***%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.3%	***%	***%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	**.0%	**.0%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	**.8%	***%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	**.4%	***%
N. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	**.1%	***%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	**.1%	***%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	**.9%	**.0%

Regional market demand for LP types for the current scenario are presented in **Table 8.17**.

Top * Regions ** **** ****** (***): Europe **.7* > ***** (*.7) * N. Asia **.9*

Top * Regions ** **/** growth (***): N. Asia **.1* > ***** (*.8) * Europe **.7*

Top * Regions ** **/** CAGR (%):*India (**.4) * S. Asia ***.1* > *. Asia ***.6*

Table 8.17 - Regional Market Demand for LP Types using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
Africa	*	*	*	*.*	*.*	*.*	*.*	*	*.*%	*.*%	**.*%	*.*%
China	*.*	*.*	*.*	*.*	*.*	**.*	**.*	**%	**.*%	**.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.*%	*.*%	*.*%
Europe	*.*	*.*	*.*	*.*	*.*	**.*	**.*	**%	**.*%	**.*%	*.*%	*.*%
India	*	*.*	*.*	*.*	*.*	*.*	*.*	***%	*.*%	**.*%	**.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.*%	*.*%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.*%	*.*%	*.*%
N. Asia	*.*	*.*	*.*	*.*	*.*	**.*	**.*	**%	**.*%	**.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.*%	*.*%	*.*%

Note: No vision scenario for LP types the current scenario is used for both scenarios.

Regional market demand for LP STY types for the current scenario are presented in **Table 8.18**.

Top * Regions ** **** ****** (***): N. Asia **.4* > ***** = ****** (*.3)

Top * Regions ** **/** growth (***): China **.4* > *. Asia **.2* > ****** = ***** (*.1)

Top * Regions ** **/** CAGR (%):*CIS (**.1) * India ***.2* > ***** (*.8)

Table 8.18 - Regional Market Demand for LP STY Types using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*	*.*%	*.*%	*.*%	*.*%
China	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	***%	**.*%	**.*%	*.*%	*.*%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.4%	*.*%	*.*%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
N. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%

Regional market demand for LP STY types for the vision scenario are presented in **Table 8.19**.

Top * Regions ** **** ****** (***): N. Asia **.4* > ***** = ****** (*.3)

Top * Regions ** **/** growth (***): China **.3* > *. Asia **.1*

Top * Regions ** **/** CAGR (%):*CIS (**.5) * India **.1* > ***** (*.0)

Table 8.19 - Regional Market Demand for LP STY Types using Vision Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*	*.*%	*.*%	*.*%	*.*%
China	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.2%	**.7%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	***%	**.*%	**.*%	**.3%	**.5%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	**.3%	**.4%	**.0%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	**.8%	**.8%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.4%	*.*%	**.5%	**.2%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.8%	**.3%
N. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.4%	**.1%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.9%	**.4%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	**.7%	**.1%

Regional market demand for TP types for the current scenario are presented in **Table 8.20**.

Top * Regions ** **** ****** (***): Europe **.0* > *. Asia **.7* > ***** (*.1)

Top * Regions ** **/** growth (***): China **.9* > *. Asia **.3* > ****** (*.7)

Top * Regions ** **/** CAGR (%):*China (**.4) * Africa **.8* > *. East **.5*

Table 8.20 - Regional Market Demand for TP Types using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	*.*%	*.*%
China	*.*	*.*	*.*	*.*	**.*	**.*	**.*	**%	**.*%	**.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
Europe	*.*	*.*	*.*	*.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	*.*%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
N. Asia	*.*	*.*	*.*	*.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%

Note: No vision scenario for LP types the current scenario is used for both scenarios

8.2 RPOs

This section provides RPO market demand in kMT.

8.2.1 Total Demand All Types

8.2.1.1 Global Demand

Global ****** for *** types ** presented ** **Table *.****. **** ****** is ********* at **** kMT. CAGR *** the **/** period ******* scenario ** estimated ** *.*% (****/5* *.*%, 2025/**: 2.*%), this reduces **** successive *** year *******. The ****** scenario ***** reductions ** all *** year *******, the ********** becoming ****** post ****, vision ***** ****/*: 1.*%, 2025/**: -*.7%.

Table 8.21 - Total Market Demand for All Types by Scenario 2015 to 2050

kMT								Δ	CAGR			
Scenario	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
Current	****	****	****	****	****	****	****	*%	*.*%	*.*%	*.*%	*.*%
Vision	****	****	****	****	****	***	***	*%	*.*%	**.4%	**.2%	**.6%

8.2.1.2 Regional Demand

Regional market demand for all RPO groups for the current scenario are presented in **Table 8.22.**

*** * ** **** ****** (***): China ****.8* > *. Asia ****.1* > ****** (***.2)

*** * ** **/** growth (***): China ****.8* > *. Asia ***.8* > ****** (**.6)

*** * ** **/** CAGR (%):*India (*.7) * China **.4* > ****** (*.9)

Table 8.22 - Regional Market Demand for All RPO Types using Current Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	**.*	*.*	*.*	**.*	**.*	**.*	**.*	*%	**.4%	*.*%	*.*%	*.*%
China	***.*	***.*	***.*	***.*	***.*	****	****	*%	*.*%	*.*%	*.*%	*.*%
CIS	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.0%	*.*%	*.*%	**.1%
Europe	***.*	***.*	***.*	***.*	***.*	***.*	***.*	**%	**.1%	*.*%	*.*%	*.*%
India	**.*	**.*	**.*	**.*	**.*	**.*	***.*	**%	*.*%	*.*%	*.*%	*.*%
M. East	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.3%	*.*%	*.*%	*.*%
USMCA	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.9%	*.*%	*.*%	*.*%
N. Asia	***.*	***.*	***.*	***.*	***.*	***.*	***.*	*%	**.3%	*.*%	*.*%	*.*%
S. Am.	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.1%	*.*%	*.*%	*.*%
S. Asia	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.2%	*.*%	*.*%	*.*%

Regional market demand for all RPO groups for the vision scenario are presented in **Table 8.23.**

*** * ** **** ****** (***): China ****.8* > *. Asia ****.1* > ****** (***.2)

*** * ** **/** growth (***): China ****.4* > ***** (*.6)

*** * ** **/** CAGR (%):*India (*.2) * China **.1* > *. Asia ***.7*

Table 8.23 - Regional Market Demand for All RPO Types using Vision Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	**.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.4%	**.5%	***%	**.1%
China	***.*	***.*	***.*	***.*	***.*	***.*	***.*	*%	*.*%	*.*%	**.2%	**.2%
CIS	**.*	**.*	**.*	**.*	**.*	*.*	*.*	*%	**.0%	**.3%	**.4%	**.5%
Europe	***.*	***.*	***.*	***.*	***.*	**.*	**.*	**%	**.1%	**.3%	**.7%	**.5%
India	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	**.0%	**.9%
M. East	**.*	**.*	**.*	**.*	**.*	*.*	*.*	*%	**.3%	**.1%	***%	**.2%
USMCA	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.9%	**.4%	**.5%	**.6%
N. Asia	***.*	***.*	***.*	***.*	***.*	***.*	**.*	*%	**.3%	**.7%	**.3%	**.2%
S. Am.	**.*	**.*	**.*	**.*	**.*	*.*	*.*	*%	**.1%	**.8%	***%	***%
S. Asia	**.*	**.*	**.*	**.*	**.*	*.*	*.*	*%	**.2%	**.7%	**.9%	**.2%

8.2.2 Demand by RPO Type

This section provides totals by RPO type.

8.2.2.1 Global

Global market demand by RPO type for the current scenario is presented in **Table 8.24**.

*** * ** **** ****** (***): TDAE ****.3* > *** (***.5) * HN ****.7*

*** * ** **/** growth (***): TDAE ****.1* > *** (***.1) * MES ***.5*

*** * ** **/** CAGR (%):*RAE (*.8) * TDAE **.2* > ** (*.9)

Table 8.24 - Global Market Demand by RPO Type using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
RPO Type	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
DAE	***.*	***.*	***.*	***.*	**.*	**.*	**.*	**%	**.6%	***%	*.*%	*.*%
MES	**.*	***.*	***.*	***.*	***.*	***.*	***.*	*%	*.*%	*.*%	*.*%	*.*%
HN	***.*	***.*	***.*	***.*	***.*	***.*	***.*	*%	**.8%	*.*%	*.*%	*.*%
PAR	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.6%	*.*%	*.*%	*.*%
RAE	***.*	***.*	***.*	***.*	***.*	***.*	***.*	**%	*.*%	*.*%	*.*%	*.*%
TDAE	***.*	***.*	***.*	***.*	***.*	****	****	**%	*.*%	*.*%	*.*%	*.*%
VO	**.*	**.*	**.*	**.*	**.*	**.*	***.*	**%	*.*%	*.*%	*.*%	*.*%

Global market demand by RPO type for the vision scenario is presented in **Table 8.25**.

*** * ** **** ****** (***): TDAE ****.3* > *** (***.5) * HN ****.7*

*** * ** **/** growth (***): TDAE ****.9* > *** (**.0) * VO ***.1*

*** * ** **/** CAGR (%):*RAE (*) > VO **) > **** (*)

Table 8.25 - Global Market Demand by RPO Type using Vision Scenario 2015 to 2050

kMT								Δ	CAGR			
RPO Type	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
DAE	***.*	***.*	***.*	***.*	**.*	*.*	*.*	**%	**%	***%	**%	***%
MES	**.*	***.*	***.*	***.*	**.*	**.*	*.*	*%	*%	**%	***%	***%
HN	***.*	***.*	***.*	***.*	***.*	**.*	*.*	*%	**%	**%	***%	***%
PAR	**.*	**.*	**.*	**.*	**.*	*.*	*.*	*%	**%	**%	***%	***%
RAE	***.*	***.*	***.*	***.*	***.*	***.*	**.*	**%	*%	*%	**%	**%
TDAE	***.*	***.*	***.*	***.*	***.*	***.*	***.*	**%	*%	*%	**%	***%
VO	**.*	**.*	**.*	**.*	**.*	**.*	***.*	**%	*%	*%	*%	*%

8.2.2.2 Regional

Regional market demand for DAE types for the current scenario is presented in **Table 8.26**.

*** * ** **** ****** (***): China ****.4* > *. Asia ***.2* > ***** (**.0)

*** * ** **/** growth (***): S. Am. (*.3) * USMCA **.1*

*** * ** **/** CAGR (%):*S. Am. (*.8) * USMCA **.2*

Table 8.26 - Regional Market Demand for DAE Types using Current Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	***%	***%	**.7%	**.1%	*.*%
China	***.*	***.*	***.*	***.*	**.*	**.*	**.*	**%	*.*%	***%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	***%	***%	***%	*.*%	*.*%
Europe	*.*	*.*	*.*	*	*	*	*	***%	***%	*.*%	*.*%	*.*%
India	**.*	**.*	**.*	*.*	*.*	*.*	*.*	**%	**.6%	***%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	***%	***%	***%	*.*%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.4%	*.*%	*.*%	*.*%
N. Asia	*.*	*.*	*.*	*	*	*	*	***%	***%	*.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	***%	*.*%	*.*%	*.*%
S. Asia	**.*	**.*	**.*	*.*	*.*	*.*	*.*	**%	**.2%	***%	*.*%	*.*%

Regional market demand for DAE types for the vision scenario is presented in **Table 8.27**.

*** * ** **** ****** (***): China ****.4* > *. Asia ***.2* > ***** (**.0)

*** * ** **/** growth (***): No ******

*** * ** **/** CAGR (%):*All negative *****

Table 8.27 - Regional Market Demand for DAE Types using Vision Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	***%	***%	***%	***%	*%
China	***.*	***.*	***.*	***.*	*.*	*.*	*.*	**%	*%	***%	**%	***%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	***%	***%	***%	***%	*%
Europe	*.*	*.*	*.*	*	*	*	*	***%	***%	*	*	*
India	**.*	**.*	**.*	*.*	*.*	*.*	*.*	**%	**%	***%	**%	***%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	***%	***%	***%	***%	*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**%	**%	**%	**%
N. Asia	*.*	*.*	*.*	*	*	*	*	***%	***%	*	*	*
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	***%	**%	***%	*%
S. Asia	**.*	**.*	**.*	*.*	*.*	*.*	*.*	**%	**%	***%	***%	***%

Regional market demand for MES types for the current scenario is presented in **Table 8.28**.

*** * ** **** ****** (***): Europe ***.0* > ***** (**.4) * N. Asia ***.5*

*** * ** **/** growth (***): China ***.5* > ****** (**.3) * N. Asia **.7*

*** * ** **/** CAGR (%):*S. Asia **.8* > *. Am. (*.2) * China **.6*

Table 8.28 - Regional Market Demand for MES Types using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
China	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.*%	*.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.2%	*.*%	**.4%	**.8%
Europe	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	**.0%	*.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.1%	*.*%	*.*%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.8%	*.*%	**.7%	*.*%
N. Asia	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.1%	*.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.*%	*.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%

Regional market demand for MES types for the vision scenario is presented in **Table 8.29**.

*** * ** **** ****** (***): Europe ***.0* > ***** (**.4) * N. Asia ***.5*

*** * ** **/** growth (***): China **.8*

*** * ** **/** CAGR (%):*China (*) > S. Asia **)

Table 8.29 - Regional Market Demand for MES Types using Vision Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
China	**.*	**.*	**.*	**.*	**.*	**.*	*.*	*%	**%	*%	**%	***%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**%	**%	***%	*%
Europe	**.*	**.*	**.*	**.*	**.*	*.*	*.*	**%	**%	**%	***%	*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**%	**%	***%	*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**%	**%	***%	***%
N. Asia	**.*	**.*	**.*	**.*	**.*	*.*	*.*	*%	*%	**%	***%	***%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**%	**%	**%	***%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*%	*%	***%	***%

Regional market demand for HN types for the current scenario is presented in **Table 8.30**.

*** * ** **** ****** (***): USMCA ***.3* > *. Asia ***.4* > ****** (**.1)

*** * ** **/** growth (***): Europe ***.3* > ***** (**.9) * N. Asia ***.1*

*** * ** **/** CAGR (%):*China (*.8) * Europe **.5* > *. Asia * India **.8*

Table 8.30 - Regional Market Demand for HN Types using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
China	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	*.*%	*.*%	*.*%	*.*%
CIS	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.1%	*.*%	*.*%	**.3%
Europe	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	**.3%	*.*%	*.*%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.6%	*.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*.*%	*.*%	*.*%	*.*%
USMCA	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.5%	*.*%	*.*%	*.*%
N. Asia	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	*.*%	*.*%	*.*%	*.*%
S. Am.	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.2%	*.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.8%	*.*%	*.*%	*.*%

Regional market demand for HN types for the vision scenario is presented in **Table 8.31**.

*** * ** **** ****** (***): USMCA ***.3* > *. Asia ***.4* > ****** (**.1)

*** * ** **/** growth (***): China **.2*

*** * ** **/** CAGR (%):*China (*) > India **) > *. Asia ***)

Table 8.31 - Regional Market Demand for HN Types using Vision Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*%	**%	***%	*%
China	**.*	**.*	**.*	**.*	**.*	*.*	*.*	*%	**%	*%	**%	***%
CIS	**.*	**.*	**.*	*.*	*.*	*.*	*.*	*%	**%	**%	***%	*%
Europe	**.*	**.*	**.*	**.*	**.*	*.*	*.*	**%	*%	**%	***%	***%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**%	*%	**%	***%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*%	**%	***%	*%
USMCA	**.*	**.*	**.*	**.*	**.*	*.*	*.*	*%	**%	**%	***%	***%
N. Asia	**.*	**.*	**.*	**.*	**.*	*.*	*.*	*%	*%	**%	***%	***%
S. Am.	**.*	**.*	**.*	**.*	*.*	*.*	*.*	*%	**%	**%	***%	***%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**%	**%	***%	***%

Regional market demand for PAR types for the current scenario is presented in **Table 8.32**.

*** * ** **** ****** (***): N. Asia ***.5* > ****** (**.1) * S. Am. (*.0)

*** * ** **/** growth (***): N. Asia **.2* > ****** = *. Am. (*.8)

*** * ** **/** CAGR (%):*S. Am. (*.8) * Europe * N. Asia **.7*

Table 8.32 - Regional Market Demand for PAR Types using Current Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
Europe	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	**.7%	*.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.1%	*.*%	*.*%	*.*%
N. Asia	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.2%	*.*%	*.*%	*.*%
S. Am.	**.*	*.*	*.*	*.*	**.*	**.*	**.*	**%	**.1%	*.*%	*.*%	*.*%

Regional market demand for PAR types for the current scenario is presented in **Table 8.33**.

*** * ** **** ****** (***): N. Asia ***.5* > ****** (**.1) * S. Am. (*.0)

*** * ** **/** growth (***): No ******.

*** * ** **/** CAGR (%):*N. Asia ***) > ****** = *. East * S. Am ***)

Table 8.33 - Regional Market Demand for PAR Types using Vision Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
Europe	**.*	**.*	**.*	*.*	*.*	*.*	*.*	**%	**%	**%	***%	*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**%	**%	***%	*%
N. Asia	**.*	**.*	**.*	**.*	*.*	*.*	*.*	*%	*%	**%	***%	***%
S. Am.	**.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**%	**%	***%	*%

Regional market demand for RAE types for the current scenario is presented in **Table 8.34**.

*** * ** **** ****** (***): China ***.5* > *. Asia ***.7* > ***** (*.3)

*** * ** **/** growth (***): China ****.5* > *. Asia ***.0* > ***** (*.2)

*** * ** **/** CAGR (%):*China (**.4) * India * S. Asia **.0*

Table 8.34 - Regional Market Demand for RAE Types using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.1%	*.*%	*.*%	*.*%
China	**.*	**.*	**.*	***.*	***.*	***.*	***.*	**%	*.*%	**.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.2%	*.*%	*.*%	*.*%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.0%	**.1%	*.*%	*.*%
India	*.*	*.*	*.*	*.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**.9%	*.*%	*.*%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	***%	**.5%	**.3%	**.5%
N. Asia	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.3%	*.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.9%	*.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%

Regional market demand for RAE types for the vision scenario is presented in **Table 8.35**.

*** * ** **** ****** (***): China ***.5* > *. Asia ***.7* > ***** (*.3)

*** * ** **/** growth (***): China ****.5* > *. Asia ***.0* > ***** (*.2)

*** * ** **/** CAGR (%):*China (**.4) * India * S. Asia **.0*

Table 8.35 - Regional Market Demand for RAE Types using Vision Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**%	**%	**%	**%
China	**.*	**.*	**.*	***.*	***.*	**.*	**.*	**%	*%	**%	**%	**%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**%	**%	**%	**%
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**%	**%	**%	**%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*%	*%	**%	**%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	**%	**%	**%	**%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	***%	**%	***%	***%
N. Asia	**.*	**.*	**.*	**.*	**.*	**.*	*.*	*%	*%	**%	**%	***%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**%	**%	***%	***%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*%	*%	**%	***%

Regional market demand for TDAE types for the current scenario is presented in **Table 8.36**.

*** * ** **** ****** (***): China ****.3* > *. Asia ****.5* > ****** (**.0)

*** * ** **/** growth (***): China ****.8* > *. Asia ***.2* > ***** (**.2)

*** * ** **/** CAGR (%):*India (**.2) * China ***.5* > *. Asia **.1*

Table 8.36 - Regional Market Demand for TDAE Types using Current Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	**.*	**.*	*%	*.*%	*.*%	*.*%	*.*%
China	***.*	***.*	***.*	***.*	***.*	***.*	***.*	**%	*.*%	**.*%	*.*%	*.*%
CIS	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	**.8%	*.*%	*.*%	*.*%
Europe	***.*	**.*	***.*	***.*	***.*	***.*	***.*	**%	**.3%	*.*%	*.*%	*.*%
India	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	**.*%	*.*%	*.*%
M. East	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
USMCA	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	**.6%	*.*%	**.3%	**.4%
N. Asia	***.*	***.*	***.*	***.*	***.*	***.*	***.*	*%	**.2%	*.*%	*.*%	*.*%
S. Am.	**.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.0%	*.*%	*.*%	*.*%
S. Asia	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%

Regional market demand for TDAE types for the vision scenario is presented in **Table 8.37**.

*** * ** **** ****** (***): China ****.3* > *. Asia ****.5* > ****** (**.0)

*** * ** **/** growth (***): China ****.6* > ***** (**.3) * S. Asia **.6*

*** * ** **/** CAGR (%):*India (*) > China **) > *. Asia **)

Table 8.37 - Regional Market Demand for TDAE Types using Vision Scenario 2015 to 2050

kMT								Δ		CAGR		
Region	2015	2020	2021	2025	2030	2040	2050	20/21	15/20	20/30	30/40	40/50
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*%	*%	**%	***%	***%
China	***.*	***.*	***.*	***.*	***.*	***.*	**.*	**%	**%	*%	**%	***%
CIS	**.*	**.*	**.*	**.*	*.*	*.*	*.*	**%	**%	**%	***%	***%
Europe	***.*	**.*	***.*	**.*	**.*	**.*	**.*	**%	**%	**%	**%	**%
India	**.*	**.*	**.*	**.*	**.*	**.*	*.*	**%	*%	*%	**%	***%
M. East	**.*	**.*	**.*	**.*	**.*	*.*	*.*	**%	*%	**%	***%	***%
USMCA	**.*	**.*	**.*	**.*	**.*	*.*	*.*	**%	**%	**%	**%	**%
N. Asia	***.*	***.*	***.*	***.*	***.*	**.*	**.*	*%	**%	**%	**%	***%
S. Am.	**.*	**.*	**.*	*.*	*.*	*.*	*.*	*%	**%	**%	***%	***%
S. Asia	**.*	**.*	**.*	**.*	**.*	*.*	*.*	**%	*%	*%	***%	***%

Regional market demand for VO types for the current scenario is presented in **Table 8.38**.

*** * ** **** ****** (***): China ***.3* > *. Asia ***.9* > ****** (**.4)

*** * ** **/** growth (***): China **.8* > *. Asia **.2* > ****** (*.1)

*** * ** **/** CAGR (%):*Africa (**.1) * USMCA **.8* > ***** (*.1)

Table 8.38 - Regional Market Demand for VO Types using Current Scenario 2015 to 2050

kMT								Δ	CAGR			
Region	**2015**	**2020**	**2021**	**2025**	**2030**	**2040**	**2050**	**20/21**	**15/20**	**20/30**	**30/40**	**40/50**
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	**.*%	*.*%	*.*%
China	*.*	**.*	**.*	**.*	**.*	**.*	**.*	*%	**.*%	*.*%	*.*%	*.*%
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.3%	*.*%	*.*%	*.*%
Europe	*.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	*.*%	*.*%	*.*%	*.*%
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
N. Asia	**.*	**.*	**.*	**.*	**.*	**.*	**.*	**%	*.*%	*.*%	*.*%	*.*%
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.1%	*.*%	*.*%	*.*%
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	**%	**.*%	*.*%	*.*%	*.*%

Note: No vision scenario for VO types the current scenario is used for both scenarios.

9 MARKET PRICES & MARKET VALUES

This section looks at TPR and RPO average market prices and uses this information to generate regional and global market values. Prices are average delivered prices in USD/MT. Values are in millions of USD (MM$).

9.1 MARKET PRICES

9.1.1 TPRs by Region

Historic regional delivered market prices were obtained from a range of confidential sources. Market pricing is dependent upon region, volume usage and specific resin type and manufacturer, therefore these prices should be considered as directional only.

Pricing is indicative of TPR types modified for enhanced performance, the average pricing of the full range of TPR types may be lower. Historic 2017/18 baseline pricing was used to adjust 2019/20 figures using manufacturer's financial reporting and RCCL estimates.

9.1.1.1 APAC

Table *.* presents ******* pricing ** TPR **** for ****. ***** ***** have ****** differentiated ******* followed ** **** ******** *** **** which **** similar ******* levels.

Table 9.1 - Average 2017 to 2020 Prices by TPR Type for APAC

TPR Type	Price, USD/MT			
	2017	2018	2019	2020
AMS	****	****	****	****
C5	****	****	****	****
C5C9	****	****	****	****
C9	****	****	****	****
HDCPD	****	****	****	****
LP	****	****	****	****
LP STY	****	****	****	****
TP	****	****	****	****

9.1.1.2 EMEA

Table *.* presents *** average ******* by *** type *** Europe. ***** ***** have ****** differentiated ******* followed ** ****** ****** *** then ****** types.

Table 9.2 - Average 2017 to 2020 Prices by TPR for EMEA

TPR Type	Price, USD/MT			
	2017	2018	2019	2020
AMS	****	****	****	****
C5	****	****	****	****
C5C9	****	****	****	****
C9	****	****	****	****
HDCPD	****	****	****	****
LP	*****	*****	*****	****
LP STY	*****	*****	*****	****
Terpene	****	****	****	****

9.1.1.3 USMCA

Table *.* presents *** average ******* by *** type *** USMCA. ***** ****** have ****** differentiated ******* followed ** ****** ****** *** then *** types.

Table 9.3 - Average 2017 to 2020 Prices by TPR Type for USMCA

TPR Type	Price, USD/MT			
	2017	2018	2019	2020
AMS	****	****	****	****
C5	****	****	****	****
C5C9	****	****	****	***
C9	****	****	****	****
HDCPD	****	****	****	****
LP	*****	*****	*****	****
LP STY	*****	*****	*****	****
Terpene	****	****	****	****

9.1.2 RPOs by Region

Historic regional delivered market prices were obtained from a range of confidential sources. Market pricing is dependent upon region, volume usage and specific RPO type and manufacturer, therefore these prices should be considered as directional only.

Historic 2017/18 baseline pricing was used to adjust 2019/20 figures using: WTI oil pricing for DAE, TDAE, HN and RAE; changing Group II base oil pricing for MES and PAR; various oil crop indices for VO.

9.1.2.1 APAC

Table *.* presents ******* pricing ** RPO **** for ****. ***** *** **** the ******* pricing ******** by *** and **** types.

Table 9.4 - Average 2017 to 2020 Prices by RPO Type for APAC

TPR Type	Price, USD/MT			
	2017	2018	2019	2020
DAE	***	****	***	****
TDAE	****	****	****	****
HN	****	****	****	****
MES	****	****	****	*****
PAR	****	****	****	*****
RAE	***	****	****	****
VO	*****	*****	*****	*****

9.1.2.2 EMEA

Table *.* presents ******* pricing ** RPO **** for ****. ***** ******* the ******* pricing ******** by **** and ***.

Table 9.5 - Average 2017 to 2020 Prices by RPO Type for EMEA

TPR Type	Price, USD/MT			
	2017	2018	2019	2020
TDAE	****	****	****	****
HN	***	****	****	****
MES	***	****	****	****
PAR	****	****	****	*****
RAE	****	****	****	****
VO	****	*****	*****	*****

9.1.2.3 USMCA

Table *.* presents ******* pricing ** RPO **** for *****. ** *** **** the ******* pricing ******** by ***.

Table 9.6 - Average 2017 to 2020 Prices by RPO Type for USMCA

TPR Type	Price, USD/MT			
	2017	2018	2019	2020
DAE	***	****	****	****
TDAE	****	****	****	****
HN	***	****	***	****
MES	****	****	****	****
PAR	****	****	****	*****
RAE	****	****	****	*****
VO	*****	*****	*****	*****

9.2 MARKET VALUES

This section uses the average market prices from **Section 9.1** to generate regional and global market values. The average pricing from the three regions was assigned to the appropriate market volume regions (e.g. APAC pricing was assigned to China, India, North Asia and South Asia).

Note: 2030, 2040 and 2050 values use the estimated volumes for the respective year and the **unadjusted** 2019 average market price (i.e. not inflation adjusted). The 2019 price has been used as it is considered more reflective of future pricing. 2020 market values use the 2020 market price.

All values are presented in millions (MM) of United State dollars ($).

9.2.1 TPRs

This section presents market values for TPR types.

9.2.1.1 Market Values for All TPR Types

Total ****** value *** all *** types ** presented ** **Table *.***. The **** market ***** was ********* to ** $*** MM, ***** the ******* scenario **** is ******** to ******** to **** by ****.

Table 9.7 - Global Market Value All TPR Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
	2020	2030	2040	2050	2020	2030	2040	2050
Global	***	***	****	****	***	***	***	***

Global market value by region for all TPR types is presented in **Table 9.8**.

Top 3 region ranking for current scenario:

**** ******: Europe ****) > ***** (**) > N. Asia ***)

**** ******: China ****) > ****** (***) > N. Asia ****)

Top 3 region ranking for vision scenario:

**** demand* China ****) > ****** (***) > N. Asia ****)

Table 9.8 - Regional Market Value All TPR Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	**	***	***	***	**	***	***	***
CIS	**	**	**	**	**	**	**	**
Europe	***	***	***	***	***	***	***	***
India	*	**	**	**	*	**	*	*
M. East	*	**	**	**	*	*	*	*
USMCA	**	**	***	***	**	**	**	***
N. Asia	**	***	***	***	**	***	***	***
S. Am.	*	**	**	**	*	**	**	**
S. Asia	*	**	**	**	*	*	*	*

9.2.1.2 Market Values by TPR Type

Regional market values by TPR type are presented in **Table 9.9.**

Top 3 region ranking for current scenario:

**** ******: AMS ****) > ******* (**) > LP ***)

**** ******: LP ****) > *** (***) > Terpene ****)

Top 3 region ranking for vision scenario:

**** demand* LP ****) > ******* (***) > AMS ****)

Table 9.9 – Global Market Value by TPR Type 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
TPR Type	2020	2030	2040	2050	2020	2030	2040	2050
AMS	***	***	***	***	***	***	**	**
C5	**	**	**	***	**	**	**	*
C9	**	**	**	**	**	**	**	**
C5C9	*	*	*	*	*	*	*	*
H-DCPD	**	***	***	***	**	**	**	*
Terpene	**	***	***	***	**	***	***	***
LP	**	***	***	***	**	***	***	***
LP STY	**	**	**	**	**	**	**	*

Regional market values for AMS types are presented in **Table 9.10.**

Top 3 region ranking for current scenario:

**** ******: Europe ***) > ***** (**) > N. Asia ***)

**** ******: China ***) > *. Asia ***) > ****** (**)

Top 3 region ranking for vision scenario:

**** demand* China ***) > *. Asia ***) > ****** (**)

Table 9.10 - Regional Market Value for AMS Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	**	**	**	***	**	**	**	**
CIS	*	*	*	*	*	*	*	*
Europe	**	**	**	**	**	**	*	*
India	*	*	*	*	*	*	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	**	**	**	**	**	**	*	*
N. Asia	**	**	**	**	**	**	**	*
S. Am.	*	*	*	*	*	*	*	*
S. Asia	*	*	*	*	*	*	*	*

Regional market values for C5 types are presented in **Table 9.11.**

Top 3 region ranking for current scenario:

**** ******: Europe ***) > ***** (**) > N. Asia **)

**** ******: China ***) > ****** (**) > N. Asia ***)

Top 3 region ranking for vision scenario:

**** demand* China ***) > ****** (**) > N. Asia **)

Table 9.11 - Regional Market Value for C5 Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	**	**	**	**	**	**	*	*
CIS	*	*	*	*	*	*	*	*
Europe	**	**	**	**	**	**	*	*
India	*	*	*	*	*	*	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	*	*	*	*	*	*	*	*
N. Asia	*	**	**	**	*	*	*	*
S. Am.	*	*	*	*	*	*	*	*
S. Asia	*	*	*	*	*	*	*	*

Regional market values for C9 types are presented in **Table 9.12.**

Top 3 region ranking for current scenario:

**** ******: Europe **) > ***** (*) > N. Asia **)

**** ******: China ***) > ****** (**) > N. Asia **)

Top 3 region ranking for vision scenario:

**** demand* China ***) > ****** (*) > N. Asia **)

Table 9.12 - Regional Market Value for C9 Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	*	**	**	**	*	**	**	*
CIS	*	*	*	*	*	*	*	*
Europe	*	**	**	**	*	*	*	*
India	*	*	*	*	*	*	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	*	*	*	*	*	*	*	*
N. Asia	*	*	*	*	*	*	*	*
S. Am.	*	*	*	*	*	*	*	*
S. Asia	*	*	*	*	*	*	*	*

Regional market values for C5C9 types are presented in **Table 9.13.**

Top 3 region ranking for current scenario:

**** ******: USMCA **.6* > *. Asia * China **.4*

**** ******: USMCA **.9* > ***** (*.7) * N. Asia * Europe **.6*

Top 3 region ranking for vision scenario:

**** demand* China **.6* > ***** (*.4) * N. Asia * Europe **.3*

Table 9.13 - Regional Market Value for C5C9 Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
China	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
N. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*

Regional market values for H-DCPD types are presented in **Table 9.14.**

Top 3 region ranking for current scenario:

**** ******: N. Asia ***) > ***** (**) > Europe ***)

**** ******: China ***) > *. Asia ***) > ****** (**)

Top 3 region ranking for vision scenario:

**** demand* China ***) > *. Asia ***) > ****** (**)

Table 9.14 - Regional Market Value for H-DCPD Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	**	**	**	**	**	**	**	*
CIS	*	*	*	*	*	*	*	*
Europe	**	**	**	**	**	**	*	*
India	*	*	*	*	*	*	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	*	**	**	*	*	*	*	*
N. Asia	**	**	**	**	**	**	*	*
S. Am.	*	*	*	*	*	*	*	*
S. Asia	*	*	*	*	*	*	*	*

Regional market values for TP types are presented in **Table 9.15.**

Top 3 region ranking for current scenario:

**** ******: Europe ***) > *. Asia ***) > ***** (**)

**** ******: Europe ***) > ***** (**) > N. Asia ***)

Top 3 region ranking for vision scenario:

Current scenario also used for vision scenario.

Table 9.15 - Regional Market Value for TP Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	**	**	**	**	**	**	**	**
CIS	*	*	*	*	*	*	*	*
Europe	**	**	**	**	**	**	**	**
India	*	*	*	*	*	*	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	**	**	**	**	**	**	**	**
N. Asia	**	**	**	**	**	**	**	**
S. Am.	*	*	*	*	*	*	*	*
S. Asia	*	*	*	*	*	*	*	*

Regional market values for LP types are presented in **Table 9.16.**

Top 3 region ranking for current scenario:

**** ******: Europe ***) > ***** (**) > N. Asia **)

**** ******: Europe ***) > ***** (**) > N. Asia ***)

Top 3 region ranking for vision scenario:

Current scenario also used for vision scenario.

Table 9.16 - Regional Market Value for LP Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	**	**	***	***	**	**	***	***
CIS	*	**	**	**	*	**	**	**
Europe	**	**	***	***	**	**	***	***
India	*	*	*	*	*	*	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	*	**	**	**	*	**	**	**
N. Asia	*	**	***	***	*	**	***	***
S. Am.	*	*	*	**	*	*	*	**
S. Asia	*	*	*	*	*	*	*	*

Regional market values for LP STY types are presented in **Table 9.17.**

Top 3 region ranking for current scenario:

**** ******: N. Asia **.5* > ****** (*.2) * China **.6*

**** ******: China **.0* > *. Asia **.4* > ****** (*.7)

Top 3 region ranking for vision scenario:

**** ******: China **.9* > *. Asia **.1* > ****** (*.3)

Table 9.17 - Reginal Market Value for LP STY Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
China	*.*	*.*	*.*	**.*	*.*	*.*	*.*	*.*
CIS	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
Europe	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
India	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
M. East	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
USMCA	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
N. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
S. Am.	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*
S. Asia	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*

9.2.2 RPOs

This section presents market values for RPO types.

9.2.2.1 Market Value for All RPO Types

Total ****** value *** all *** types ** presented ** **Table *.****. The **** market ***** was ********* to ** $**** MM, ***** the ******* scenario **** is ******** to ******** to ***** by ****.

Table 9.18 - Global Market Value for All RPO Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
	2020	2030	2040	2050	2020	2030	2040	2050
Global	****	****	****	****	****	****	***	***

Global market value by region for all RPO types is presented in **Table 9.19**.

Top 3 region ranking for current scenario:

**** ******: China ****) > *. Asia ****) > ****** (***)

**** ******: China ****) > *. Asia ****) > ****** (***)

Top 3 region ranking for vision scenario:

**** demand* China ****) > *. Asia ****) > ****** (***)

Table 9.19 - Regional Market Value for All RPO Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	**	**	**	*	*	*	*
China	***	***	****	****	***	***	***	***
CIS	**	**	**	**	**	**	**	*
Europe	***	***	***	***	***	***	**	**
India	**	**	***	***	**	**	**	**
M. East	**	**	**	**	**	**	*	*
USMCA	**	**	**	**	**	**	**	**
N. Asia	***	***	***	***	***	***	***	**
S. Am.	**	**	**	**	**	**	**	*
S. Asia	**	**	**	**	**	**	**	*

9.2.2.2 Market Value by RPO Type

Regional market values by RPO type are presented in **Table 9.20.**

Top 3 region ranking for current scenario:

**** ******: TDAE ****) > *** (***) > NH ****)

**** ******: TDAE *****) > *** (***) > HN ****)

Top 3 region ranking for vision scenario:

**** demand* TDAE ****) > *** (***) > VO ****)

Table 9.20 - Global Market Value by RPO Type 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
TPR Type	2020	2030	2040	2050	2020	2030	2040	2050
DAE	***	**	**	**	***	**	*	*
TDAE	***	****	****	****	***	***	***	***
HN	***	***	***	***	***	***	**	*
MES	**	***	***	***	**	***	**	*
PAR	**	**	***	***	**	**	**	*
RAE	**	***	***	***	**	***	***	**
VO	**	***	***	***	**	***	***	***

Regional market values by DAE types are presented in **Table 9.21.**

Top 3 region ranking for current scenario:

**** ******: China ****) > *. Asia ***) > ***** (**)

**** ******: China ***) > ***** (*) > S. Am. = *. Asia **)

Top 3 region ranking for vision scenario:

**** demand* China **) > ***** (*) > S. Am. = *. Asia **)

Table 9.21 - Regional Market Value for DAE Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	***	**	**	**	***	*	*	*
CIS	*	*	*	*	*	*	*	*
Europe	*	*	*	*	*	*	*	*
India	**	*	*	*	**	*	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	*	*	*	*	*	*	*	*
N. Asia	*	*	*	*	*	*	*	*
S. Am.	*	*	*	*	*	*	*	*
S. Asia	**	*	*	*	**	*	*	*

Regional market values by TDAE types are presented in **Table 9.22.**

Top 3 region ranking for current scenario:

**** ******: China ****) > *. Asia ****) > ****** (**)

**** ******: China ****) > *. Asia ****) > ****** (***)

Top 3 region ranking for vision scenario:

**** ******: China ****) > *. Asia ****) > ****** (**)

Table 9.22 - Regional Market Value for TDAE Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	**	**	**	*	*	*	*
China	***	***	***	***	***	***	***	**
CIS	**	**	**	**	**	**	*	*
Europe	**	***	***	***	**	**	**	**
India	**	**	**	***	**	**	**	*
M. East	**	**	**	**	**	**	*	*
USMCA	**	**	**	**	**	**	*	*
N. Asia	***	***	***	***	***	***	**	**
S. Am.	*	**	**	**	*	*	*	*
S. Asia	**	**	**	**	**	**	*	*

Regional market values by HN types are presented in **Table 9.23.**

Top 3 region ranking for current scenario:

**** ******: N. Asia ***) > ****** (**) > USMCA ***)

**** ******: N. Asia ***) > ****** (**) > China ***)

Top 3 region ranking for vision scenario:

**** ******: N. Asia ***) > ***** (**) > Europe ***)

Table 9.23 - Regional Market Value for HN Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	**	**	**	**	**	**	**	*
CIS	*	**	**	**	*	*	*	*
Europe	**	**	**	**	**	**	*	*
India	*	*	*	*	*	*	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	**	**	**	**	**	**	*	*
N. Asia	**	**	**	**	**	**	**	*
S. Am.	**	**	**	**	**	*	*	*
S. Asia	*	*	*	*	*	*	*	*

Regional market values by MES types are presented in **Table 9.24.**

Top 3 region ranking for current scenario:

**** ******: China ***) > *. Asia ***) > ****** (**)

**** ******: China ***) > ****** (**) > N. Asia ***)

Top 3 region ranking for vision scenario:

**** ******: China ***) > *. Asia ***) > ****** (**)

Table 9.24 - Regional Market Value for MES Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	**	**	**	***	**	**	**	*
CIS	*	*	*	*	*	*	*	*
Europe	**	**	**	**	**	**	*	*
India	*	*	*	*	*	*	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	*	*	*	*	*	*	*	*
N. Asia	**	**	**	**	**	**	*	*
S. Am.	*	*	*	*	*	*	*	*
S. Asia	*	*	*	*	*	*	*	*

Regional market values by PAR types are presented in **Table 9.25.**

Top 3 region ranking for current scenario:

**** ******: N. Asia ***) > ****** (**) > S. Am. (**)

**** ******: N. Asia ***) > ****** (**) > S. Am. (**)

Top 3 region ranking for vision scenario:

**** ******: N. Asia ***) > ****** (**) > S. Am. (**)

Table 9.25 - Regional Market Value for PAR Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	*	*	*	*	*	*	*	*
CIS	*	*	*	*	*	*	*	*
Europe	**	**	**	**	**	**	*	*
India	*	*	*	*	*	*	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	*	*	*	*	*	*	*	*
N. Asia	**	**	**	**	**	**	*	*
S. Am.	**	**	**	**	**	**	*	*
S. Asia	*	*	*	*	*	*	*	*

Regional market values by RAE types are presented in **Table 9.26.**

Top 3 region ranking for current scenario:

**** ******: China ***) > *. Asia ***) > ****** = ***** (*)

**** ******: China ****) > *. Asia ***) > ***** (**)

Top * region ******* for ****** scenario*

**** ******: China ****) > *. Asia ***) > ***** (**)

Table 9.26 - Regional Market Value for RAE Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	**	***	***	***	**	***	**	**
CIS	*	*	*	*	*	*	*	*
Europe	*	*	*	*	*	*	*	*
India	*	**	**	**	*	**	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	*	*	*	*	*	*	*	*
N. Asia	**	**	**	**	**	**	**	*
S. Am.	*	*	*	*	*	*	*	*
S. Asia	*	**	**	**	*	*	*	*

Regional market values by VO types are presented in **Table 9.27.**

Top 3 region ranking for current scenario:

**** ******: China ***) > *. Asia ***) > ****** (**)

**** ******: China ***) > *. Asia ***) > ****** (**)

Top 3 region ranking for vision scenario:

The current scenario is also used for the vision scenario for VO.

Table 9.27 - Regional Market Value for VO Types 2020/30/40/50

MM$	Current Scenario				Vision Scenario			
Region	2020	2030	2040	2050	2020	2030	2040	2050
Africa	*	*	*	*	*	*	*	*
China	**	**	**	**	**	**	**	**
CIS	*	*	*	*	*	*	*	*
Europe	**	**	**	**	**	**	**	**
India	*	*	*	*	*	*	*	*
M. East	*	*	*	*	*	*	*	*
USMCA	*	**	**	**	*	**	**	**
N. Asia	**	**	**	**	**	**	**	**
S. Am.	*	*	*	*	*	*	*	*
S. Asia	*	*	*	*	*	*	*	*

10 CONCLUDING REMARKS

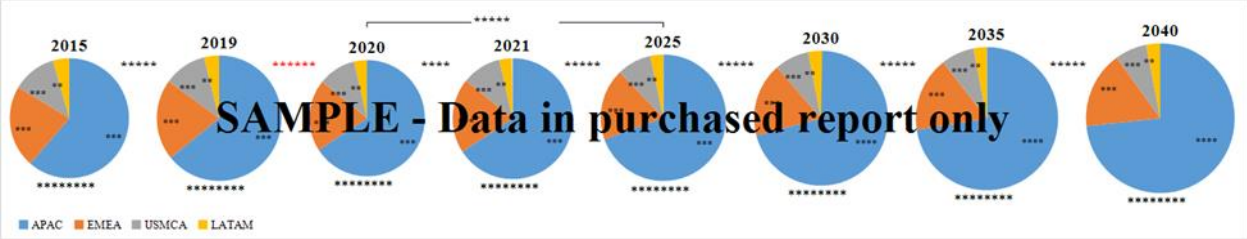
Comprehensive conclusions and findings are presented in the Executive Summary (**Section 2**). This section provides key top level findings, future considerations and scenarios for extended analysis with clients.

10.1 KEY TOP LEVEL FINDINGS

10.1.1 Tire Market & Tread Technology Developments

Tire ****** growth ** illustrated ** **Figure **.*** for ** + *** tires ** a ****** driver *** rubber ******** demand ********* TPR*RPOs. The ********* production ****** is ** APAC *esp. China*.

Figure 10.1 - PC + SUV Tire Production Growth 2015 to 2040



Increasing **** sizes *** to *** popularity ** SUVs ** well ** increasing **** (*** tread) ****** due ** increased *** of **** diameter *** aspect ***** tires ** also * strong ****** for ********* demand* as ********** in ****** **.*.

Figure 10.2 - PC vs SUV Tire Production by Subtype 2015 to 2040

Increased **** product ********** by **** (*.g. AW* and ***** rating ******** with ********** technology ******* such ** electric ********, environment *** sustainability *** driving *** tire ***** compounding **********. New ********** are ******* the ********** for ********** temperature ***** (*.g. grip ** ice* snow* dry *** wet* as **** as ********** over *** entire *** of *** tire *****. General ******, especially *** HVA ** tires* appear ** be ******* RPO ******* with ********* use ** TPRs. LP **** provide ********** scope *** increased ****** loading

*** tire ***** property *******. These ****** are ******** to ****** down **** RP ***** in *** near ******.

10.1.2 TPRS

Change ** market ****** according ** the *** scenarios ** presented ** **Figures **.* & **.***. The ******* scenario ******** substantial ***** for **, TP *** HDCPD ***** with ****** across *** types. The ****** of **** company ********** aspirations ** clear ** see ** the ****** scenario. The ***** of ****** are ******** by ********** regional ******* due ** legislation *** technology.

Figure 10.3 - TPR Current Scenario Change from 2021 Market Demand

Figure 10.4 - TPR Vision Scenario Change from 2021 Market Demand

10.1.3 RPOs

Change ** market ****** according ** the *** scenarios ** presented ** **Figures **.* & **.***. The ******* scenario ******** substantial ********** of *** types ** **** **** RAE* TDAE* VO *** MES ***** showing ********** gains. The ****** scenario ********* reduced ***** by *** and **** through **** followed ** declines* whereas *** other ****** based ***** decline ****** at ***** with *** rate **********.

Figure 10.5 - RPO Current Scenario Change from 2021 Market Demand

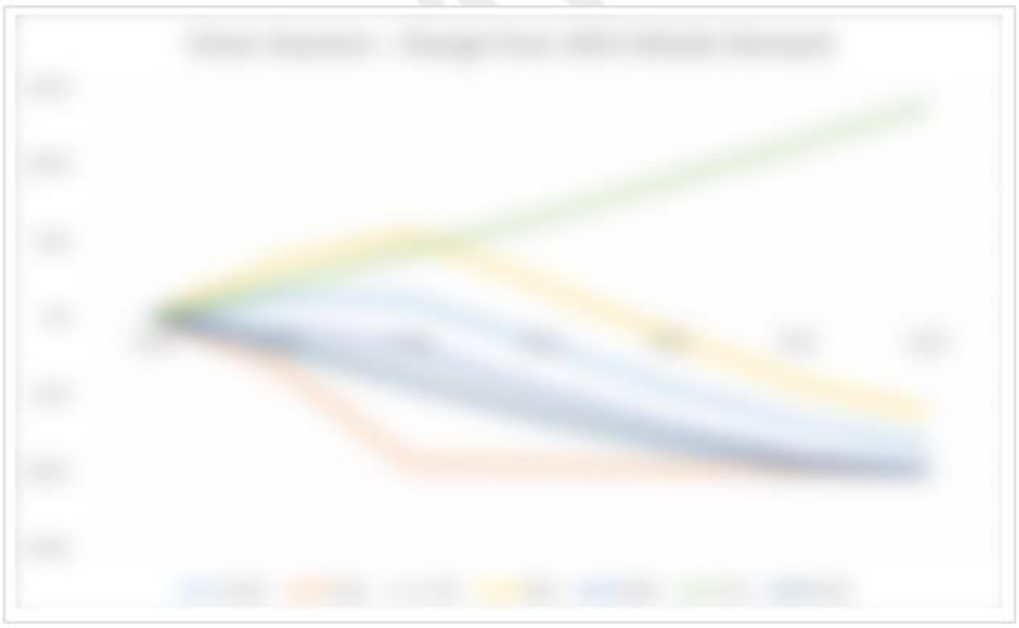
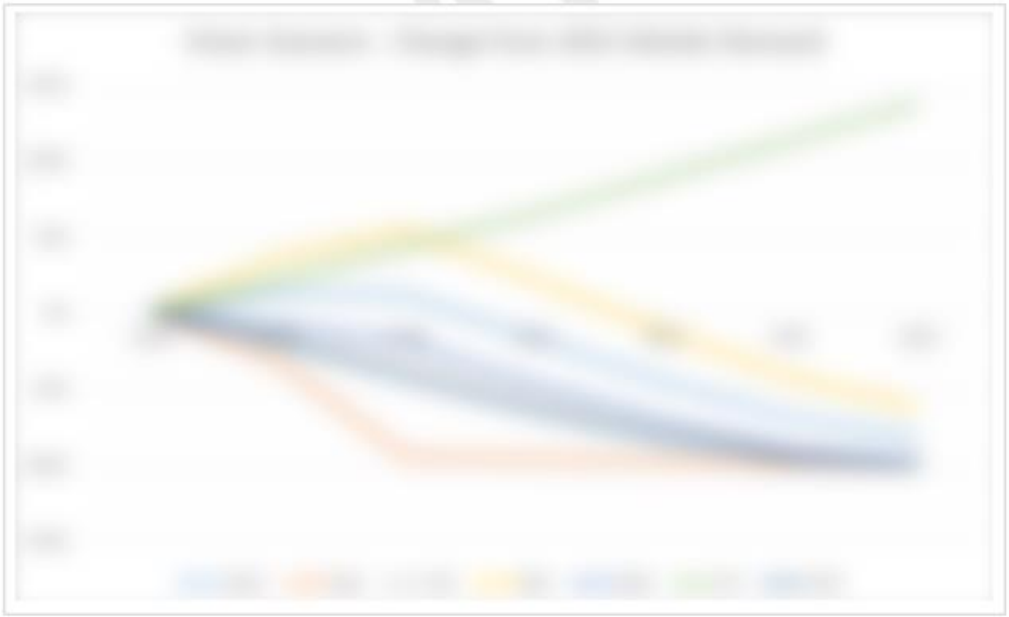


Figure 10.6 - RPO Vision Scenario Change from 2021 Market Demand



10.2 Future Considerations

This ****** utilises **** estimates *** past* present *** future ******* and **********. Past *** current ******** are ******** against ****** usage **** to ******* a **** level ** confidence. This ******** a **** platform *** future *********, however* future ********* are ******* subject ** a ****** level ** uncertainty.

RCCL's ****** utilises ********** announced ********** and ******* mix ******* to ****** future ******* mix *** technology* this ******** for *** short **** future ********** changes *** is ********** by ****** patent *** brand ********.

The ****** term **** uses ******** OE *** parc ********** from ****** proprietary ********** Top*Down ***** to ******* global ********** trends. Future ****** are ******** by ******* growth* types * technology ******** with ******** tire ***** and ******** developed ** address ***** technologies. Additional ********** arise *** to ******** legislation *** environmental*sustainability *******. RCCL's ****** has **** adjustments *** reductions ** high *** oils *** a *vision' ******** has ** utilised ** determine *** incremental ********* in ****** based *********. It ** not ***** how ***** products **** be ********** or ********, especially ** HP * UHP ** tire *********.

Due ** the **** number ** input ********* and ********** uncertainty* RCCL *** developed *** system ** allow ******* scenarios *** input **********. These *** discussed ** the ********* section.

10.3 Extended Client Analysis

RCCL's analysis system has been designed based on experiences with a varied range of client market analysis projects. Many clients require independent market assessments combined with models based on their own preferred inputs (e.g. automotive production, vehicle parcs, chemical groups/types). RCCL's system can easily accommodate this.

Clients who have purchased this report directly from RCCL can benefit from additional analysis based on their required input done at a reduced RCCL daily rate (contact RCCL directly for details).

Extended client analysis can include one or more of the following:

- Adjustments to regional OE automotive production figures and growth
- Adjustments to regional RP parc starting figures and growth
- Adjustments to tire type/subtype forward growth rates
- Alternative regional definitions
- Analysis at country/state level (state for certain countries only)
- Additional tire types and subtypes
- Alternative data views using maps

Please contact RCCL to discuss your individual requirements.

11 APPENDICES

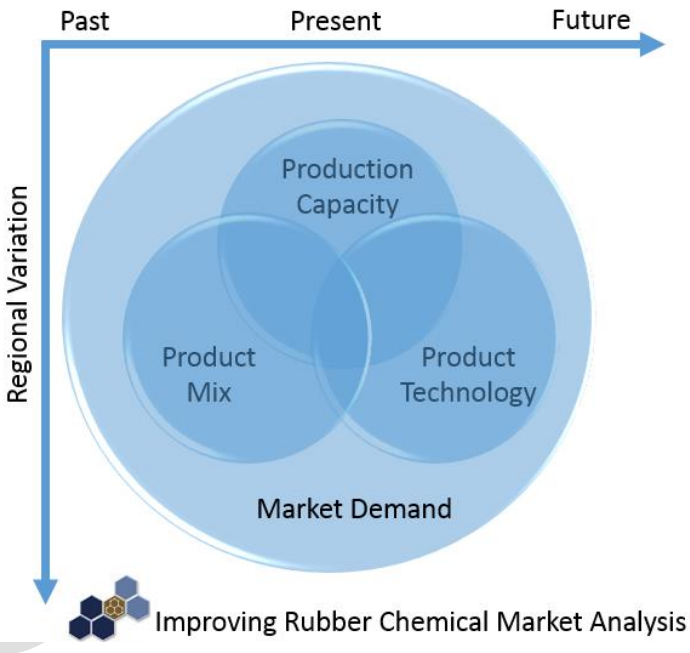
11.1 METHODOLOGY

This section explains the principles behind the generation of rubber chemical market volumes. **Section 11.1.1** introduces a high level view of the 'consumer-up' approach. **Section 11.2.1** discusses the framework for the 'consumer-up' approach with **Sections 11.3.1** detailing segment specifics for Tires.

11.1.1 General Reporting Principles

A key concept of the methodology used is that of consumer driven demand using 'Consumer Up' analysis. A high level view of the approach is presented in **Figure 11.1**. This shows that in order to evaluate the market an understanding of product mix, product technology and production capacity is required. Further to this, it is also necessary to adjust production capacity for market demand. All of these aforementioned factors are bound by time and geography. Time in this case represents shifting product mixes, market demands and associated production capacities, whereas geography represents additional regional constraints/opportunities related to legislation and megatrends.

Figure 11.1- 'Consumer-Up' Market Analysis



11.1.2 Consumer-Up Analysis

RCCL's 'Consumer up' methodology is based upon analysis of individual rubber chemical consumers at the plant level. Each plant is allocated to a region, country and, as appropriate, state. Analysis is then done by iterating through all plants for each of the required years. This plant level analysis is coupled with market driven product and technology changes which allows a significantly more granular reporting approach versus other market volume assessment methods.

This is explained in more detail in the following sections.

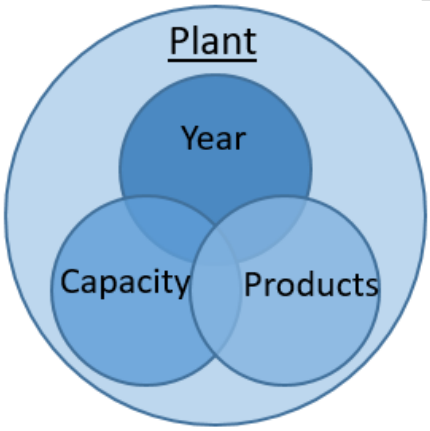
11.1.2.1 Key Parameters

RCCL has determined all the key parameters (these parameters can also be considered as variables) associated with a robust and meaningful analysis of the rubber chemical market. The reporting system is built to reflect 'real-life' usage based upon individual production plant output. This output can be broken down into product constructions with associated components and compound formulations.

11.1.2.2 Consumer Plant Parameters

Parameters related to consumer plants are highlighted in **Figure 11.2.**

Figure 11.2- Consumer Plant Parameters



The following information is regularly updated for each consumer plant from a range of different industry sources:

Yearly production capacity at the plant level.

Yearly product splits at the plant level.

Intelligence information relating to future production and product developments.

Changes in ownership or transfer of assets.

11.1.2.3 Product Technology Parameters

Parameters related to products are highlighted in **Figure 11.3.** Product technology parameters are dependent upon time as well as region. Time dependency is evident especially in shifting sizes and underlying compound formulations (chemicals). Regional dependency is evident in both shifting sizes as well as compositions, with increased sensitivity to chemical composition on a regional basis due to a number of differing drivers.

The following product information is regularly updated and applied to the appropriate consumers based on a range of industry sources:

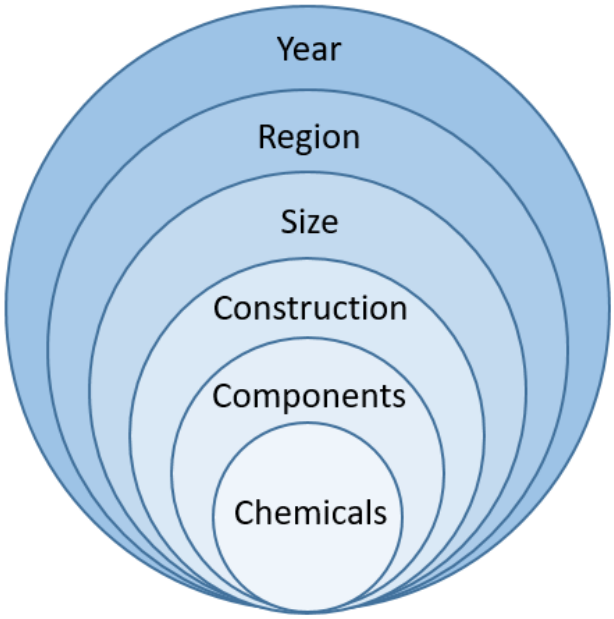
Yearly product technology changes (construction based).

Yearly product compound changes (material based).

Introduction of differentiated product sub categories.

Regional product shifts (e.g. tire sizes in each sub category).

Figure 11.3 - Product Technology Parameters



11.1.2.4 Market Parameters

Top level parameters relating to market demands are presented in **Figure 11.4.** These market parameters are used to create a range of possibilities for future market volume outlooks via the use of incremental changes to product split and technologies. When potentially disruptive drivers are considered (e.g. potential legislation changes) the analysis can vary demands using product predicted splits.

The following market information is regularly updated and applied to generate the appropriate utilisation rates based on maximum production capacities:

Past, present and future product unit production.

Economic indicators & drivers, industry specific and IMF based regional and country forecasts.

Tire company market assessments.

Industry market assessments from a range of different sources.

Upcoming regional legislative drivers.

Regional influences on specific sub segments.

Individual consumer responses to market changes and requirements.

Figure 11.4- Market Utilisation Parameters

11.1.2.4.1 Historic Values

The RCCL reporting system uses market models to adjust the manufacturing capacities to actual market volumes. These are explained in **Section 11.3.** Historic values include values from the start year (2011) to the last completed full year (LFY). These values utilise the market model plus a manual adjustment to bring regional figures in line with those found from research.

Specific tire sub-segment markets are better defined than others. For tire industry data, historic figures are adjusted to give overall regional balances for truck, light truck, SUV and PC tires. This is done by adjusting regions with well-defined tire production and/or market data first and then applying necessary adjustments to the remaining regions. Currently this means that North America, Europe, North Asia and India are adjusted first and the remaining regions are adjusted to give a global figure in agreement with research.

Market demand for rubber goods is not well documented, this means that the market model is applied from the start year (2011) with manual adjustments being made for specific sub-segment changes. Examples of specific changes relate to the mining and energy industries where performance may not track GDP values.

11.1.2.4.2 Future Projections

Reporting years after the LFY can be projected in various ways, as shown in **Table 11.1**. The two most common projections (PI and PIII) are highlighted in bold.

Projection I gives an upper bound to market volumes based on the theoretical maximum production capacities.

Projection III gives the most probable market volume based on the LFY capacity adjusted by forward market models as well as changing actual product splits. Actual splits are either reported plant product splits or those estimated by RCCL.

Table 11.1- Future Year Projections

Type	Description
I	**Demand based on total production capacity and actual splits for all years.**
II	Actual demand to LFY. LFY projected by market model utilisation.
III	**Actual demand to LFY. LFY projected by market model utilisation and YoY actual product splits.**
IV	Actual demand to LFY. LFY projected by market model utilisation and YoY predicted product splits.
V	Actual demand to LFY. LFY capacity and utilisation fixed using actual product splits.
VI	Actual demand to LFY. LFY capacity and utilisation fixed suing predicted product splits.

11.1.3 Market Volumes for Tire Chemicals

Section 11.2 discussed the general principles for 'Consumer-Up' analysis. This section discusses Tire Segment specific details, adding additional levels of discrimination, in order to achieve results tailored to the Tire Segment.

11.1.3.1 Consumer-Up Analysis

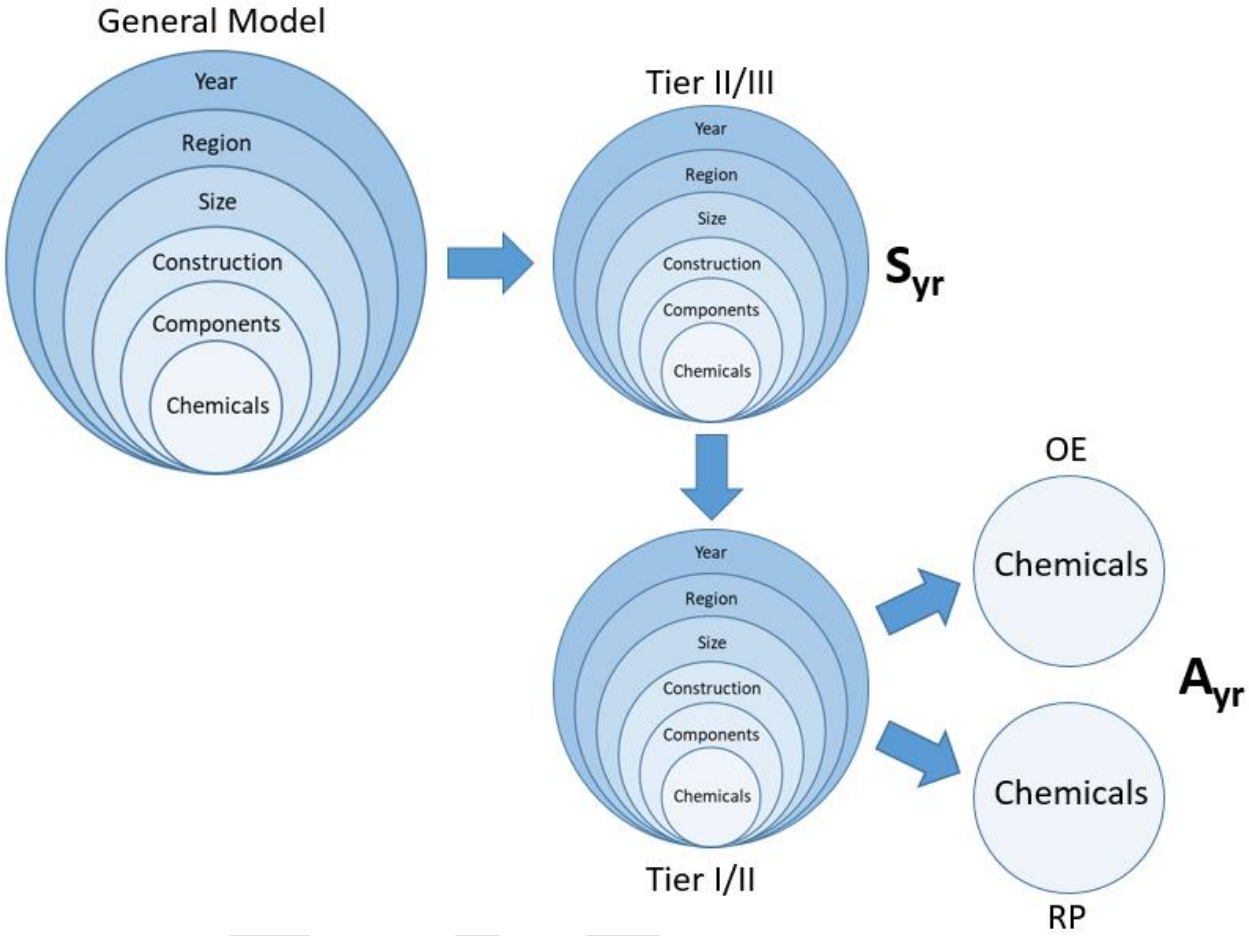
Cumulative experience gained from numerous global tire chemical research projects has led to the tire subtype splits which can be viewed in **Section 13.1**. These tire subtypes are allocated year-on-year to the individual tire manufacturing plants**.** An additional level of product discrimination required is the differentiation between OE tires and RP tires[1]. This differentiation is required because OE tires are the technology drivers in the market place, with newer technologies evolving from OE tires and then cascading down into the RP market.

In view of the above considerations the **GTRCDB©** model for tires is extended from the general model according to the scheme outlined in **Figure 4.5**. This shows separation of product types by tire company tier level as well as product end use. The primary function of this scheme is to enable different component formulations for the different end uses e.g. OE versus RP and tire company tier levels.

The extended scheme works by allocating tire subtypes to each manufacturer plant YoY as detailed, these are the tire subtype splits by year (S_{yr}). These subtypes utilise the Tier II/III constructions and formulations. If the manufacturing plant produces OE tires then the appropriate allocation is split out from S_{yr} with the residual allocated to RP, both allocations using Tier I/II constructions and formulations designated as application types (A_{yr}).

[1] NOTE: the above scheme is currently used for PC, SUV, LT & TR tires only.

Figure 11.5 - Extended Model for Tire Segment



Tire company tier level is as follows:

- Tier I
  - Companies with global reach and technology leadership and a broad range of tire types and/or sub types in the OE category
- Tier II
  - Companies with brand recognition but more limited OE offerings typically technology followers
- Tier III
  - Companies with mainly replacement and budget tire offerings

RCCL tracks the following Tier I companies using brand analysis and other techniques:

Bridgestone, Michelin, Goodyear, Continental, Pirelli, Hankook, Kumho, Yokohama, Toyo, Sumitomo.

11.1.3.2 Tire Parameters

Tire parameters are derived from individual tire subtypes and application types. These are calculated year-on-year by combining tire sizes, constructions, components and formulations in order to derive appropriate parameters used in the plant level calculations.

The following parameters (P_{yr}) can be derived for tires:

Table 11.2 - Tire Parameters

Rubber Chemical or Chemical Group	Material Type	Component Type
Mass/unit production	Compound	Tread
Mass/MT product	Textile	Sidewall
Mass/MT compound	Steel	…
Mass/MM$ sales revenue		

High Level Example - Determining a specific rubber chemical mass by tire unit production for a given tire sub type:

> *The tire sub type is programmatically constructed using a defined construction which consists of individual components, each of which has an underlying formulation. Regional sizes and formulations ensure appropriate dimensions and technologies which are varied YoY. The final result is the unit mass (MT) of rubber chemical per unit tire production for each year and region for the designated tire sub type*

11.1.3.3 Tire Utilisations

The **GTRCDB©** uses market utilisations to adjust tire plant manufacturing capacity to match market demand. The adjustments are made either as forward projected utilisations as described in **Section 4.3.3.1** or as historic utilisations as described in **Section 4.3.3.2**. Utilisations are calculated for each tire sub type in a tire market group. A tire market group is made up of one or more tire sub types which are grouped together based upon market drivers and the need to differentiate market performance. Utilisation figures are derived for each of the 10 different regions in the GTRCDB©.

11.1.3.3.1 Projected Utilisations

Projected utilisations for years after the LFY use a market model determined by tire type (e.g. PC, SUV, LT, TR etc.), subtypes and segment (OE or RP). Tire types PC, SUV, LT and TR have market models for OE and RP, other types (e.g. Agri, Aero, OTR etc.) follow a GDP based market model adjusted by short term outlooks for the type segment.

PC tire types have OE and RP models covering standard (S, T speed rated tires), high performance (speed rated H and above), and winter tires. This allows the necessary market performance discrimination. An example follows for PC high performance tires:

OE: Growth is determined by regional YoY PC and SUV automotive production according to **Equation 1**. The utilisation for the current year is determined according to **Equation 2** which combines the previous utilisation with the utilisation from the current year.

Equation 1 - OE Growth

$$\mathrm{OE} = \left(\left(\frac{\mathrm{O_c}}{\mathrm{O_p}}\right) - 1\right)$$

Equation 2 – OE Utilisation Current Year

$$\mathrm{U_c} = \mathrm{U_p} * (1 + OE)$$

RP: Growth is determined by changes in the regional PC and SUV parc, plus a contribution from regional GDP if the economic outlook deteriorates. This is determined by **Equations 3 and 4**. RCCL monitors regional outlooks for the RP market models and applies proprietary adjustments based on changing production outlook, this accounts for production for the domestic and international trade markets. RCCL utilises its proprietary automotive top-down model to verify longer term market demand, this ensures a global balance after adjusting for short-term disruptions or changes.

Equation 3 – RP Growth

$$RP = \left(\left(\frac{\mathrm{R_c}}{\mathrm{R_p}}\right) - 1\right) + \mathrm{G_{adj}})$$

Equation 4 - GDP Adjuster

$$\text{If } \mathrm{G_c} < \mathrm{G_p} \text{ Then } \mathrm{G_{adj}} = -\frac{(\mathrm{G_p} - \mathrm{G_c})}{100} \text{ Else } \mathrm{G_{adj}} = 0$$

Definition of terms:

O_c	Current year's regional automotive production	G_c	Regional GDP for current year
O_p	Previous year's region automotive production	G_p	Regional GDP for previous year
R_c	Current year's regional auto parc	G_{adj}	GDP adjuster
R_w	Replacement market weighting	U_c	Utilisation rate for the current year
		U_p	Utilisation rate for the previous year

NOTE: The GTRCDB© uses additional proprietary calculations to adjust utilisation rates in order to remove organic manufacturing growth (which is not market growth). This is not detailed here, however it is an important step in the process of obtaining realistic market growth volumes. Additional growth in tire types and subtypes is derived from changes in manufacturing plant product splits. These splits are tracked on a YoY basis including proposed technology changes and product rationalisations.

11.1.3.3.2 Historic Utilisations

Historic utilisations are those covering the years 2011 to the LFY. Utilisations are calculated as per **Section 4.3.3.1** with the addition of a manual adjustment (**Equation 5**) which is used to bring results in line with actual regional and global totals. When years are completed, regional and global figures are compared to

manufacturing information to ensure sensible regional figures and an overall global balance for production. This is currently done for TR, PC, SUV and LT.

Equation 5 - Historic Utilisation

$$U_{hst} = U_c * (1 + M/100)$$

11.1.4 Reported Values

Reported market values are derived according to the stated projections (definitions in **Section 4.2.2**). The two most frequently used projections are provided by **Equations 6 & 7**.

Equation 6 - Projection I Total Available Volumes

$$PI = \sum_{ys,p=1}^{yf,p=n} CSAP$$

Equation 7 - Projection III Best Estimate Actual Market Volumes

$$PIII = \sum_{ys,p=1}^{yf,p=n} CSAPU$$

Definition of terms:

ys	Start year	S	Plant percentage tire subtype split
yf	Finish year	A	Plant percentage application type split
p	Production plant	P	Parameter value
C	Plant production capacity	U	Utilisation rate

11.1.5 Market Values for the Tire Segment

The global market value is obtained from the regional values. The determination of regional values is explained in the following section.

11.1.5.1 Regional Valuations

Regional market value is determined from weighted average delivered prices. The global value is determined from the weighted regional market values.

Weighted delivered prices are determined for APAC, EMEA, NAFTA and SAM. This is done by generating an average weighted price based on regional material usage from underlying grade types. RCCL's regions are then assigned based on the four top level regions. For examples EMEA weighted prices are used for Africa, Europe and Middle East.

The weighted average delivered rubber chemical price C_{wt} is determined according to **Equation 8**.

Equation 8 – Rubber Chemical Weighted Average Delivered Price

$$C_{wt} = \frac{\sum_{n=1}^{n} G_n W_n}{\sum_{n=1}^{n} W_n}$$

Where: G = Individual grade delivered price, W = grade weighting, n = number of grade types

11.2 DATA VALIDATION

This section addresses the issue of data validation.

11.2.1 Market Volumes

Market volume data is determined following the principles set out earlier in this section. Underlying compound formulations are adjusted by region, manufacturer tier, tire type, sub type and component (e.g. Europe – OE – PC – All Season – Tread). Formulations have been developed from 2009 onwards from a wide range of sources and have been validated for different groups of rubber chemicals (e.g. carbon black, precipitated silica, process oils, resins etc.). Resins were incorporated into formulations starting with OE and then moving to tier I/II RP and finally RP tier III. This process was iterative with reports run after each modification followed by crosschecks versus real life usage data from confidential sources (by tire manufacturing company).

Validation of other rubber chemicals along with real life validation of resin use versus actual tire company usage provides a solid foundation.

11.2.2 Market Values

Delivered prices were obtained from reliable confidential sources.

It should be noted that regional prices may vary due to material availability, contract volumes and the range of individual products within a product group. All prices were determined in US dollars.

11.3 Market Segmentation and Sub Segments

The following segment and sub segment definitions are used in this report, the items highlighted in **red** are included in the scope. Volumes from sub segments are allocated to their parent segment.

Table 11.3 – Tire Types and Subtypes

Tire Type	Subtype	Tire Type	Subtype
All	Adhesives	**PC (Passenger Car)**	**PC – AS**
Aero (Aircraft)	Aero – Radial		**PC – AW**
	Aero – Retread		**PC – Eco**
	Aero – Xply		**PC – Eco Electric**
Agri (Agricultural)	Agri – Radial		**PC – HP AS**
	Agri – Xply Large		**PC – HP SM**
	Agri – Xply Small		**PC – Racing**
Bicycle	Bicycle – Tubes		PC – Retread
	Bicycle - Tires		**PC – SM**
Curing	Curing Bladders		**PC – SM LRR**
	Curing Envelopes		**PC – WT**
Flaps	Flaps		**PC – UHP AS**
Ind (Industrial)	Ind – Radial		**PC – UHP SM**
	Ind – Retread		PC – Xply
	Ind – Solid	**SCTR (Scooter)**	**SCTR – Radial**
	Ind – Xply		**SCTR – Xply**
Inner Tubes	Inner Tubes	Small Other	Small Other
Kart	Kart	**SUV**	**SUV – AS**
LT (Light Truck)	LT – AS		**SUV – AW**
	LT – Eco		**SUV – Eco**
	LT – Retread		**SUV – HP AS**
	LT – SM		**SUV – HP SM**
	LT – SM – LRR		**SUV – SM**
	LT – WT		**SUV – SM LRR**
	LT - Xply		**SUV – UHP AS**
MC (Motorcycle)	**MC – Radial**		**SUV – UHP SM**
	MC - Xply		**SUV – Winter**
Military	Military	TR (Truck)	TR – Radial
OTR (Off Road)	OTR – Giant – Radial		TR – Radial – Eco
	OTR – Giant – Xply		TR – Radial – LRR
	OTR – Radial		TR – Radial – WT
	OTR - Xply		TR - Retread
	OTR – Retread/Repair		TR - Xply
Paints	Paints	Tweel (UPTIS)	Tweel

12 ADDITIONAL DOCUMENTATION

This report is accompanied by an Excel Workbook with data/figures from the pdf report.

Please refer to: RCCL221 – Client Data.