Robert Eller Associates LLC

CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

TPEs: POSITIONING FOR SUCCESS IN THE GLOBAL AUTOMOTIVE SECTOR

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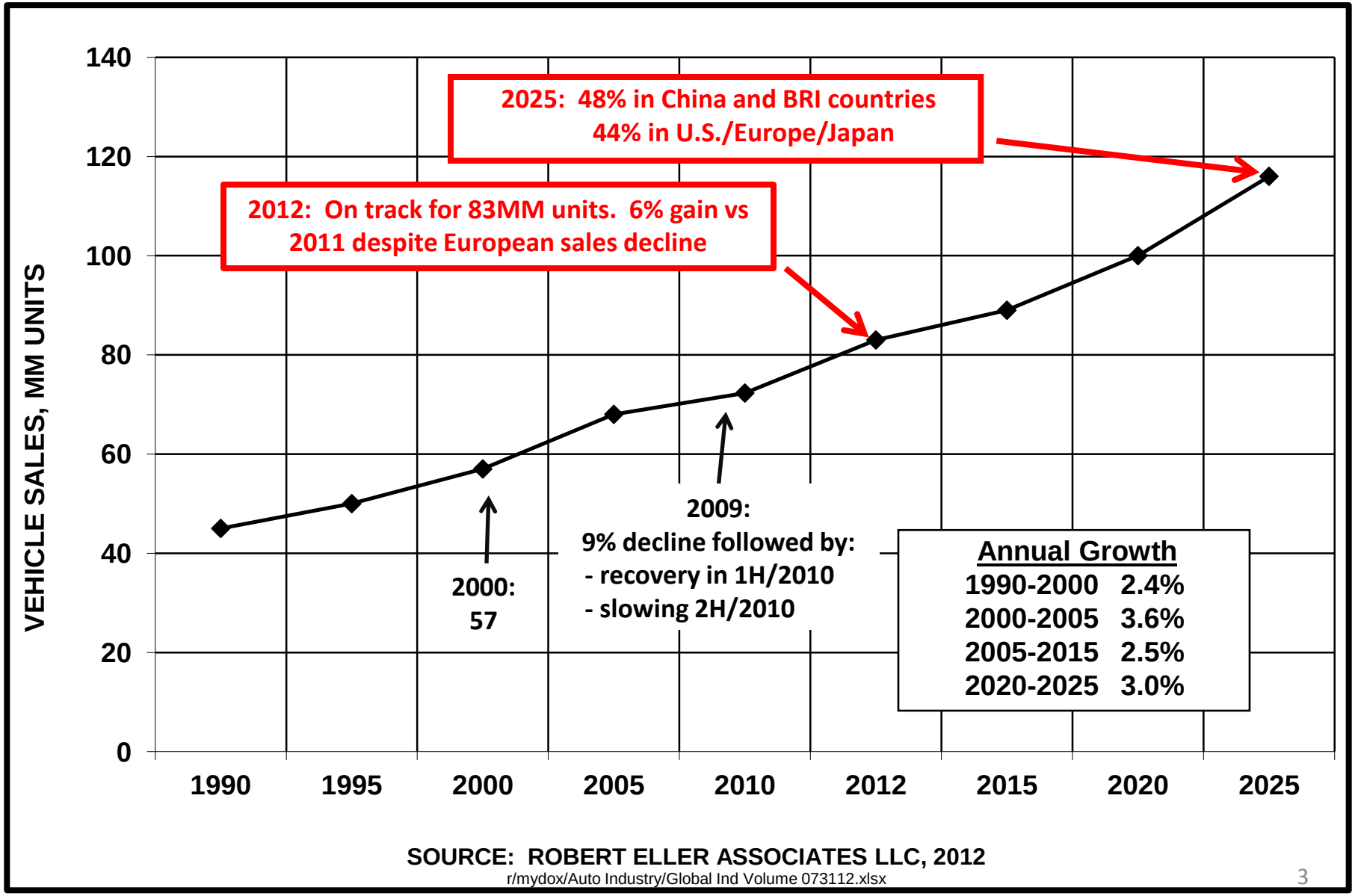
b/papers/spetpo 2012

OUTLINE

- **Global Trends:**
  - **Global automotive market/regional differences**
  - **Asia shift implications**
  - **TPE industry structure shifts**
- **Automotive TPEs**
  - **The auto TPE product life cycle/looking toward the future**
  - **Recent automotive TPE target applications**
  - **Overview of the automotive TPE battleground**
- **s-TPVs: role in automotive**
- **Bio-TPEs: potential in automotive/sustainable applications**

GLOBAL VEHICLE SALES OUTLOOK



SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

r/mydox/Auto Industry/Global Ind Volume 073112.xlsx

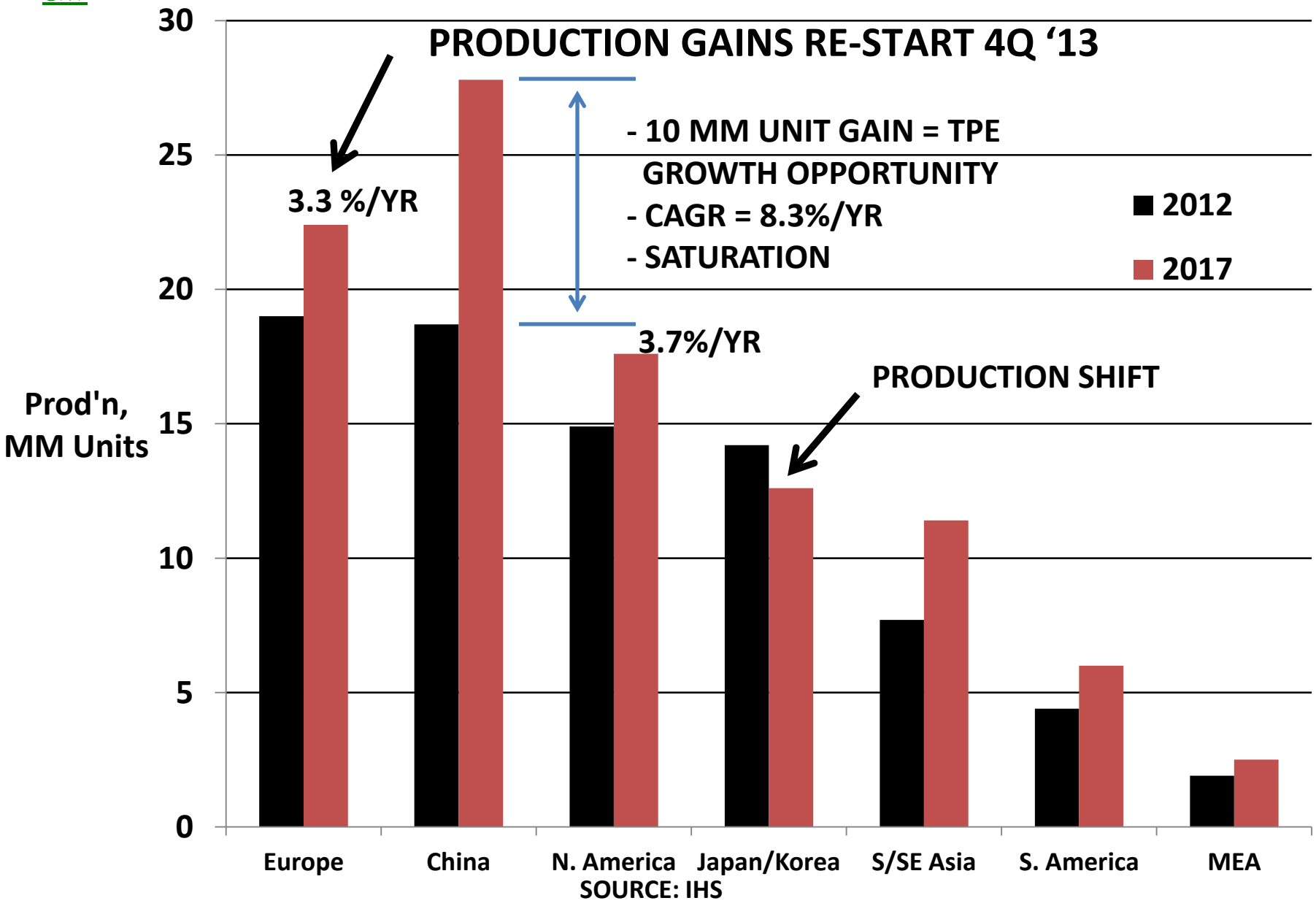
THE ASIA SHIFT: EFFECT ON AUTO TPEs

- **Auto production in China**
  - **Focused on domestic market (only 4% of production is exported)**
  - **Domestic market → saturated by 2020 (at 25-30MM units)**

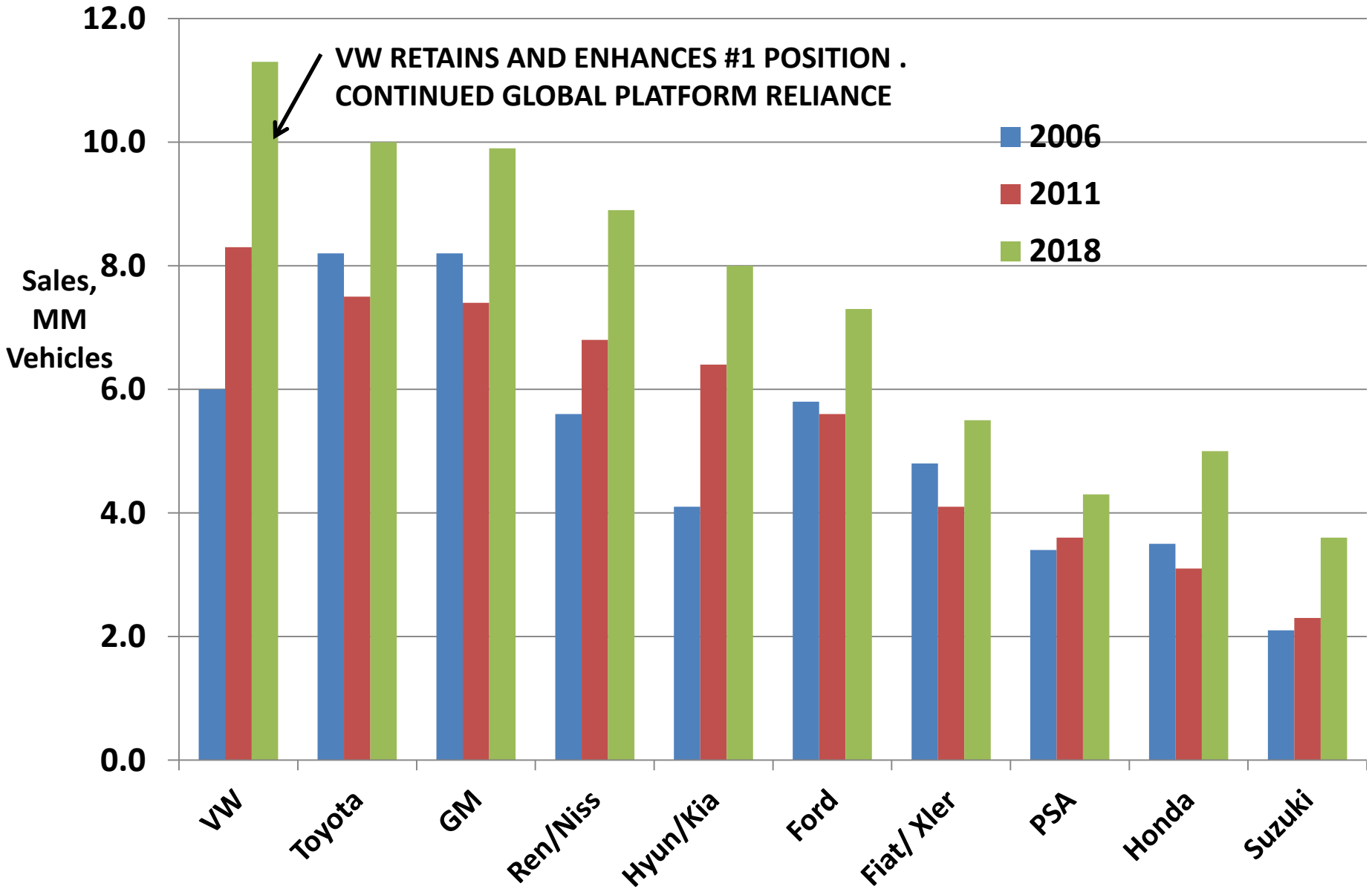
- **Supply chain effects as Asia infrastructure matures:**
  - **Western companies become dependent on Asian supply chain even for products with low labor cost share**
  - **Supply chain infrastructure becomes established**
  - **Shift of R/D to region (technology and innovation shift?)**
  - **Scale of Asia resin supply and compounding plants → competitive**

- **Current TPE usage/vehicle is below global average, creating growth opportunity via:**
  - **Vehicle production growth**
  - **Increased usage/vehicle**

VEHICLE PRODUCTION SHIFT TO CHINA CONTINUES

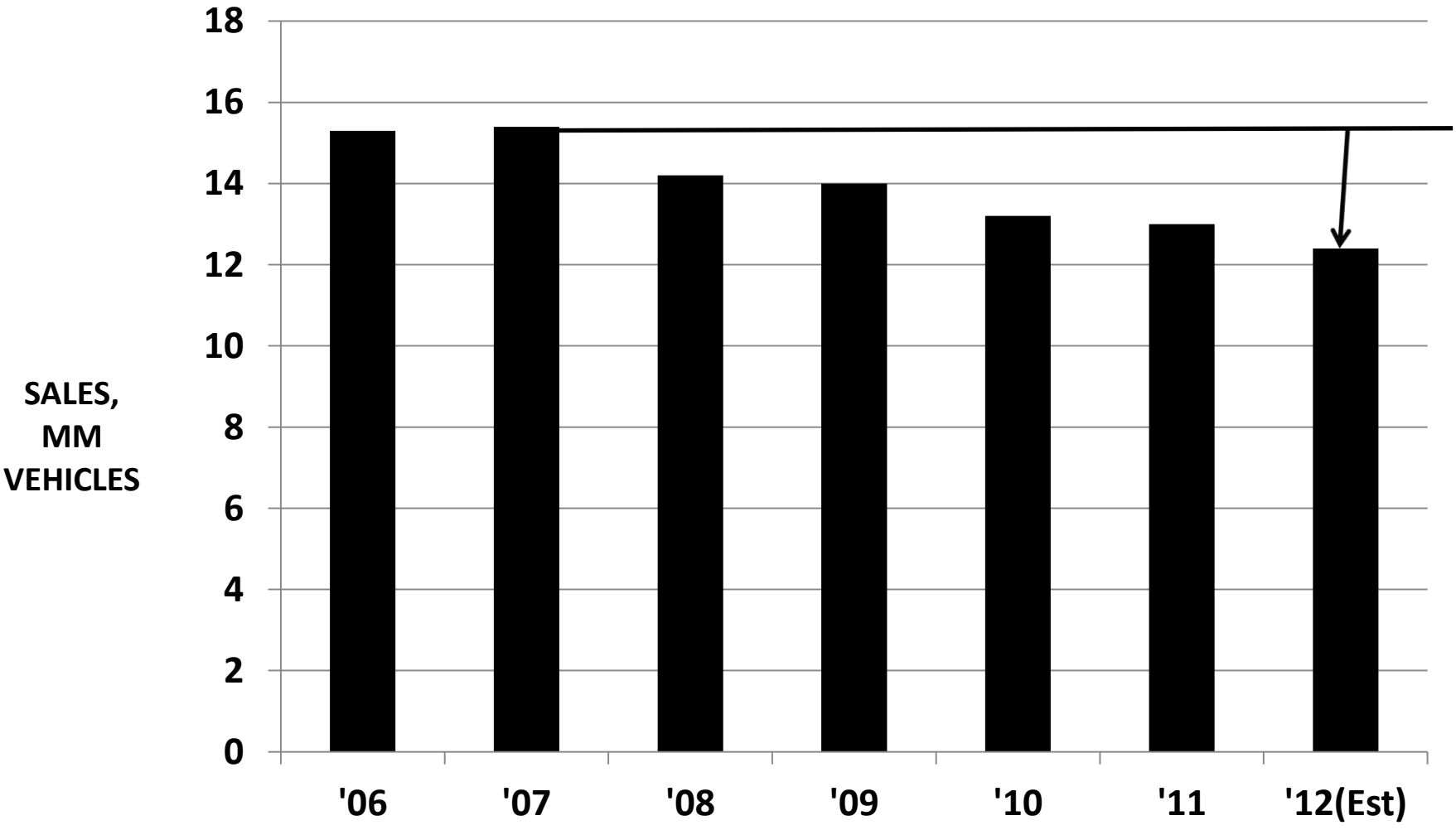


GLOBAL AUTO SALES FORECAST FOR MAJOR OEMs



Source: IHS

EUROPEAN UNION CAR SALES: 20% DECLINE SINCE 2007, OVERCAPACITY REMAINS

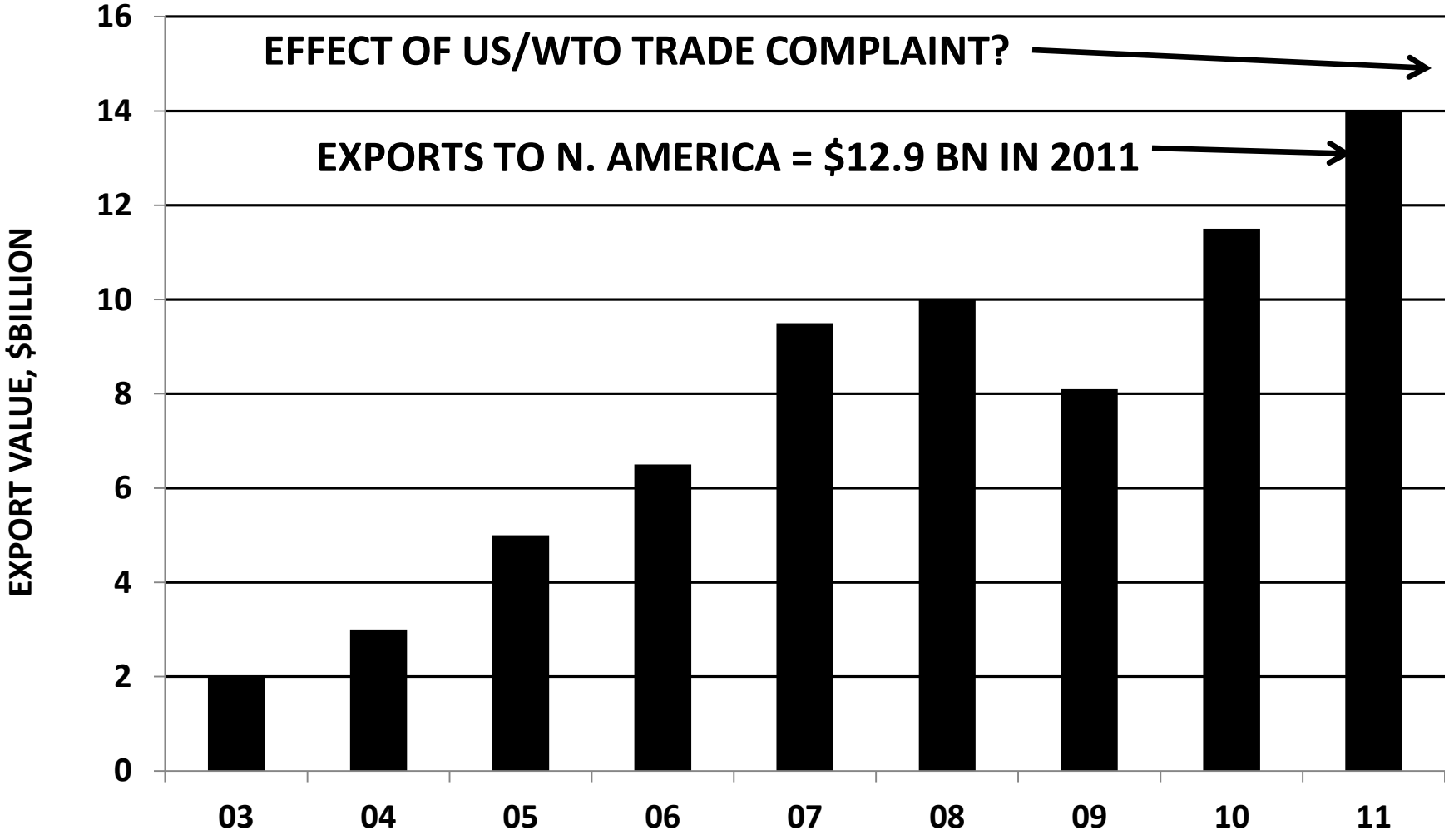


SOURCE: EAMA/EUROPEAN COMMISSION

VW: PRIORITY TARGET FOR AUTOMOTIVE TPE SUPPLIERS

- Rollout of MQB (modular architecture) platform:
  - Cost savings (plant flexibility, reduced production time)
  - 6MM units/40 models by 2020
  - More integrated systems/modular constructions
- Global positions
  - On course toward retaining global #1 position
  - Very strong position in developing markets (Brazil and China)
  - Benefit from structural changes in European auto sector (currently 25% share)
  - N. American turnaround (currently 5% share)
- Pricing power vs mass market competitors

VALUE OF CHINA AUTOMOTIVE PARTS EXPORTS



SOURCE: STEWART AND STEWART, ROBERT ELLER ASSOCIATES LLC
2011 estimated based on first 9 months
b/mydox/auto china parts

GLOBAL INVESTMENT, TECHNOLOGY, AND MATERIAL FLOWS IN AUTO TPEs

ASIA:

- **DOMESTIC AUTO DEMAND GROWTH**
- **EXPORT: SMALL CURRENT SHARE**

MANUFACTURING

INVESTMENT: COMPDG/ RESIN

INVESTMENT PROFITS

COMPOUND EXPORT

FABRICATED AUTO PARTS

MATURE WESTERN ECONOMIES/AUTO MKTS

- **EUROPE STAGNANT**
- **U.S. AUTO MKT. GROWTH**

- **INVESTMENT**
- **RAW MATERIALS**

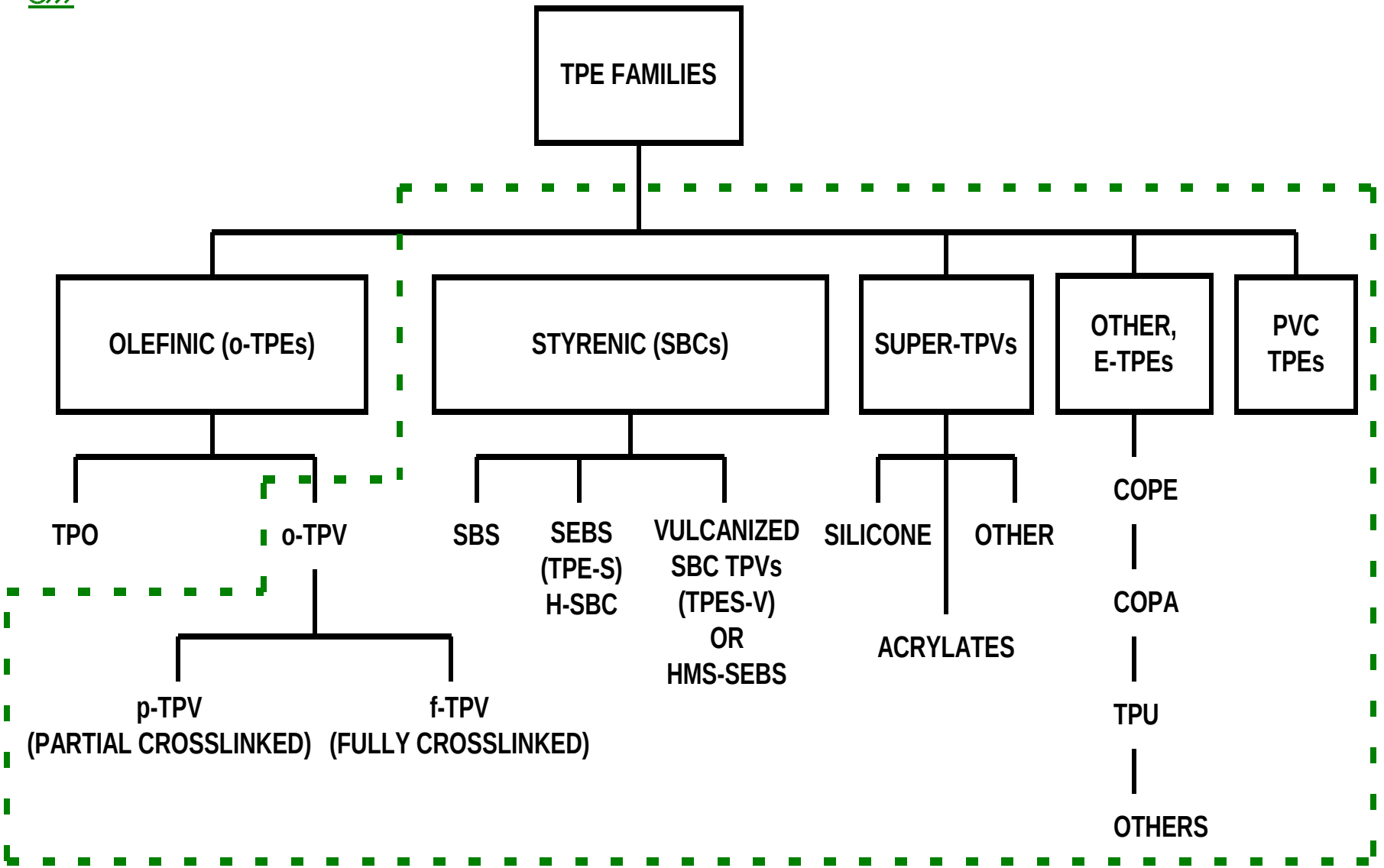
INVESTMENT

INVESTMENT, TECHNOLOGY TRANSFER

ASSET-RICH REGIONS:

- **MIDDLE EAST**

THE TPE FAMILIES



SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

r/mydox/visio/TPE Fam Challenge to Rubber 2011 12pt.vsd // lg/myfiles/visio/TPE FamChallenge to Rubber 2012 12pt.vsd

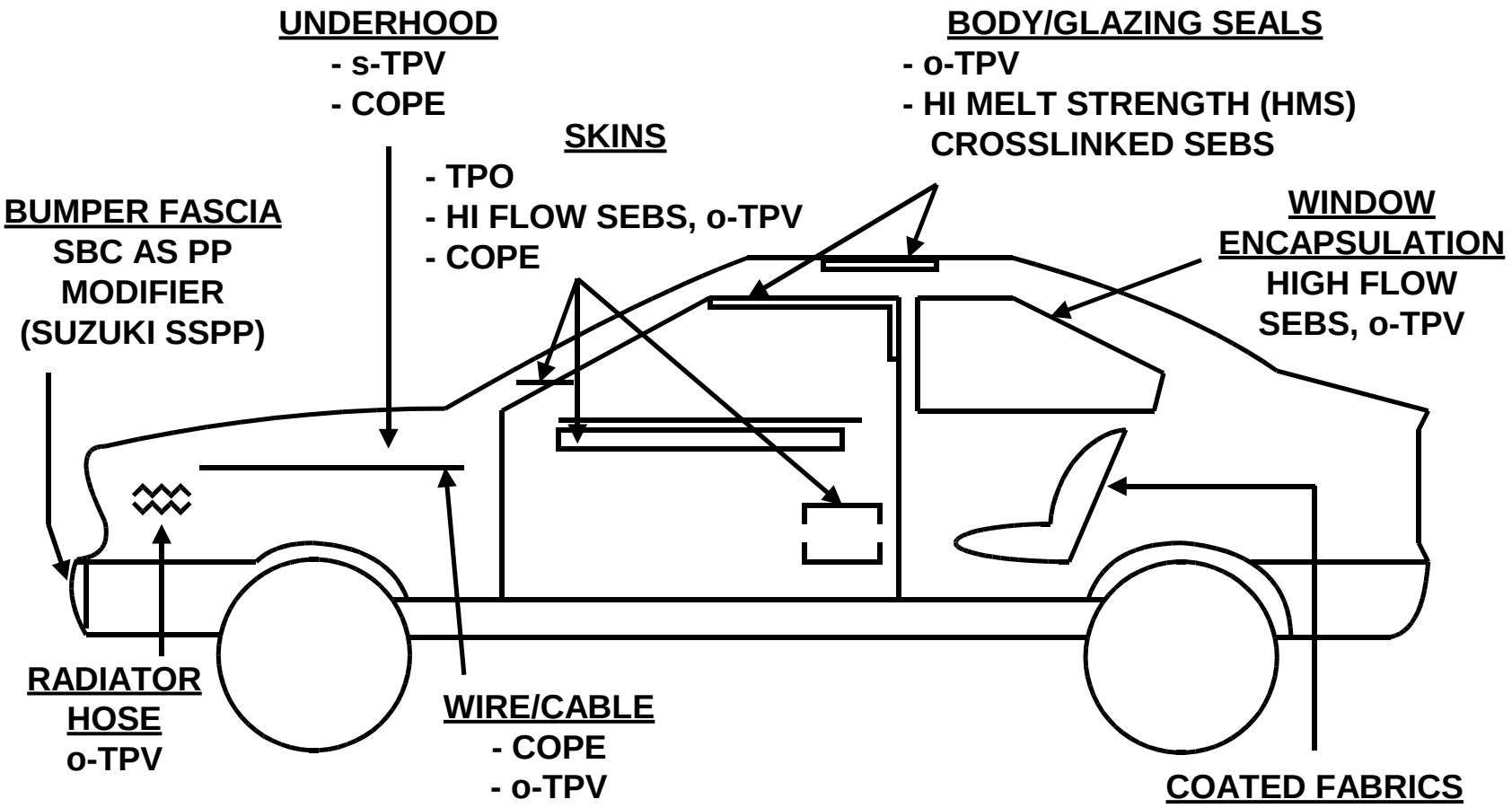
TPE INDUSTRY STRUCTURE SHIFT EXAMPLES

SHIFT TYPE	EXAMPLE/IMPLICATIONS
Acquisition by major TPE supplier	- Lubrizol acquisition by Merquinsa
Distributor entry into TPEs	- Albis TPV entry. Expansion into N. America - Alliance entry into compounding
Resin supplier → compounding	- TSRC, PP resin suppliers, others
Investment: Asia to West	- Nantong Polymax (TPE compound supply) - TSRC acquisition of Dexco*
Growth of domestic China/Korean/Indian TPV compd'rs	- Hyundai EP, Shandong Dawn, Zylog, Nantex
Product line broadening by major TPE suppliers	- Teknor Apex acquisition of DSM Sarlink®* - Kraiburg entry, high temperature TPE (Hipex®)
Major TPE suppliers emphasizing specialty vs commodity grades	- Kraton entry into higher performance grades* - Creates opening for new TPE compounders
Shifts to Asian production and market development	- Many TPE suppliers, recently: Hexpol, CTS, Dow Corning/Multibase

*= Major raw materials company exiting "commodity" grades

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

AUTOMOTIVE: KEY TARGET MARKET FOR NEW TPEs



THE AUTO MARKET

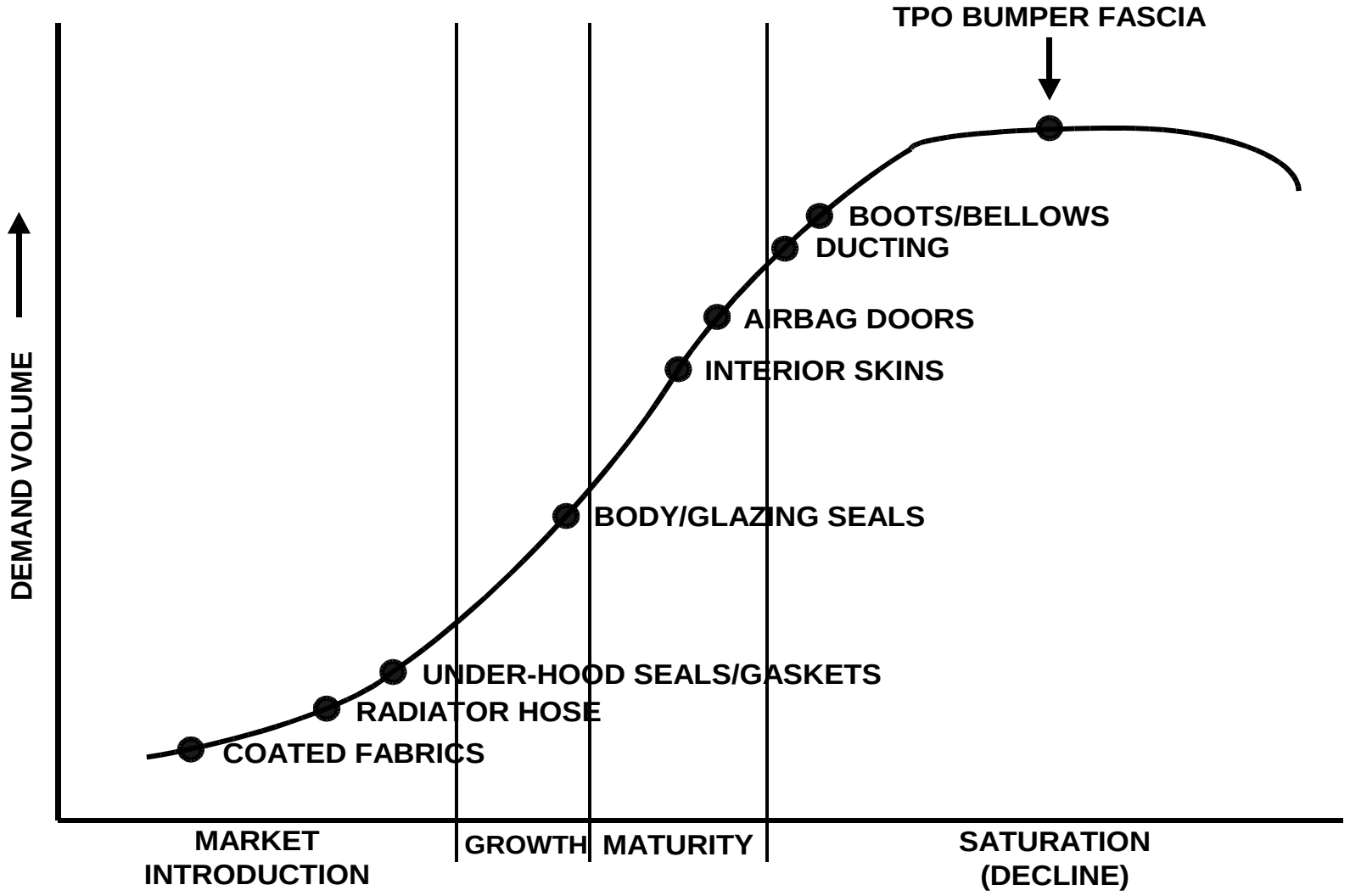
- 40-50% of current TPE demand
- Key incumbents: EPDM, PVC, TPO
- Global footprint

- Role for lightweighting, systems cost-save
- Key target properties: low V.O.C., thin wall, low odor, oil/ fuel resistance, heat resistance, sustainable
- Role for process technology, co-processing innovations

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

r/mydox/Visio./Auto Key Tgt for New TPEs 2012.vsd

PRODUCT LIFE CYCLE (PLC) POSITION OF AUTOMOTIVE TPEs (EXAMPLES)



Note: China/India demand growth shifts the product life cycle curves

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

r/mydox/Visio/Prod Life Cycle Auto TPE 081512.vsd

AUTO TPE PRODUCT LIFE CYCLE STAGES

	MARKET INTRO	GROWTH	MATURITY	SATURATION (DECLINE?)
Sales vol.	0→Low	Increasing	Steady	Steady or decline
Dev. costs	High	Reduced	None	
Branding	None	High	None (commodity)	None (commodity)
Mkt. approach	"Shaping"	Order seek	Order take	Exit
Inter TPE competition	Varies	Starts	Cascades to lowest cost TPE	Intense (supplier withdrawal)
Incumbent	Entrenched	Resistance	Replaced	
Systems	None yet	Stimulates growth	Refined	Accepted or shift to new system
Fab. tech	Standard	Adopt starts	Accepted	New challenger arrives
Asia role	None	Slight	Adopt	Wide use
Global spec	No	Starts	In place	
Example	Radiator hose	Body/glazing seals	TPO fascia	- Pass. airbag door cover - SEBS heavy layer insulation→ TPO, EVA

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

NEW PROPERTY/APPLICATION EXAMPLES FOR AUTO TPEs

PROPERTY	TPE TYPES	AUTOMOTIVE APPLICATION	NOTE
	O-TPV	Hose	EPDM dominant incumbent
Foam	SEBS, o-TPV, COPE	- Body/glazing seals - Skins , steering wheel	- 2 shot molding, extrusion - Challenge EPDM, PVC
High flow	o-TPV, SEBS	Glazing seals, skins	Soft touch is market driver
- Hi temp, - Oil resist	s-TPV	Under-hood	Challenges specialty rubbers and COPE (TPEE)
"Sustain " "Green"	SEBS, TPU, COPE	All applications where properties fit	Achieved via: - monomer, filler, oils
Transparency/ translucency	TPU, o-TPVs, SEBS	Skins/instruments	
Slush moldable	SEBS	Skins	Range of process competitors
High melt strength (HMS)	SEBS	Foam (skins)	HMS allows foaming, blow molding

SOURCE: ROBERT ELLER ASSOCIATES LLC,2012

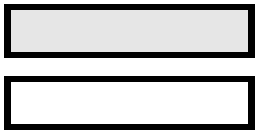
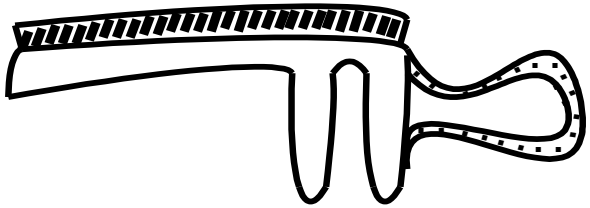
PRODUCT LIFE CYCLE (PLC) POSITION OF AUTOMOTIVE TPEs

- **<u>The function usually (not always) remains</u>: design approach shifts the**
  - **TPE being used (e.g. passenger airbag doors, some boots/bellows)**

- **<u>Globalization:</u>**
  - **Shifts the PLC curve (re-start in China)**
  - **Global TPE specifications starting**
  - **Differences between multinationals and domestic OEMs (e.g. China) and associated price/quality requirements**
  - **Introduces new TPE suppliers**

- **<u>Fabrication processes can shift:</u>**
  - **Position on the PLC curve, creating new fabrication process/TPE combination (e.g. two shot molding)**
  - **Systems costs → new TPE opportunities (e.g. body/glazing seals)**

CO-PROCESSING DRIVES TPE GROWTH IN RIGID/FLEXIBLE SYSTEMS

TYPE	STRUCTURE	NOTE/EXAMPLE APPLICATION
Overmold, Film coex, 2-shot mold		- Soft touch phones - Some 2-tone applications - Vibration damping
Side by Side		- 2-tone - Door trim, console, IP - Bumper fascia
Edging		- Body/glazing seals (profiles) - Cowl vent seals - Co-extrusion or 2-shot
Co-blow Mold		- Boots/bellows, hose - Ducting
Co-extrusion Blow Mold or Co-extrusion		Under-hood: - Hose (e.g. fuel) - Duct

Source: Robert Eller Associates LLC, 2012

r/mydox/Visio/Two Shot OM approaches 2012.vsd

TPEs IN WINDOW ENCAPSULATION

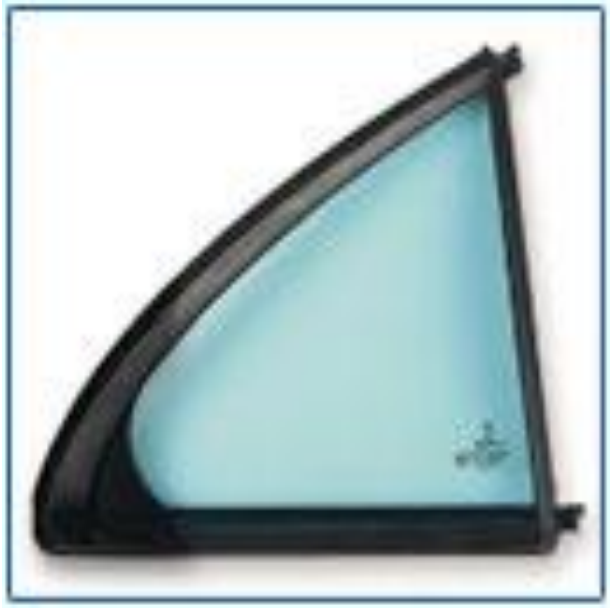
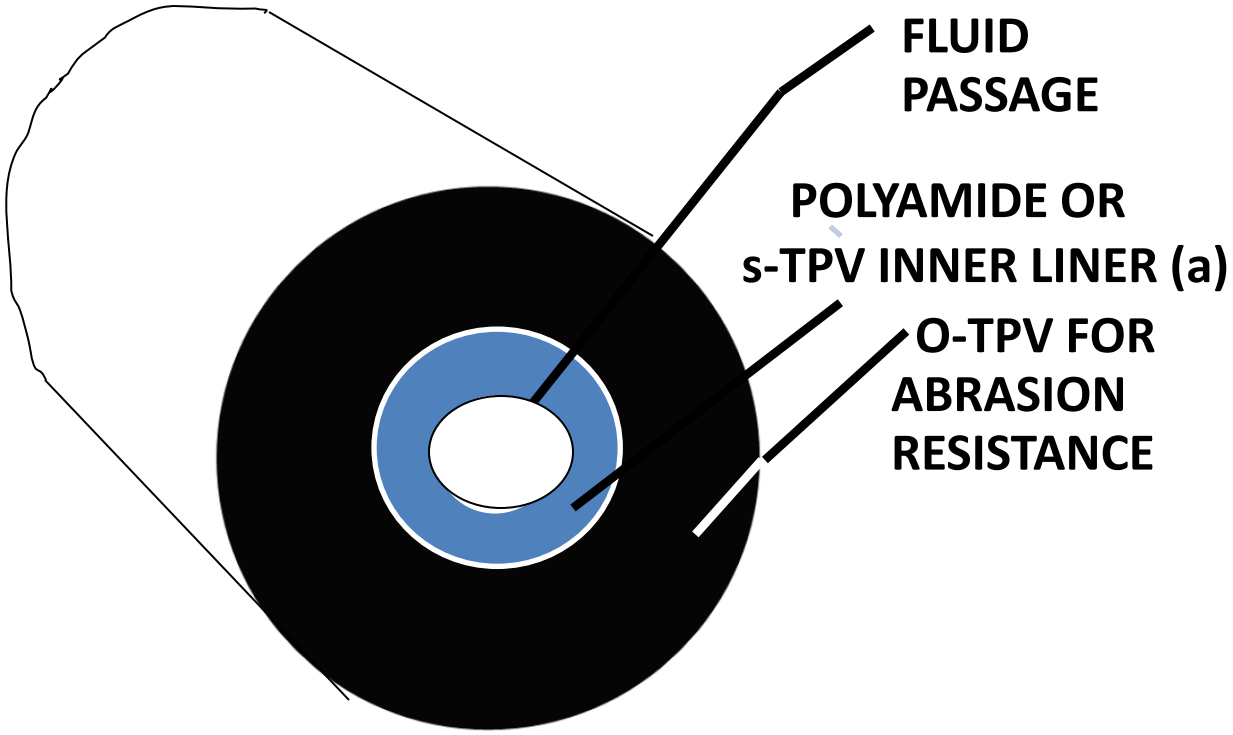


PHOTO: KRAIBURG

PHOTO: ROBERT ELLER ASSOCIATES LLC

- Application: Rear quarter window encapsulation seal
- Candidates: PUR, o-TPV, SEBS (H-SBC), PVC, EPDM
- Key requirements:
  - High flow (to reduce breakage)
  - Glass adhesion
  - UV/weather resistance
  - Low compression set
  - Squeak resistance
  - Scratch resistance
- Notes: Example of intense inter-material competition
  - Example of static seal application
  - Two shot adds value
  - Colors?
  - Narrower profiles?
  - Systems cost save opportunities
  - Polycarbonate glazing could shift requirements

AUTOMOTIVE HOSE: ADDING VALUE VIA COEXTRUSION

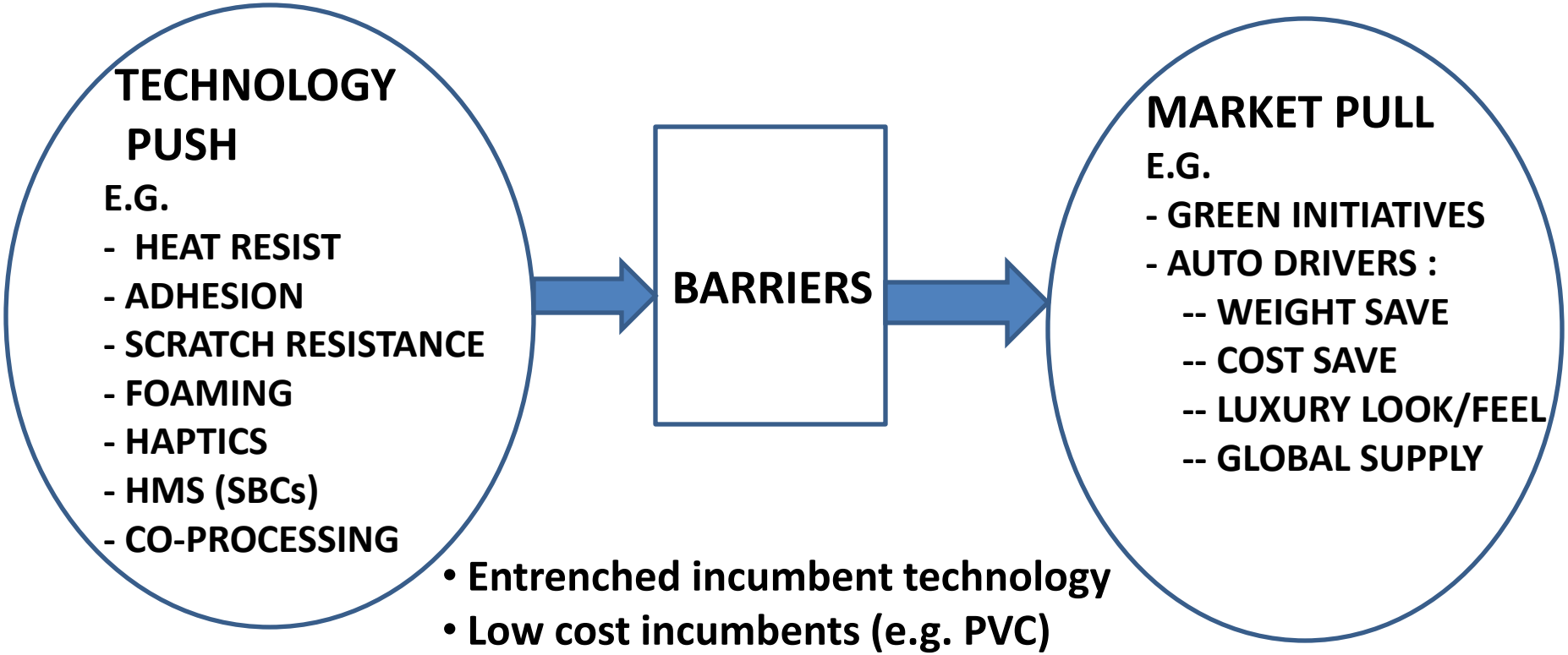


EXAMPLE OF SEBS REPLACEMENT OF EPDM AND o-TPV

PHOTO: STAR THERMOPLASTIC ALLOYS & RUBBERS

- **Application: Door lock assembly bellows**
- **TPE type: SEBS**
- **Compound supplier: Star**
- **Molder: Altratek; Longmont, CO**
- **Key properties/economics:**
  - **Moldability**
  - **Remain flexible at low temperatures (to – 40^{0}C)**
  - **Cost save vs EPDM and o-TPV**

NEXT TPE GROWTH PHASE: TECHNOLOGY PUSH/MARKET PULL



- Entrenched incumbent technology
- Low cost incumbents (e.g. PVC)
- In-house compounding by fabricators (e.g. rubber)
- Shift to commodity strategy by major TPE suppliers

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

TECHNOLOGIES THAT WILL DRIVE AUTO TPEs

TPE Materials

- HMS-SEBS
- High flow TPV and TPO
- s-TPVs
- Higher heat COPE (TPEE)
- Adhesion to engineering plastic substrates

Fabrication processes

- Foaming
- Two shot molding/core back technologies
- Controlling surface friction in body/glazing seals
- Continued penetration of 3-D blow molding

AUTOMOTIVE TPE BATTLEGROUND REVIEW

- **Bumper fascia:**
  - **Injection molded TPO remains dominant incumbent.**
  - **Gains in painting, thin-walling, recycling**

- **Boots/Bellows:**
  - **TPEs have dominant position vs rubber**
  - **Broad performance range . CV joints to simple dust covers.**
  - **TPE competitors: o-TPV (the major challenger), COPE, SEBS, s-TPV and TPU.**

- **Body/glazing seals:**
  - **EPDM the dominant incumbent. Potentially high volume application.**
  - **Continued (moderate) penetration by o-TPV and (recently) SEBS.**
  - **Systems cost savings opportunities.**
  - **Static seals easier to penetrate than dynamic seals.**
  - **Foaming, hollow profile extrusion , two shot are game changer processes.**

- **Coated fabrics :**
  - **PVC the dominant incumbent (extensive seating use).**
  - **PU dispersions in high end applications.**
  - **New challenge from SEBS**

AUTOMOTIVE TPE BATTLEGROUND REVIEW (Cont'd)

- **Ducting:**
  - **o-TPV, COPE, TPO, s-TPV and silicones contend .**
  - **COPE, silicone , s-TPVs serve the increasingly important high temp. segment.**

- **Interior skins (foils/soft touch) –**
  - **Slush molded PVC: major incumbent.**
  - **Systems cost savings opportunities**
  - **Slush molded SEBS, two shot molding and core-back processes are potential game changers.**

- **Radiator hose:**
  - **EPDM dominates , potentially large TPE application.**
  - **Recent o-TPV offerings show promise.**
  - **Co-extrusion (with polyamides), 3-D blow molding systems cost savings potential.**

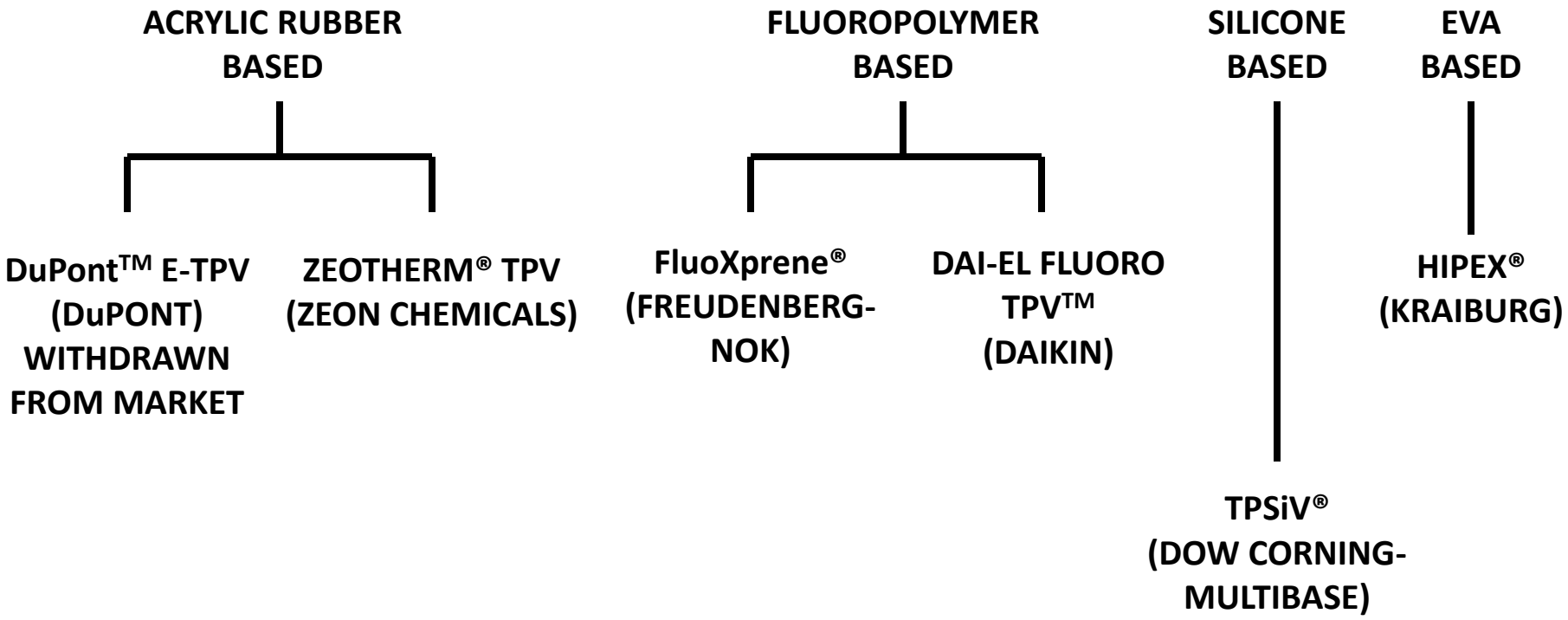
- **Under-hood seals :**
  - **s-TPVs are challenging incumbent high performance specialty rubbers**

TPEs STARTING IN COATED FABRICS

PHOTO: KRATON

- PVC: the dominant incumbent strongly entrenched, cost effective
- SBC-TPEs: Phthalate-free, UV resistance, low temp properties, hand/drape range

SUPER-TPV (s-TPV) FAMILIES



SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012
r/mydox/…/Super TPV Families 2012.ppt

UNDER HOOD TEMPERATURE RISE→ USE OF HIGH HEAT TPEs

PHOTO: ZEON CHEMICALS

- Application: Air duct cuff
- TPE type: s-TPV (Zeotherm)
- Key properties:
  - Heat resistance
  - Ease of processing
  - Polyamide adhesion

Note: Example of metal replacement (e.g. polyamide) pulling TPEs into under-hood applications

PHOTO: ZEON CHEMICALS

- Application: Hot air duct (primarily turbo engines)
- TPE type: s-TPV (Zeotherm)
- Key properties:
  - Heat resistance
  - Processing ease
- Processing: Blow molding

BIO-TPEs BEGIN AUTO MARKET PENETRATION

TPE FAMILY OR COMPONENT	RENEWABLE RESOURCE	SUPPLIERS	NOTE/RENEWABLE CONTENT, %
COPA	Castor oil	Arkema, Evonik	25-94
COPE, (TPEE)	Polyols from corn	DuPont, DSM	20-60
TPU	Polyols from corn	- Lubrizol, BMS - API,GLS/PolyOne	20-70
	Bio-propylene glycol	BASF/Oleon	From fats/oils
PP, PE (a)	Ethanol from sugar	Braskem, Dow	In TPE formulations
Bio-butadiene	Biomass	Versalis	Via butanediol
	Waste gas CO	Invista/LanzaTech	
SEBS (H-SBC)	Oyster shell (filler)	CTS	Many other bio-based fillers/fibers (b)
SEBS (H-SBC)	Starch/hydrocarbon graft (Gaialene®), Roquette	CTS	Substitute for PP in TPE formulation

Note:

(a) Toray will use bio-based PE in polyolefin foam sheet. Several auto applications

(b) At least 7 families of plant-based families provide bio-fillers for TPEs and plastic compounds

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2012

SUMMARY: POSITIONING STRATEGIES FOR GLOBAL AUTO TPE SUCCESS

- **Asia :**
  - **" Be" there**

- **Global position:**
  - **Establish global supply capability**
  - **Seek benefit from global platform trend**
  - **Seek global specification opportunities**
  - **Be willing to adjust to glocal/local requirements**

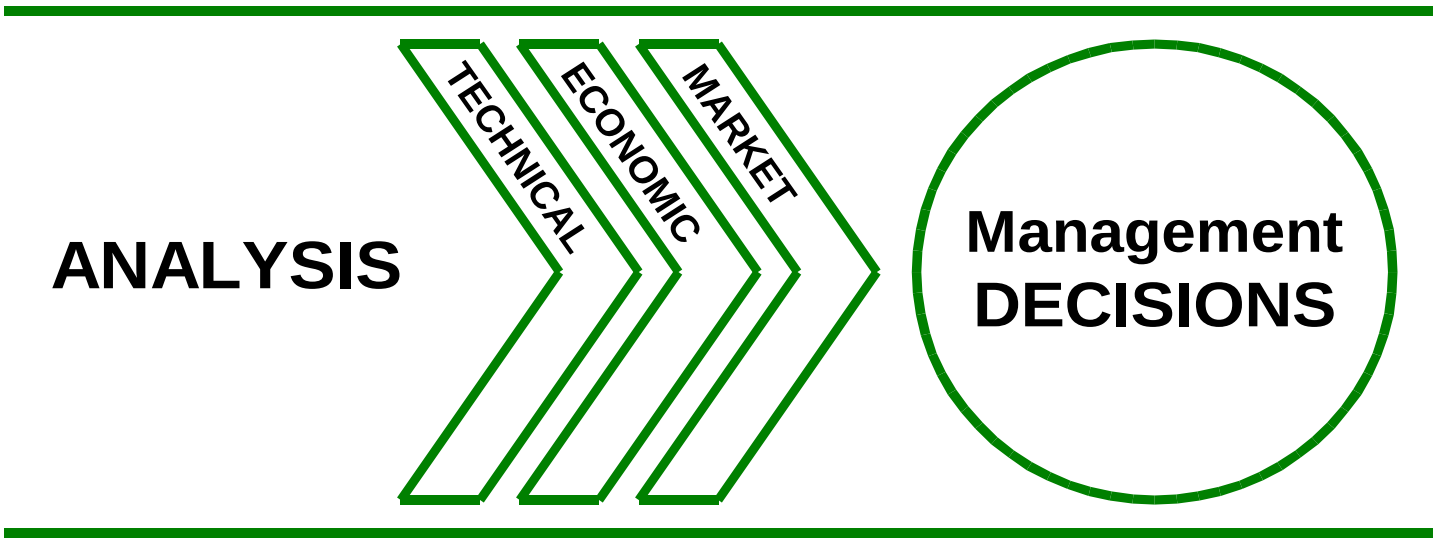
- **Technologies:**
  - **View the opportunities as a fabrication process/TPE material couple**
  - **Be willing to partner with fabrication technology source to renew a mature application**
  - **Establish fit with bio-TPE offerings**

SUMMARY: POSITIONING STRATEGIES FOR GLOBAL AUTO TPE SUCCESS(Cont'd)

- **Auto TPE life cycle/targets:**
  - Avoid mature/commodity targets
  - Target rubber applications
  - Follow plastics applications
  - Provide value via systems approaches
  - Be willing to "shape" new markets/applications

- **Seek opportunities from auto technology drivers:**
  - Lightweighting (the major driver): Increased TPE in systems (2 shot; insert molding, 3D blow molding)
  - Optimized engine performance (especially turbo engine increase):
    - -- Under-hood metal replacement by high temp plastics→ s-TPVs and other high temp TPEs in sealing applications
  - Sustainability: bio TPEs, recycling solutions
  - Electrification: TPEs in wire/cable
  - Increased luxury in small/medium cars: soft touch

THANKS FOR YOUR ATTENTION



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