



Robert Eller Associates LLC
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES

GLOBAL TPEs: NEW TECHNOLOGY, REGIONAL MARKET SHIFTS AND COMMODITIZATION

PRESENTED BY:

Robert Eller
Robert Eller Associates LLC
Phone: +1 330-670-9566
Email: bobeller@robertellerassoc.com
Web Site: www.robertellerassoc.com

PRESENTED AT:

TPE Topcon Conference 2014
Akron, OH (USA)
September 17, 2014
b/papers/topcon 2014

OUTLINE



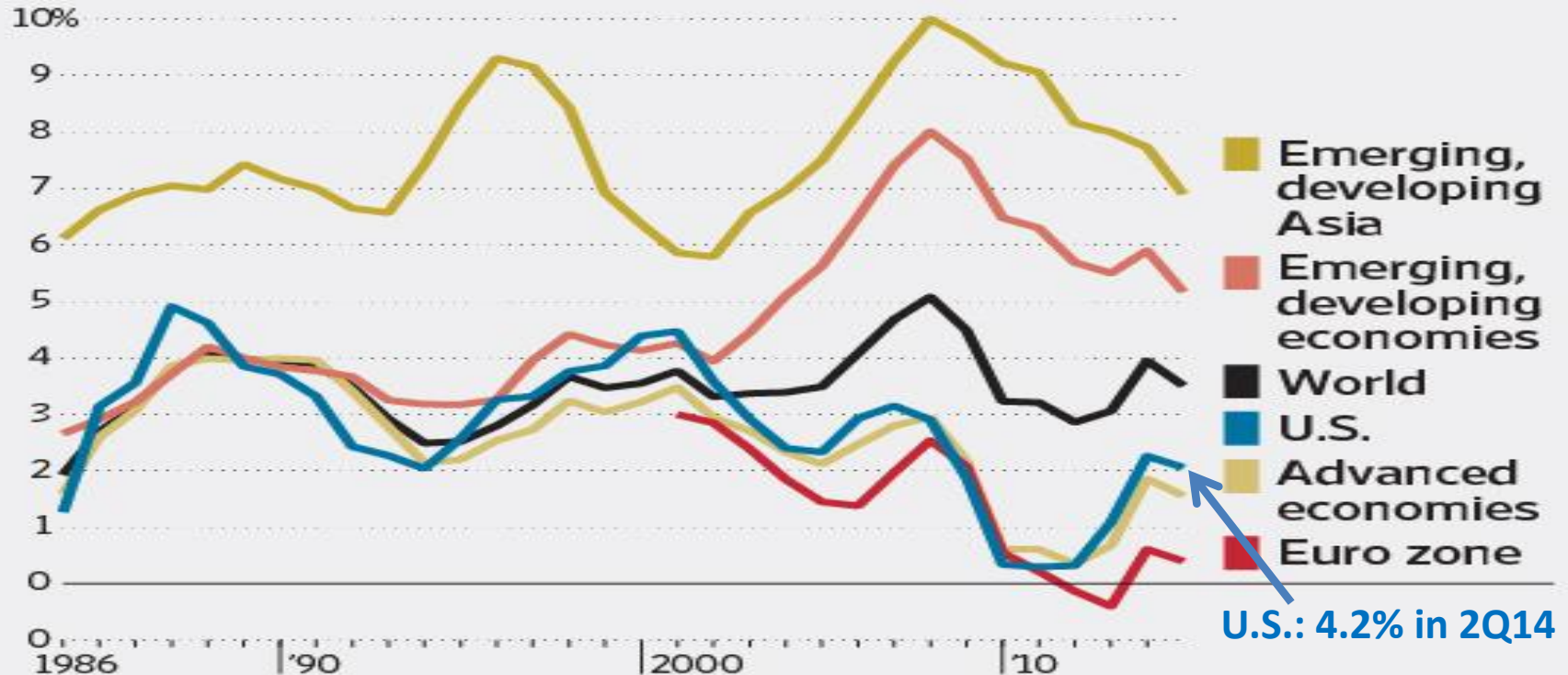
- **Role of macroeconomics in TPE globalization**
- **Automotive market: effects on TPEs**
- **China snapshot**
- **Re-shoring and TPE in NAFTA**
- **Global TPE frontiers and shifts**
- **Overcapacity perspectives**
- **Expanding the TPE family footprint**
- **Market trends and applications examples**
- **TPE strategy wheel**

GLOBAL GDP SNAPSHOT



Brave New World

More than four years after from the start of the U.S. recovery, the pace of growth has slowed globally. Average GDP growth over the previous four years, adjusted for inflation*



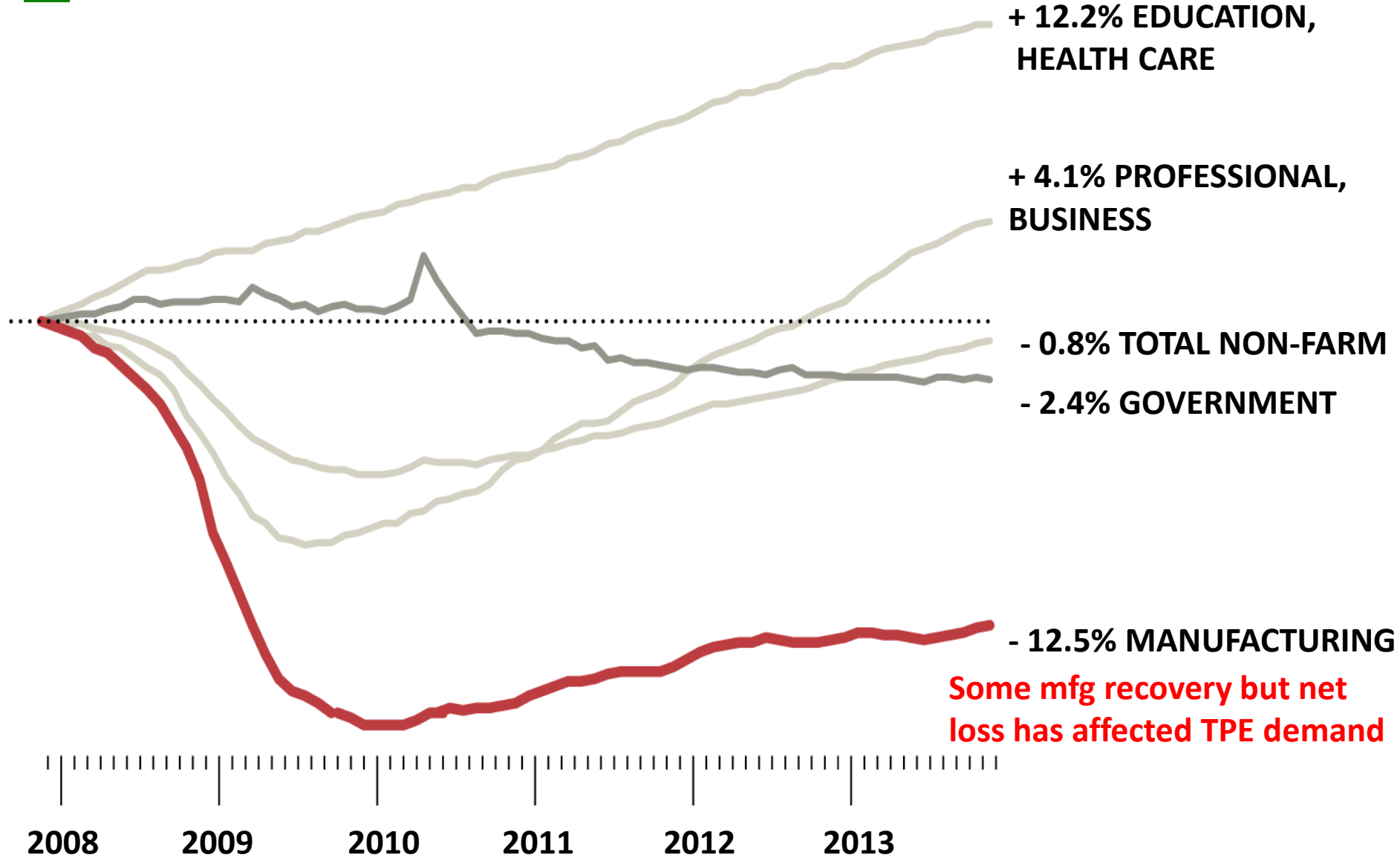
*2014 data are forecasts Source: International Monetary Fund Pat Minczeski/The Wall Street Journal

Emerging markets are changing the global TPE footprint (volumes, grade range and industry structure)

DATA SOURCE: IMF

COMMENTS: ROBERT ELLER ASSOCIATES LLC, 2014

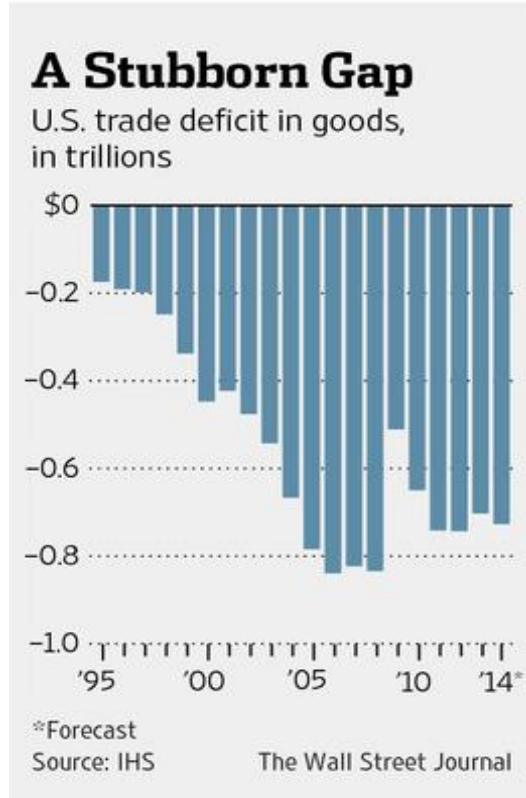
CHANGE IN U.S. JOBS SINCE DECEMBER, 2007



SOURCE: BUREAU OF LABOR STATISTICS

FALLING U. S. WAGES WILL HELP SUPPORT RE-SHORING

Change since June 2009, the end of the recession



Financial services +5.5%

Education, health +1.4

-0.1% Information

-0.5 All private-sector jobs

-1.3 Retail

-1.7 Leisure, hospitality

-1.9 Construction

-2.4 Manufacturing

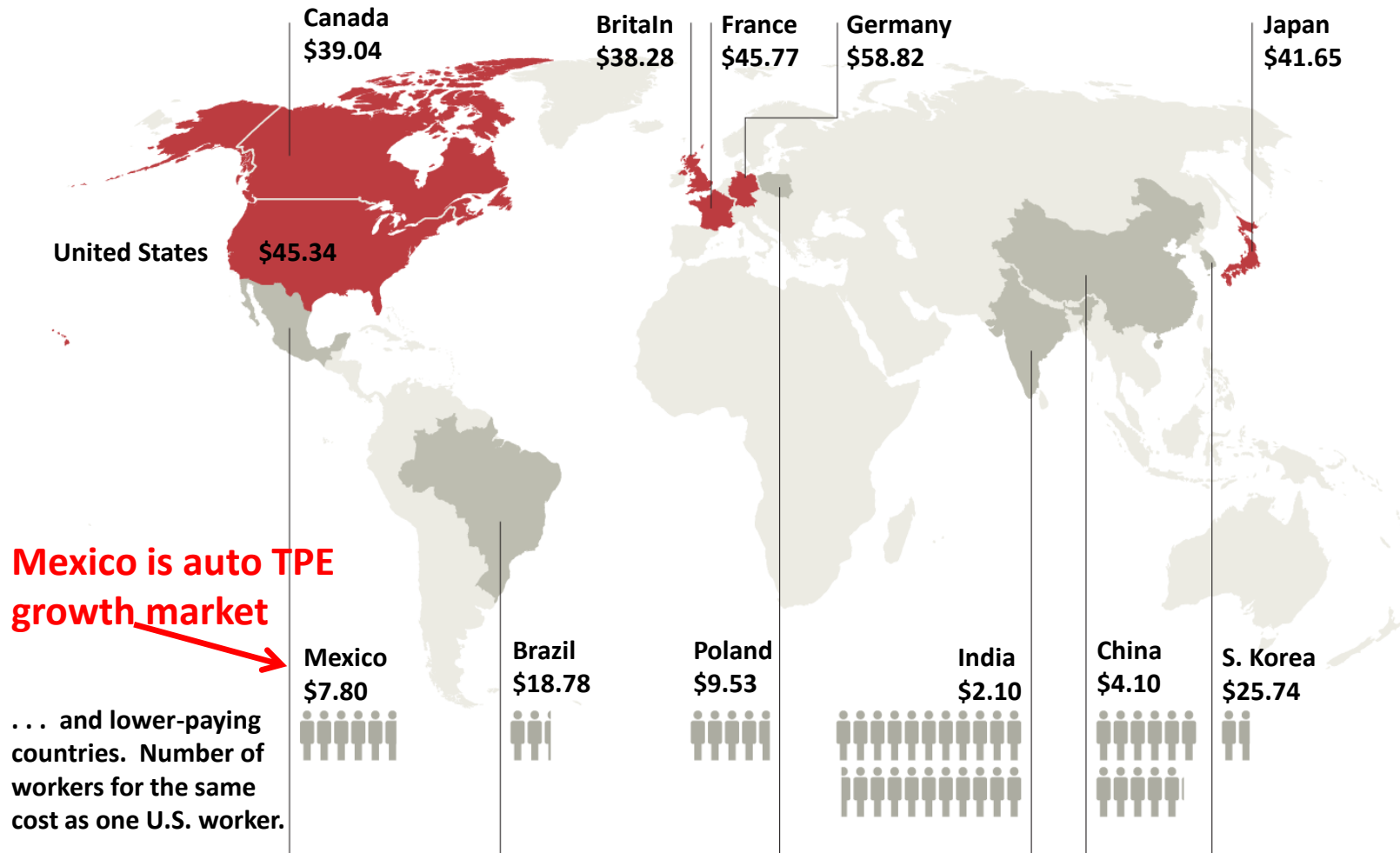
-10.0 Auto industry

Auto recovery has stimulated auto TPE demand, especially TPOs

SOURCE: BUREAU OF LABOR STATISTICS

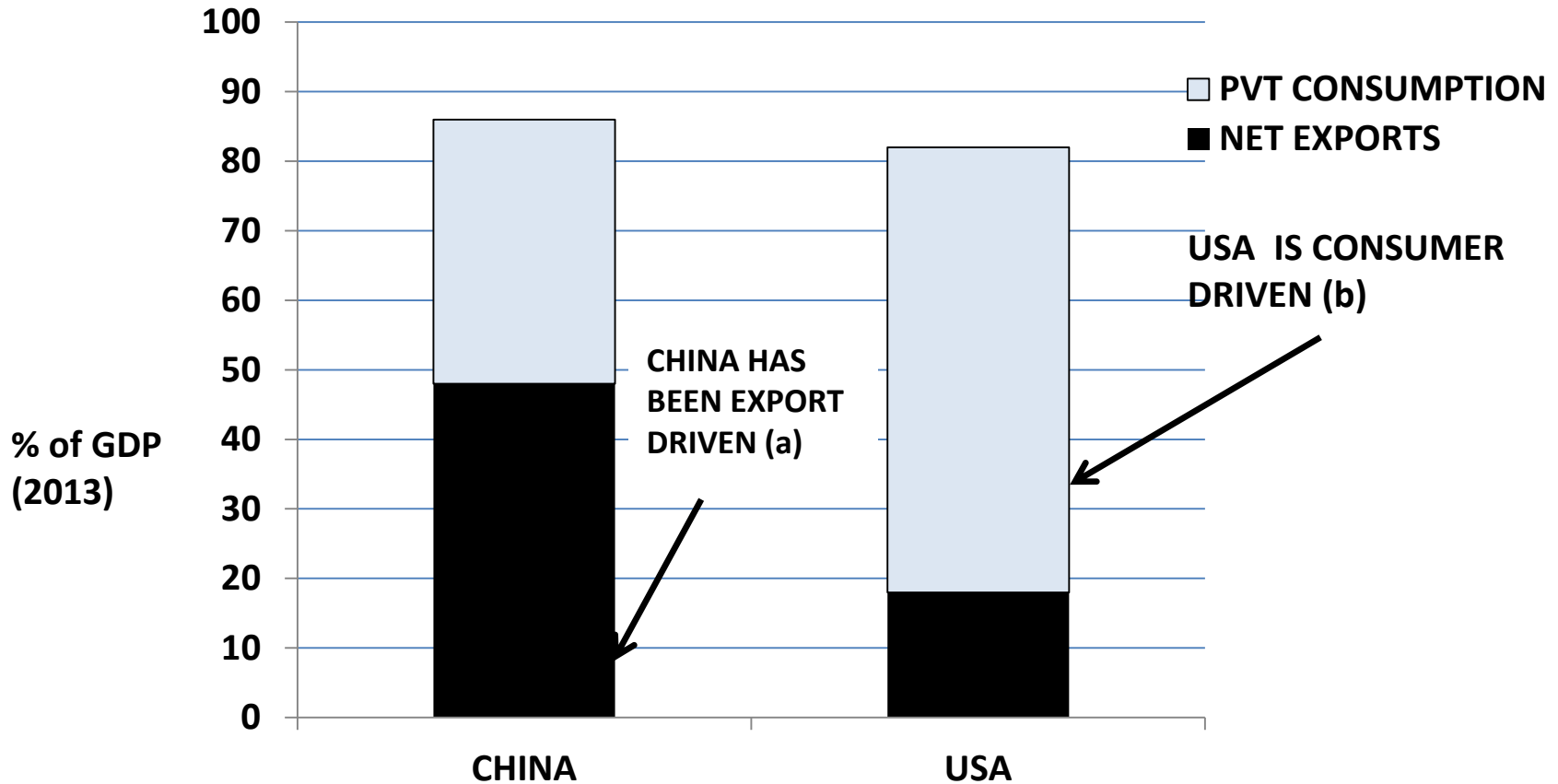
AUTO WAGES: STILL MAJOR GAP BETWEEN HIGH AND LOW PAYING COUNTRIES

Automobile industry average hourly compensation in 2012, including benefits:



Sources: Bureau of Labor Statistics; Center for Automotive Research

USA AND CHINA ECONOMIES DIFFER IN GDP USAGE (2013)



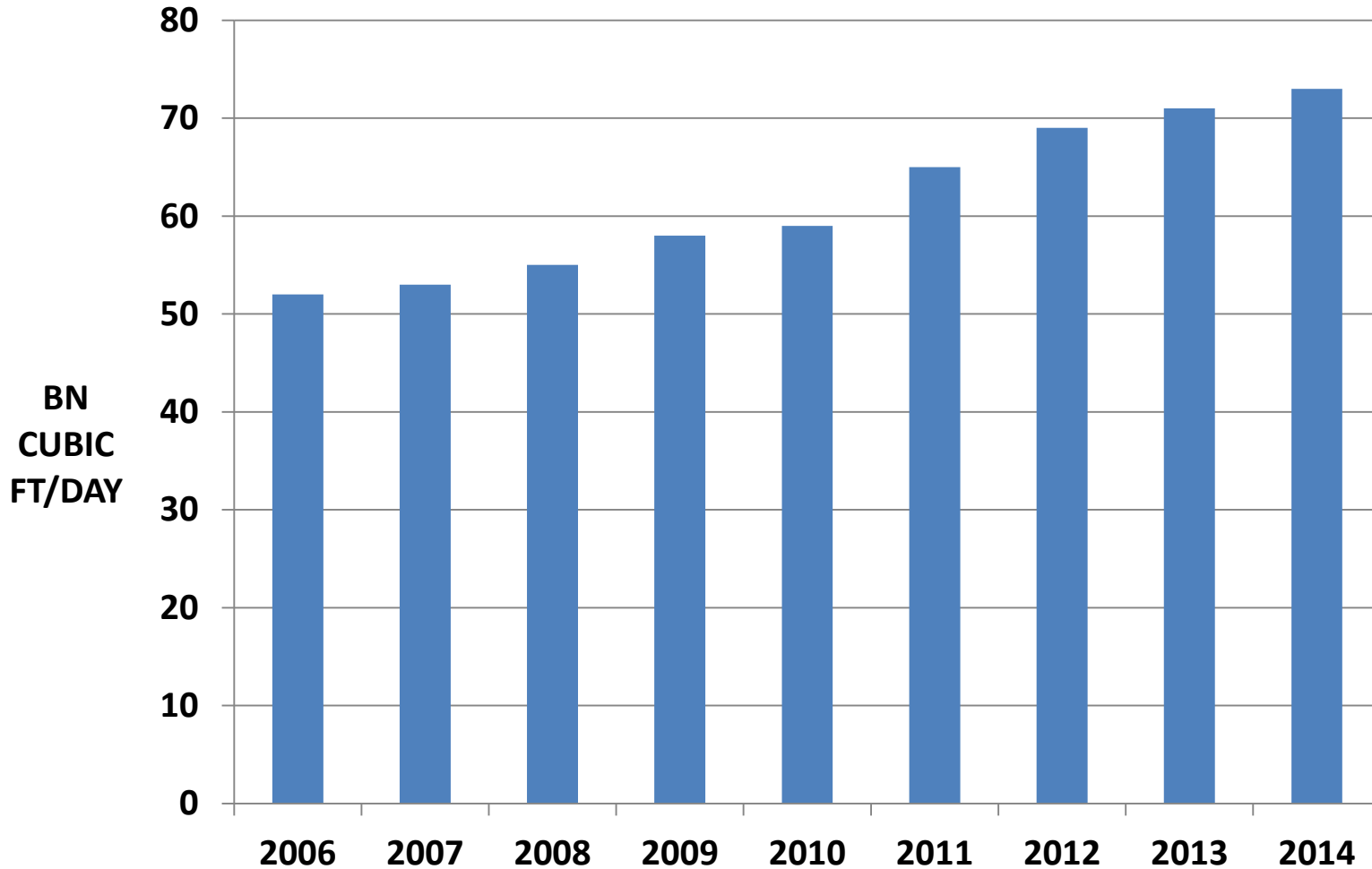
Note:

(a) China rebalancing policy could → shift to increased domestic consumption → increased TPE usage for domestic products with associated quality/price levels

(b) USA in trade deficit since mid-70s, China in trade balance surplus since 1994

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2014

GAS PRODUCTION IN U.S.



DATA SOURCE: U.S. ENERGY INFORMATION SERVICE

38% INCREASE IN GAS PRODUCTION SINCE 2006 SHIFTS ETHYLENE ECONOMICS ,
STIMULATES U.S. EXPORTS OF ETHYLENE -BASED TPEs AND RUBBERS

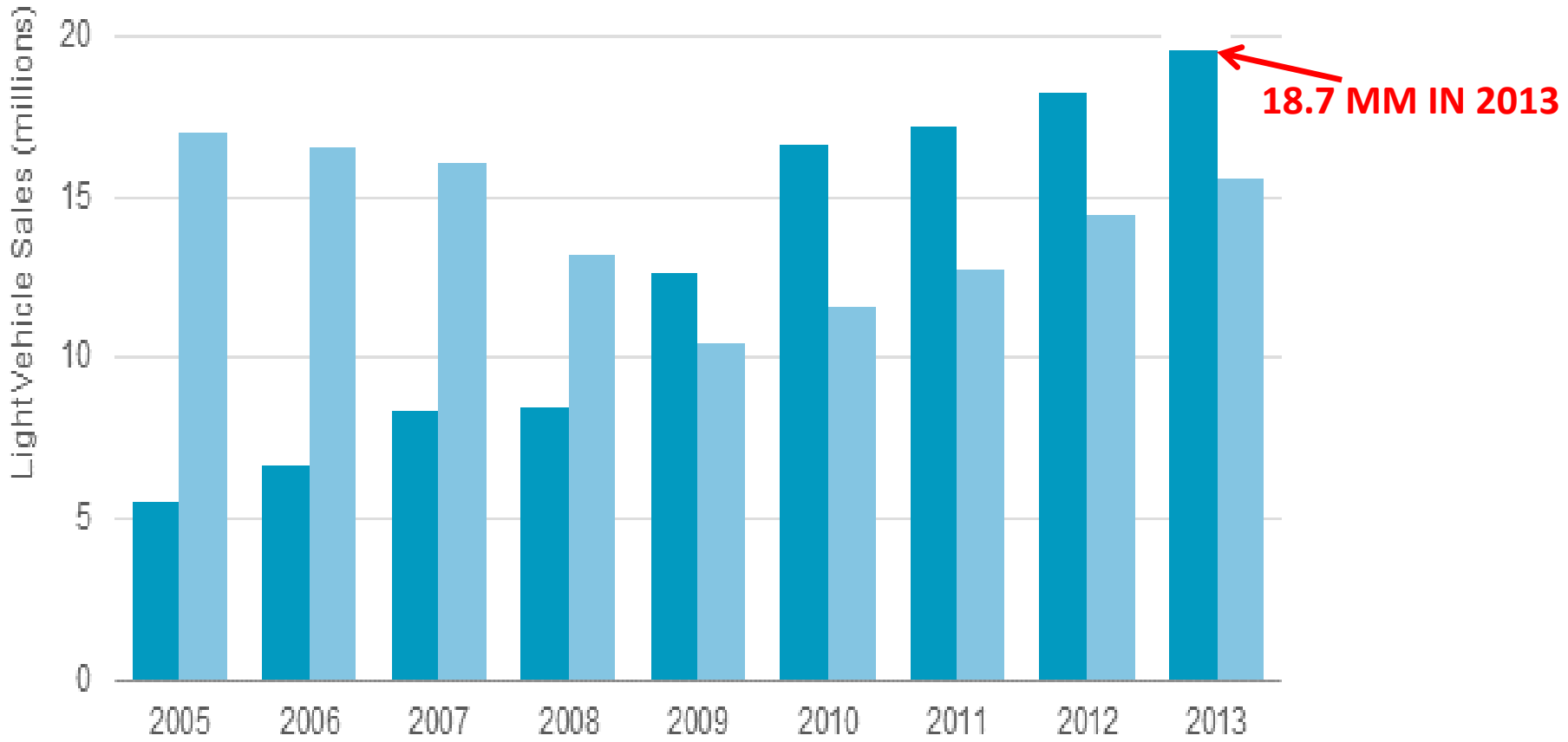
SOURCE: ROBERT ELLER ASSOCIATES LLC,2014

CHINA IS A HIGH GROWTH LIGHT VEHICLE (LV) MARKET

China:

- exceeds USA sales in 2009
- capacity overbuilt, dropped to 60% utilization in 2012 (OEM consolidation likely)
- solid growth continues through 2017 (excellent TPO and TPE growth prospects)
- potential slowing of vehicle growth > 2017 (e.g. 28-29 MM in 2018)

USA: likely to top out at ~ 17-18 MM LV sales/yr in 2017-2018



DATA: Wards Auto

■ China ■ USA

COMMENTS: ROBERT ELLER ASSOCIATES LLC, 2014

IMPORTANCE OF AUTOMOTIVE VARIES BETWEEN TPEs

TPE TYPE	AUTO SHARE OF GLOBAL DEMAND	RECENT INCUMBENT	NOTE/ AUTO TARGETS
TPO	80%	None –TPO dominates	Bumper fascia, interior trim, skins Growth in non-auto markets
o-TPV	50%	NBR/PVC, ECO, CPE, EPDM	Boots/bellows, hose, short air ducts, Body/glazing seals
SEBS	15%	EPDM, o-TPV	Auto share growing via soft touch, skins, body/glazing seals, airbag doors
TPU	11%	EPDM, o-TPV	Grommets, sleeves, door sills, overmolded films, shift knobs, lamp seals, slush molding, wire/cable
COPE	10%	EPDM, o-TPV, fluorosilicones	Under-hood ducting(higher temp capability), wire/cable, soft touch trim panels

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2014

ASIA TPE SHIFT DYNAMICS SNAPSHOT



Western TPE → China to serve → Invest in local prod'n
compounders OEM transplants

Domestic TPE → Serve domestic → Move up Q/P tiers → Serve Western mkts → Invest
compounders quality/price tiers via distribution in West

China/Taiwan- → Serve domestic → Move up Q/P tiers → Serve Western mkts → Invest
resin suppliers quality/price tiers via distribution in West

Western resin → Export → Invest in local
suppliers Asian prod'n

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2014

NAFTA RE-SHORING: RECOVER TPE MARKETS LOST IN ASIA SHIFTS



Re-shoring drivers

- Increasing wages in low cost countries (15-18%/yr in China for last 3 years)
- Transportation costs
- Shorter/more controllable supply chain in NAFTA

Challenges

- Finding enough skilled ,educated workers in US
- Redesign/re-engineering required for higher cost environment
- Consumers willing to pay a bit more

Some examples of re-shoring to NAFTA

- Apple (mobile electronics)
- GE (water heaters, refrigerators)
- Ford (various auto parts)
- Whirlpool (washing machines)
- Foxconn/Hon Hai, Taiwan (electronic components for Apple, auto)

TPE benefits

- Efficient manufacturing (2 shot, core-back techniques)
- Reduced assembly costs
- Reduced labor content vs hand assembly
- Attracting Asian TPE suppliers



- TPEs in growth phase
- Substantial investment by Western TPE compounders
- Domestic TPE compounders and resin suppliers are very competitive
- TPOs driven by continued auto production growth(o-TPVs lagging)
- State-owned enterprises (SOEs) present in TPE marketplace (e.g. SBC resin)
- Importance of quality/price (Q/P) levels impacting TPE product lines
- Overcapacity/overinvestment → downward TPE price pressures
- China “re-balancing” policy shifting from export → increased domestic consumption and developing SE Asia markets
- TPE Investment coming out of region → NAFTA, Europe

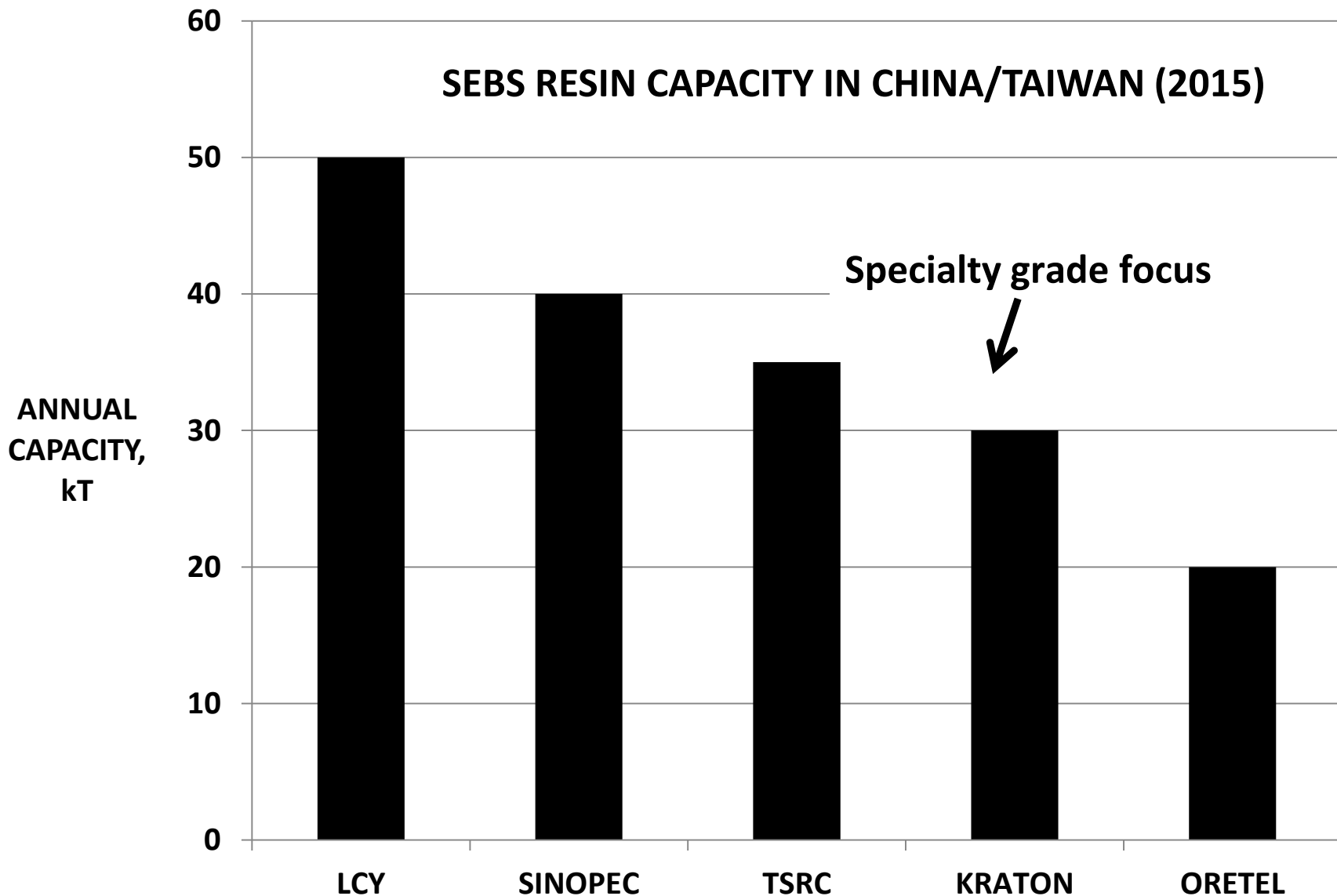
GLOBAL TPE FRONTIER: MEXICO



- **New TPE geographic growth frontier**
- **Population 111 MM (+40MM in Central America) = 45% of US population**
- **Economy:**
 - on a well managed growth trajectory
 - credible management
 - structural reforms passed
 - GDP/capita \$8,519 vs \$3,344 in China
 - currently driving immigration to US
- **Benefit from US recovery (85% of exports → US)**
- **Widening of the Panama Canal allows mega-ships, will → new ports**
- **TPE, (especially TPO) increase driven by high growth auto sector**
- **U.S., European TPE compounding and sales investment (e.g. So-F-Ter, RTP, Kraiburg)**
- **Ability of Southern U.S. TPE compounders to service market from U.S. will be tested**
- **Infrastructure, immigration, crime, and border transfer are concerns**

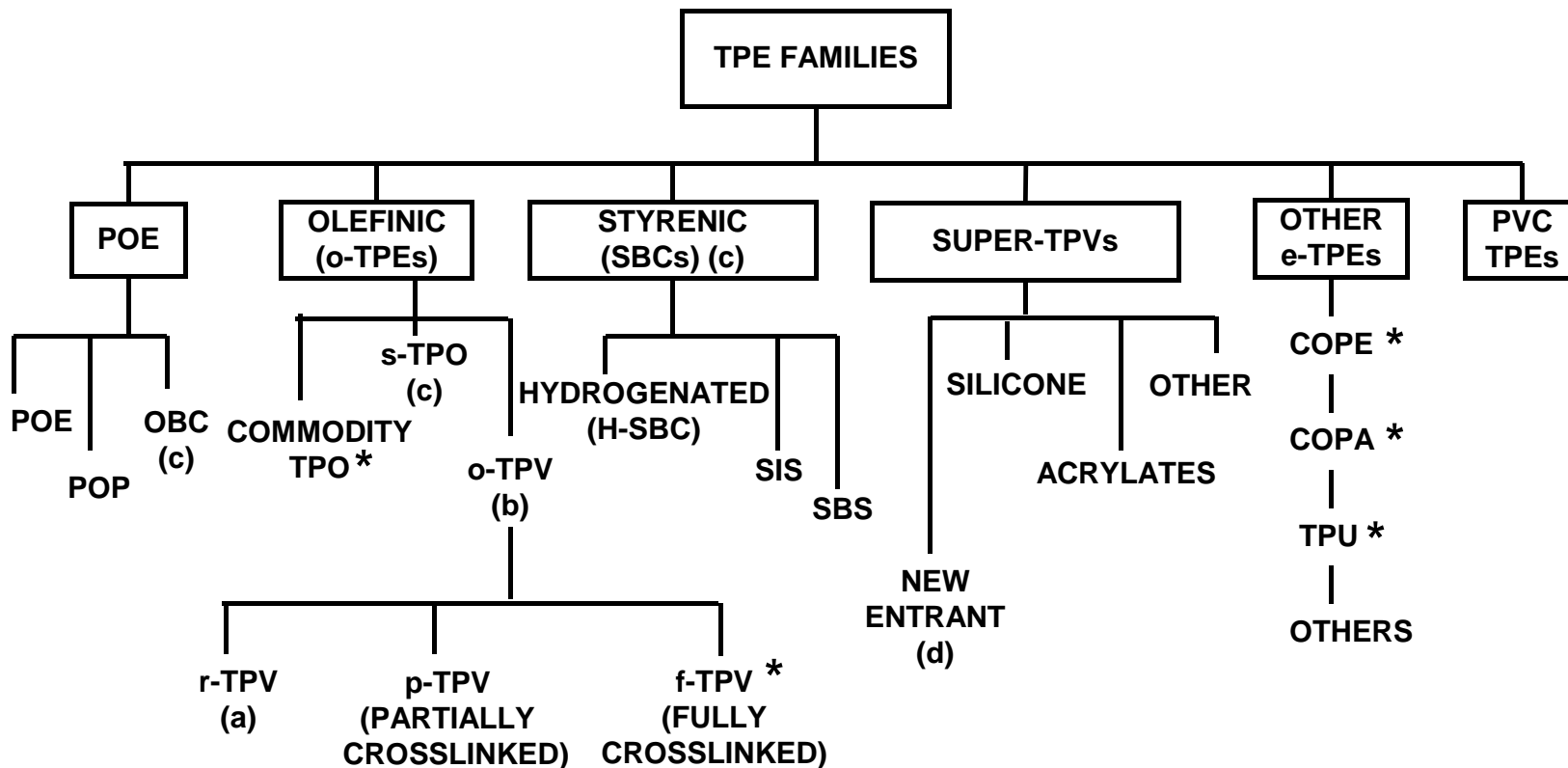
SOURCE: ROBERT ELLER ASSOCIATES, LLC

OVERCAPACITY IN SOME ASIAN TPE SECTORS: EXAMPLE SEBS RESIN



SOURCE: ROBERT ELLER ASSOCIATES LLC, 2014

TPE FAMILIES . . . EXPANDING FOOTPRINT, INTRA-TPE COMPETITION , ENTRY OF POEs



Notes: * = Production dominated by resin suppliers

(a) Recyclate-based TPV

(b) e.g. Dow Infuse™

(c) Specialty grades of TPE usually produced by independent compounders

(d) e.g. Hipex from Kraiburg®

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2014

r/mydox/TPE/TPEfamilies 072914

TPE SNAPSHOT: ETHYLENE ALPHA OLEFINS (POEs AND POPs)



- **Key characteristics**
 - Low modulus
 - Low HDT
 - Poor compression set
 - Good impact modifier
- **Low cost:** 0.80-1.00 \$/lb (1.80-2.2 \$/kg)
- **Global volume:** ~ 800kT
- **Raw materials(a):**
 - Ethylene, Propylene
 - Co-monomers (octene, hexene)
- **Major suppliers(a):**
 - Dow (Engage, Versify, Amplify)
 - ExxonMobil(Exact, Vistamaxx)
 - Mitsui (Tafmer)
 - LG, other entries likely
- **Markets/applications:**
 - Impact modification (e.g. TPO is largest app)
 - Footwear
 - Packaging
 - Adhesives
 - Healthcare and personal hygiene
 - Blown film additive
- **Growth potential:**
 - High (> 6%/yr globally)
 - New plants in Singapore (ExxonMobil) and Thailand (Dow/SCG group)
 - Swing trains(producing EPDM in same plant)
- **Intermaterials competition:**
 - SBC compounds (SBCs have better: oil absorption, compression set, heat distortion temperature)
 - EPDM (e.g. in TPOs)
 - Reactor TPOs, PVC

(a) Gas economics(shale and non-shale) will shift competitive positions of materials, suppliers and US vs Europe-based suppliers

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2014

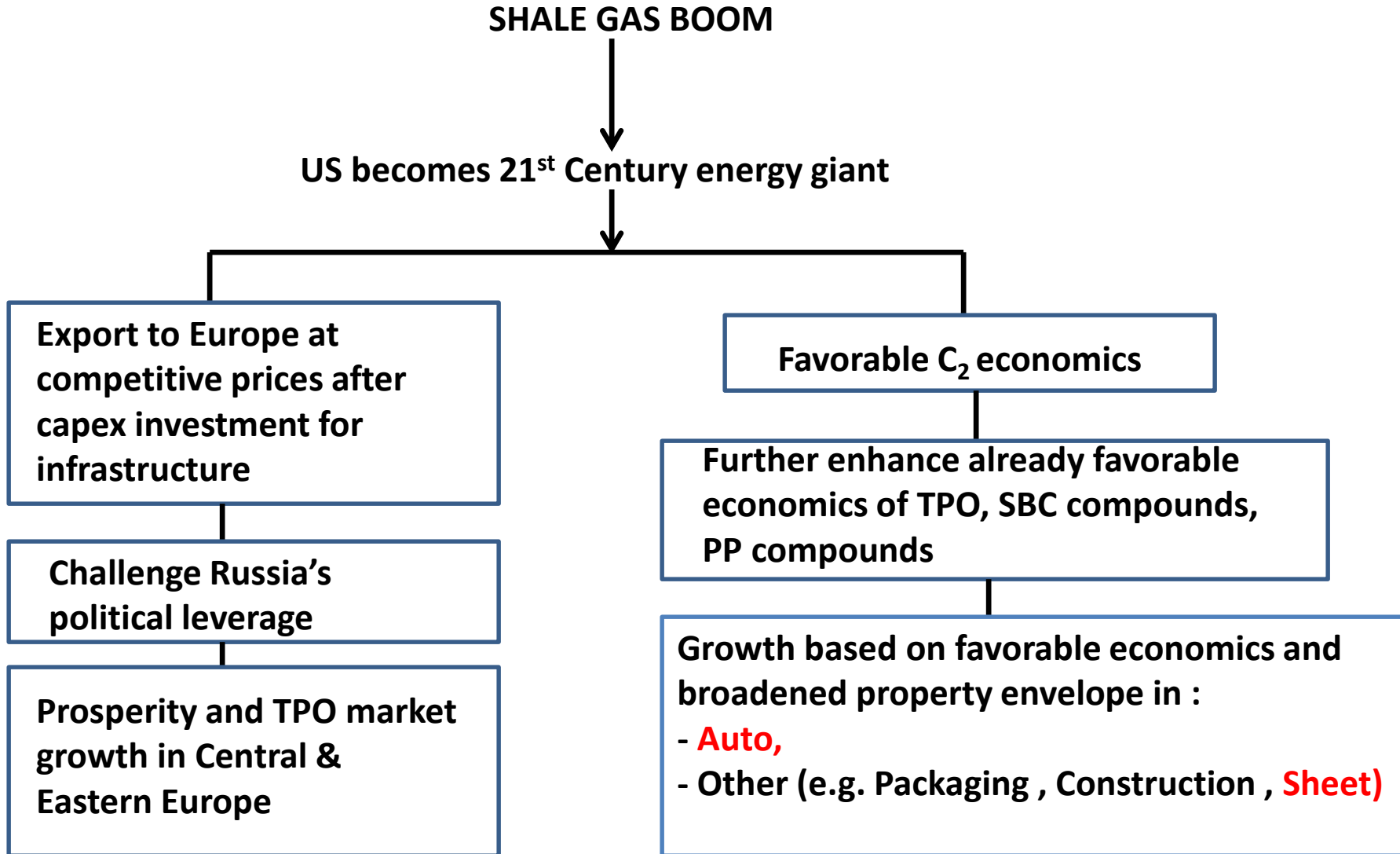
POEs COMPETE IN THE TPE MARKETPLACE



- Includes both POEs and OBCs (a)
- Relatively new technologies in early part of growth curve
- Production capacity expanding rapidly
- Producers will benefit from shale gas economics (current USA advantage)
- Direct TPE competition and as formulation ingredient (TPOs and SBC compounds)
- Competes with:
 - SBS as formulation ingredient
 - direct competition with f-PVC (both are semi-crystalline, different morphology, melting behavior, rheology)

Note: (a) for example INFUSE™ Olefin Block Copolymer from Dow

SHALE GAS EFFECTS: TPOs, SBC COMPOUNDS, PP COMPOUNDS



TPE MARKET TRENDS



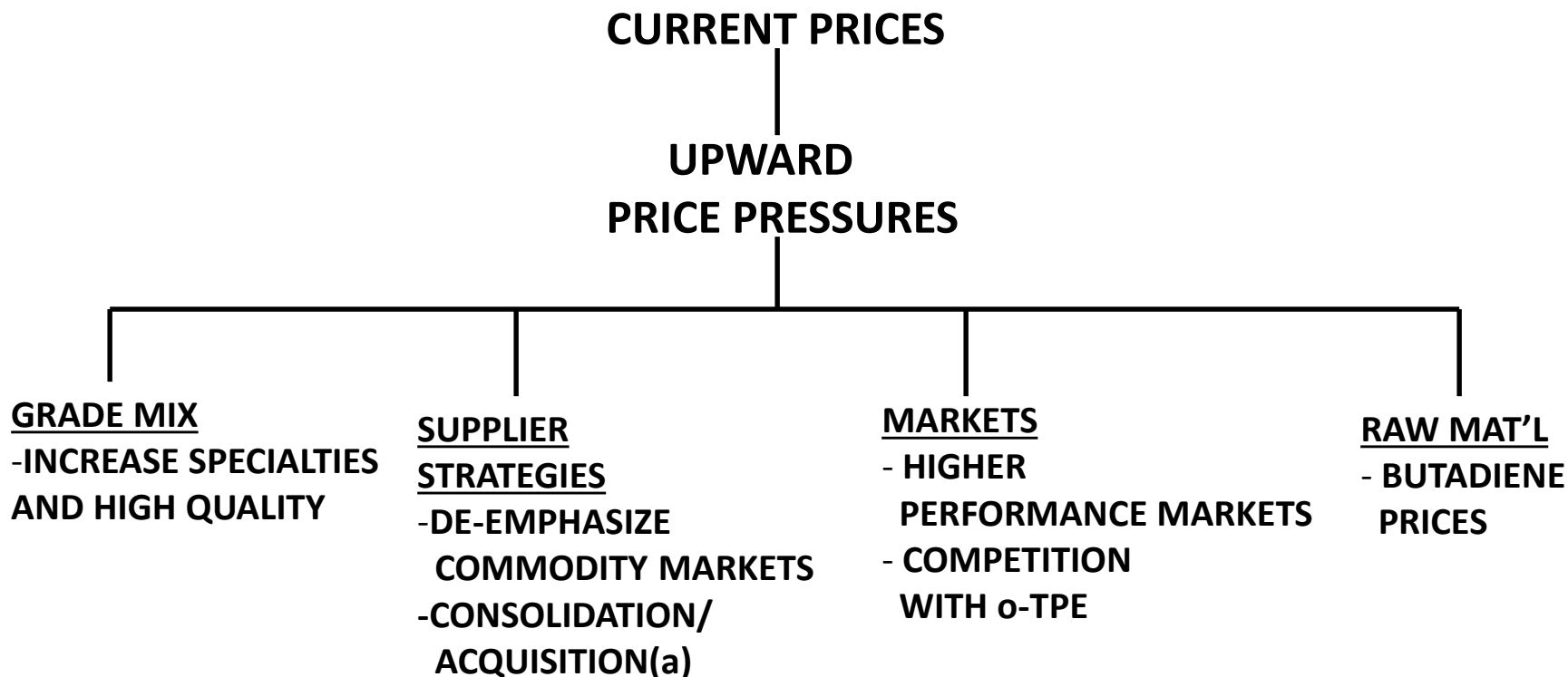
- **Commoditization:**
 - Market segments into specialties and commodities. Associated concentration by TPE suppliers
 - Back integration by distributors into compounding (e.g. Albis, Ravago, PTS, Alliance)
- **Demand growth in non-China/non-India emerging markets:**
 - Middle class empowerment;- Growth of auto demand (e.g. Indonesia)
- **Increased importance of quality/price tiers(global, glocal, local, bottom end)**

EXAMPLE TPE GROWTH MARKETS

TPE TYPE	MARKET	NOTE
SEBS	Packaging	Soft touch labels, caps
SEBS/TPO/o-TPV	Auto	Auto: Skins, body/glazing seals
SBS	Several	Increased use in SBC formulations
SEBS, COPE	Electronics	Silky feel.
o-TPV, SEBS	Auto	Body/glazing seals
SEBS	Medical	High growth: films, tubing. PVC challenge
SEBS, o-TPV	Wire/cable	Must compete with f-PPO
Bio- TPU, SEBS, COPE	Several	Multiple approaches to bio-TPEs
TPU foam	Footwear	BASF process. Application to other markets



UPWARD TPE PRICE PRESSURES/STRATEGIES: SBC COMPOUNDS



Note:

(a) As part of globalization strategy

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2014

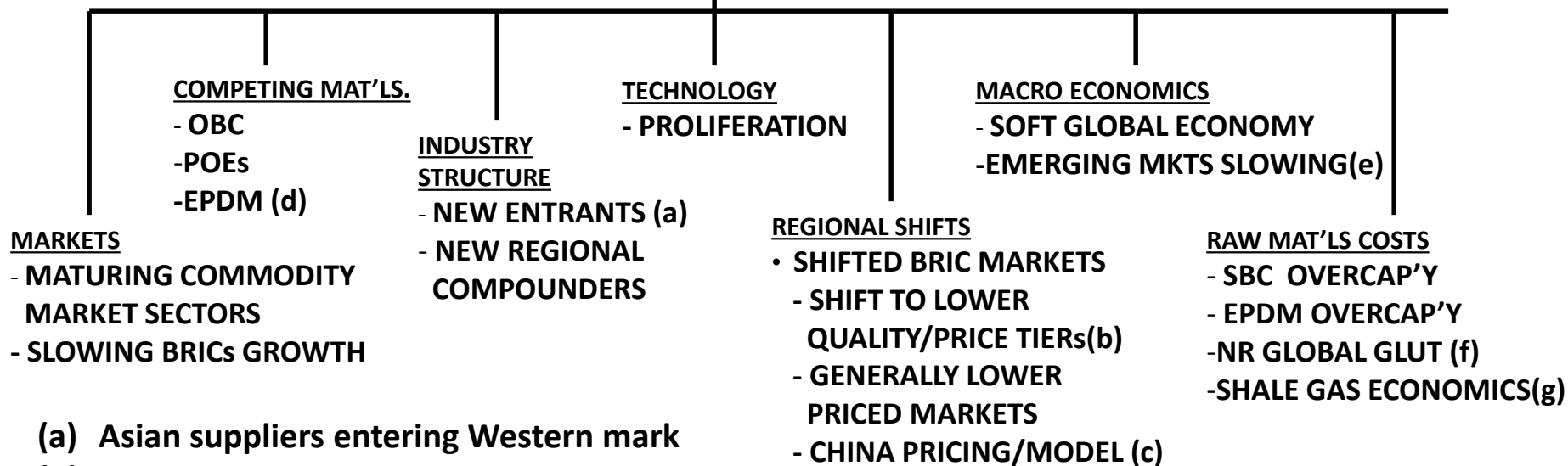
PRICE PRESSURES ON TPEs - DOWNWARD



CURRENT PRICES



DOWNWARD
PRICE PRESSURES



(a) Asian suppliers entering Western mark

(b) e.g. Global, glocal, local, bottom -end

(c) e.g. Cash flow vs. return on capital pricing model

(d) EPDM is in global overcapacity

(e) (e.g.) Slowdown of China and other emerging economies

(f) Natural rubber glut has driven prices down. Pressures SBS prices where they compete

(g) Shale gas economics currently favor U.S. producers

PARADIGM SHIFTING IN GLOBAL TPEs



- **Increased importance of quality/price tiers**
- **N. American shale gas/oil shifts economic competitiveness in polyolefins**
- **Emerging-region auto markets increase TPE demand via unit volume growth and substitution**
- **Supply chain broadening and consolidating:**
 - new entrants
 - acquisitions
- **Emergence of Asian TPE competition challenging large global incumbents via localization of supply chain**
- **Emergence of global:**
 - auto platforms
 - standards/performance requirements

SHORT AIR DUCTS: MODERATE TEMPERATURE UNDER HOOD APPLICATION



Photo source: ExxonMobil

- **Application:** Short clean-air duct
- **TPE Candidates:** o-TPV, PVC/NBR
- **Rubber competition:** EPDM
- **Key Properties:**
 - Constant temp resistance to 135⁰C
 - Oil resistance
 - 75A hardness
- **Fabrication process:** Injection or blow mold
- **Notes:**
 - Recent example (not shown) is Hyundai short air duct based on Santoprene™ TPV
 - s-TPVs and COPE for higher temp ducts
 - Weight and cost save vs TS rubbers
 - Recyclability a benefit of TPE use

POLYCARBONATE AUTO GLAZING: NEW OPPORTUNITIES FOR TPEs



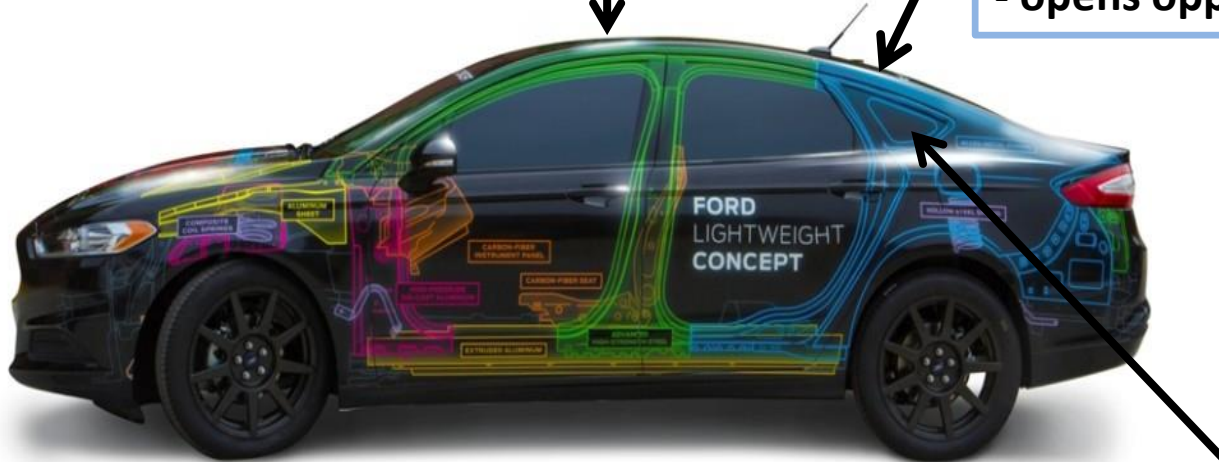
Sunroof:

- key PC glazing target
- TPE glazing seals starting

Injection molded rear window glazing:

PC from SABIC:

- 35% weight save vs glass
- plasma coating (Exatec E900)
- opens opportunity for TPE encapsulation



Vehicle: Ford Fusion multi-material
lightweight vehicle MMLV)

Rear quarter windows:

- entry point for PC
- battleground for TPE window encapsulation (wincap)
--SEBS, o-TPV vs PU-RIM, PVC

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2014

TECHNICAL TRENDS AFFECTING AUTOMOTIVE TPEs



- **COPEs:**
 - High temperature resistance
 - Adhesion
 - Haptics
 - Multi-shot

- **TPOs:**
 - High flow
 - Thin wall capabilities
 - Use in acoustic components
 - Role of POEs
 - Renewed skins growth

- **o-TPVs:**
 - High flow/glass adhesion grades for window encapsulation
 - Continued penetration into body seals and glass run channels
 - Improved attachment systems for body seals
 - Strength of the EPDM incumbency

AUTO TPE CHALLENGE: COST SAVING



The challenge: Reduce total parts cost

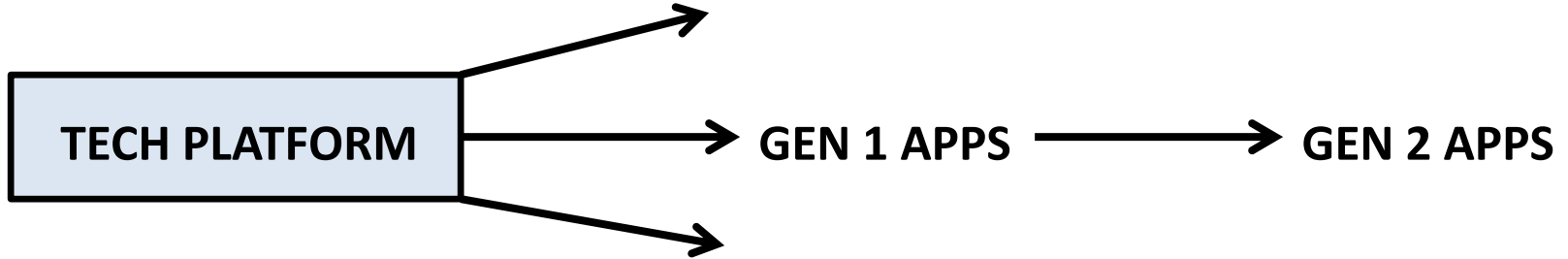
Background:

- TPEs generally cost more than incumbent
- OEMs (finally!) working to examine total system costs (not \$/kg)
- OEMs demand high performance, form and function, perceived quality
- Avoiding “cheap plastics” look

TPE solutions:

- Parts consolidation
- Redesign for ease of assembly
- Labor cost reduction
- Design for disassembly and recycling

GATEWAY TECHNOLOGY PLATFORMS FOR TPE, TPO, AND PP COMPOUNDS



TECHNOLOGY PLATFORM	EXAMPLE GEN 1 AND 2 APPLICATIONS
DYNAMIC VULCANIZATION	NEW FAMILIES OF SUPER - TPVs FOR HIGH TEMPERATURE APPLICATIONS
MALEIC ANHYDRIDE AND VARIANTS FOR ADHESION IMPROVEMENT	ALLOYS/BLENDS HARD/SOFT COMBINATIONS
CROSSLINKING SEBS COMPOUNDS	TARGET O-TPV APPLICATIONS
FOAMING TECHNOLOGIES	LIGHT WEIGHT, SOFT APPLICATIONS
CORE-BACK MOLDING	SIMPLIFIED FABRICATION OF MULTILAYER CONSTRUCTIONS (IP, DOOR TRIM)
POE ENTRY/SHALE GAS ECONOMICS	BROADEN TPO PROPERTY PROFILE/COST
SHAPE MEMORY TPEs(PolyOne)	CUSTOMIZED ERGONOMICS; REPAIRS

TECHNICAL/ECONOMIC TRENDS: SBC COMPOUNDS



- **Improved SEBS grades**
 - Slush moldable
 - Coated fabric grades
 - Competitive with o-TPV, PVC in some applications (e.g. appliance seals)
 - Substitution of SBS where feasible. Role for POEs
- **Competition from improved PVC grades to answer SEBS challenge**
- **Bio-TPEs**
- **Continued growth of multi-component technology**
 - Overmolding/2-shot and extension to foaming methods
 - Co-blow molding
 - Profiles
- **Evolution of soft touch, silky feel in multiple sectors**
- **Chinese/Taiwan commodity resin suppliers catching up in quality and versatility, not there yet**

TPE CHALLENGE: ADHESION



The challenge (usually to rigid plastics):

- Improved adhesion is an application enabler/cost save
- Value add potential

Background:

- Application in coatings, multi-materials, construction, blends, fillers, reinforcements, surface decorations
- Logos

TPE solutions:

- Sprayed surface adhesion promoters
- Additives and compounds
- Usually polar/non-polar combinations
 - MA/resin combinations
 - SMA
 - Other

GLOBAL TPE STRATEGY ANALYSIS WHEEL



GLOBALIZATION/REGIONAL MARKET SECTOR SHIFTS

- CHINA(STRONG AUTO GROWTH)
- RE-BALANCING TOWARD CONSUMER MARKETS
- PATH-TO-MARKET DIFFERENCES
- QUALITY/PRICE TIER DIFFERENCES

ECONOMICS

- REGIONAL MFG COST DIFFERENCES
- REGIONAL SUPPLY CHAIN DIFFERENCES
- GDP/CAPITA DIFFERENCES
- INVESTMENT FROM ASIA/EUROPE

SUBSTITUTION EFFECTS

- CASCADE EFFECT → LOWER COST TPEs
- BIO-TPEs STARTING
- CHALLENGE TO RUBBER CONTINUES

**EXPANDING
GLOBAL TPE
OPPORTUNITIES**

PROCESS INNOVATIONS

- FOAMING APPROACHES
- MULTI-SHOT MOLDING/CORE BACK
- SLUSH MOLDING
- TEXTILE COATING

BROADER PROPERTY RANGE

- SOFT TOUCH
- IMPROVED ADHESION
- HIGHER TEMP CAPABILITY
- SURFACE QUALITY
- ENTRY OF POEs

NEW APPLICATION DRIVERS

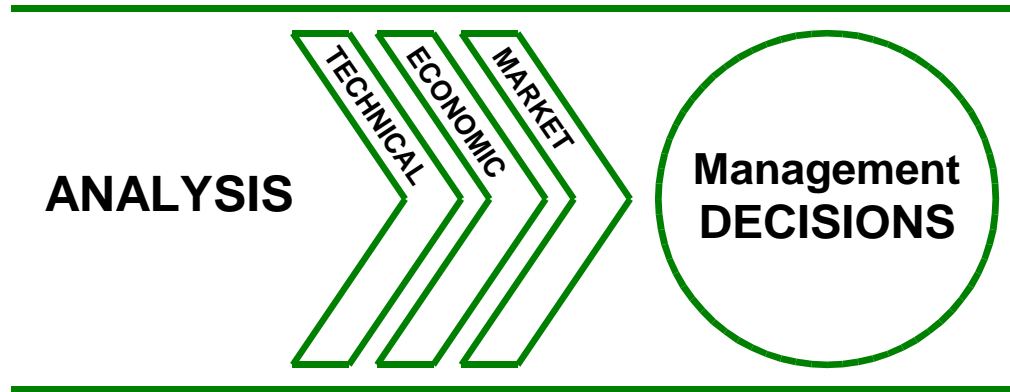
- GROWTH VIA BOTH ORGANIC GROWTH AND SUBSTITUTION
- LUXURY (SOFT TOUCH/SILKY FEEL APPROACHES)
- RIDING ETP SUBSTITUTION'S COATTAILS
- RIGID/FLEXIBLE COMBINATIONS

SUMMARY



- **Growth markets:** Auto, packaging, medical, wire/cable, sports/leisure (TPU)
- **Industry structure:** Bifurcation into specialty and commodity suppliers as commoditization affects grades
- **US:**
 - Manufacturing share of GDP has declined
 - Re-shoring will recover some markets lost to Asia
 - Wage decline helped competitiveness in some sectors, reduced buying power
- **China (a global frontier):**
 - High growth LV sector will drive TPO, o-TPV, SBC growth
 - “Rebalancing” → domestic consumption helps consumer products sector
 - Quality/price tiers → shifts TPE grade slate/properties footprint
- **Mexico:** Could emerge as a new global (smaller)TPE frontier
- **Prices:** Overcapacity will pressure TPE prices . Higher quality tiers can resist
- **POEs:** Have entered TPE sectors , will continue to enhance TPE mkt position
- **Shale gas boom:**
 - Shifting competitive position of POEs.
 - US → potential advantage in olefinic-based TPEs

THANKS FOR YOUR ATTENTION



Robert Eller Associates LLC
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES