

# Styrene's Changing Role as an UPR Feedstock

Styrenics Committee Meeting at APIC 2013

Taipei, 10 May 2013

Philippa Davies

## APIC 2013 AGENDA

- Unsaturated Polyester Resins (UPR) market characteristics:
  - Applications
  - Growth
  - Formulations
  - Feedstocks and costs
- Styrene in UPR
  - Changing consumer/regulatory environment drives change in UPR
  - Timeline of changes in regulations US and Europe
- Styrene-Free polyester resins
  1. Epoxy resins as an alternative to polyester resins
  2. Substitutes for styrene in UPR – vinyl toluene, (meth) acrylate
  3. New substitutes for styrene in UPR...

Source: Tecnon OrbiChem

## APIC 2013

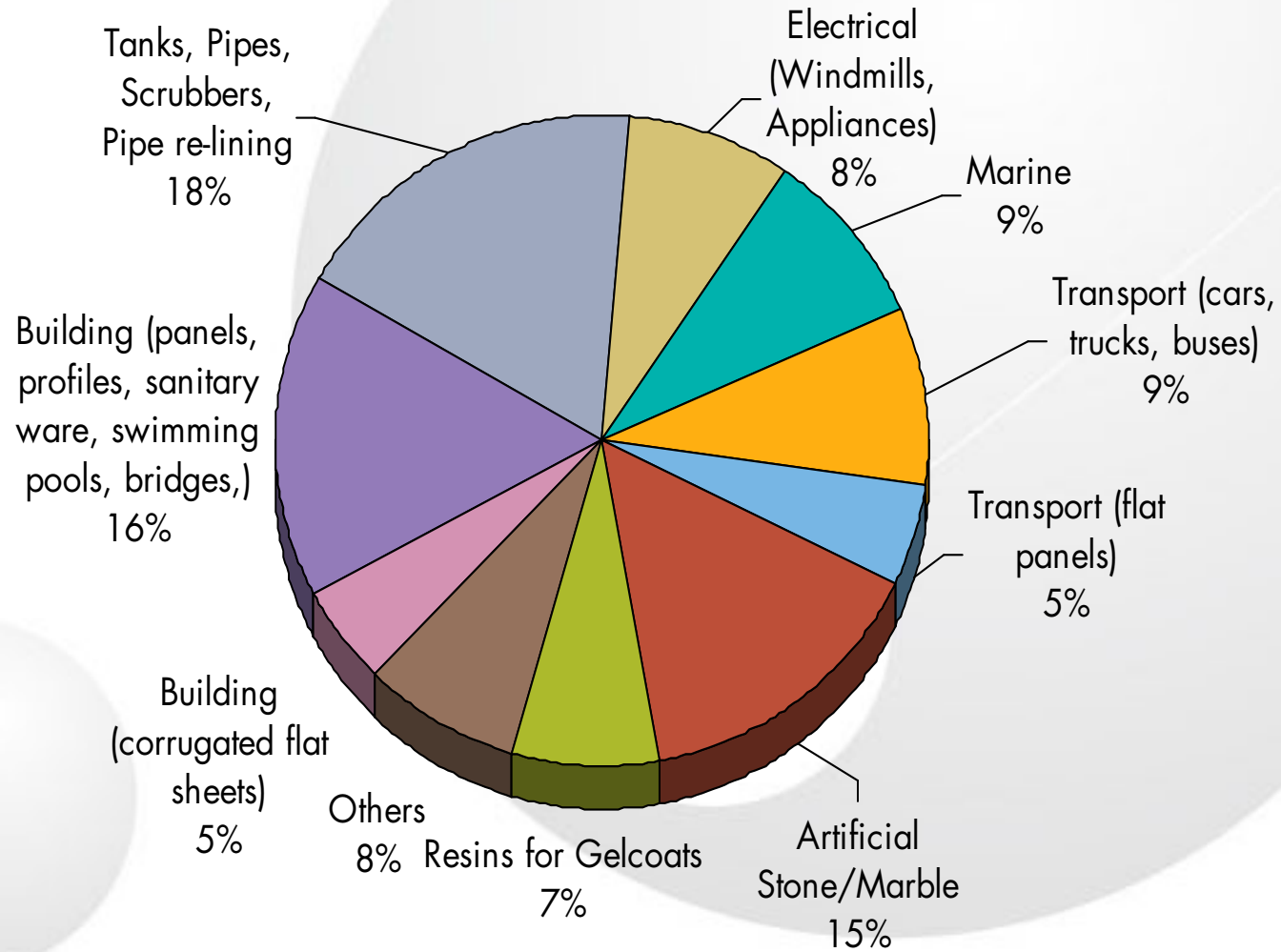
# CHARACTERISTICS OF THE UPR MARKET

- Formulations vary from producer to producer: Styrene content can be up to 50% of UPR but on average is around 34%
- Applications include:
  - Pipe (construction)
  - Marine
  - Wind Energy
  - Automotive
- Challenges – in Europe/US regulatory change is expected, which would limit styrene use. Styrene is already limited due to odour and worker exposure concerns. Styrene-free solutions exist but this is still only about 2-3% of the total UPR market
- Oversupply/splintered market. Chinese UPR operations around 50% in 2012
- Opportunities: some of the industries where UP resins can gain are green industries like wind-power (although some of this has moved to epoxy resins) and electric cars and in styrene-free and bio-based resins. The UPR market is expected to continue to keep market share and even grow, based on properties that rival epoxy resins can not match



Source: Tecnon OrbiChem

# APIC 2013 UPR MARKET SEGMENTATION



Source: CEFIC European UP/VE Resin Association

## APIC 2013

# CHINESE UPR CAPACITY – MAJOR PLAYERS 2013

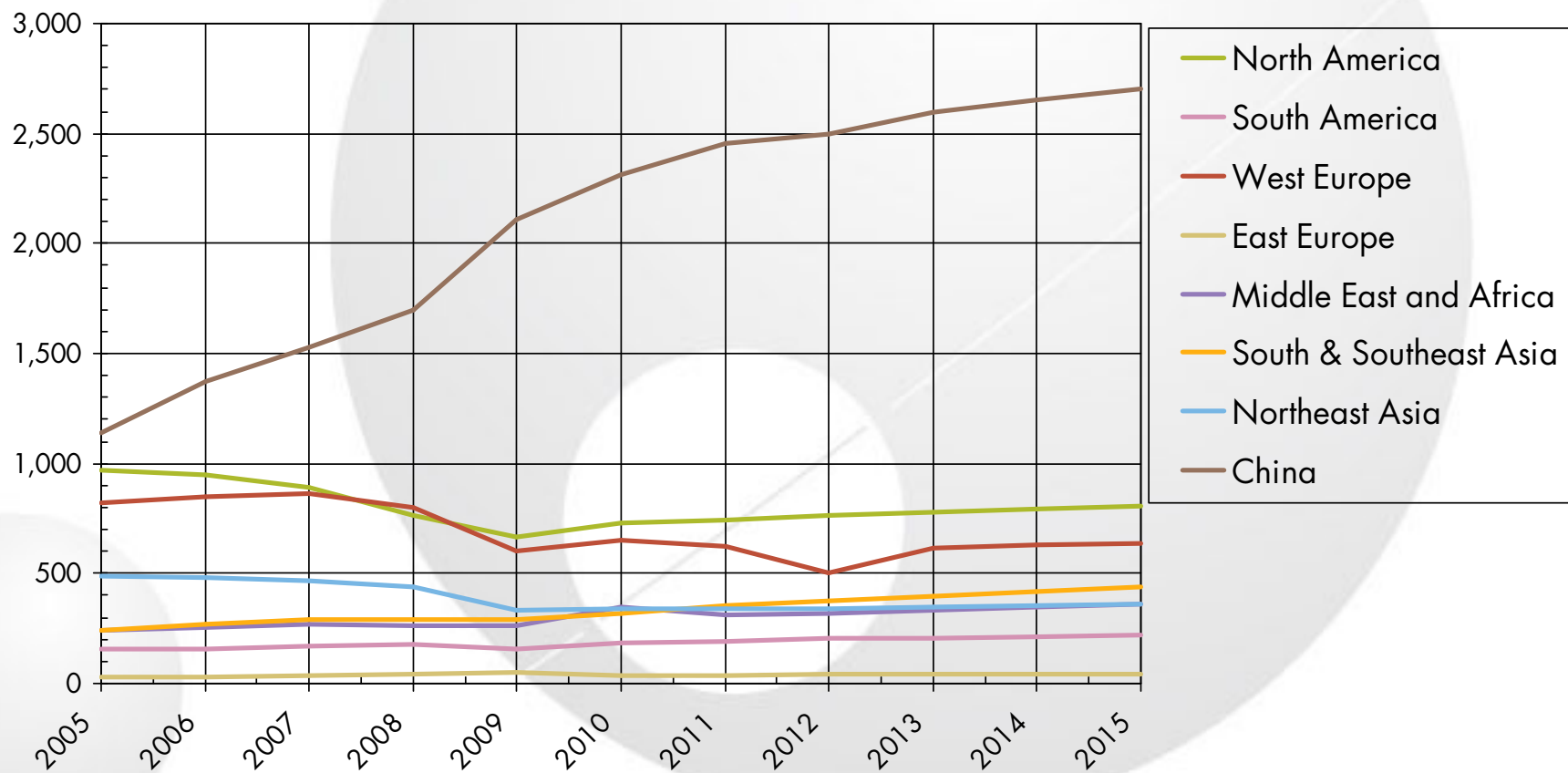
<i>Company</i>	<i>Location</i>	<i>Capacity (ktpa)</i>
DSM	Nanjing, Jiangsu	35
DIC (Huari)	Zhuhai/Kunshan	80
Eternal	Changzhou, Jiangsu	30
Ashland	Changzhou, Jiangsu	40
Tianhe	Shanghai	50
	Nantong, Jiangsu	140
	Linhai, Zhejiang	40
Yabang	Changzhou, Jiangsu	130
	Zhangzhou, Fujian	50
	Tianjin	75
(Newsolar Chemistry)	Changzhou, Jiangsu	180
Huake	Changzhou, Jiangsu	80
Panyu	Futian, Guangdong	150
Fullmark	Jingyin, Jiangsu	80
Huaxun	Guangdong	55
Reichhold	Tianjin	38
<b>TOTAL</b>		<b>1093</b>

Source: Tecnon OrbiChem

# APIC 2013

## WORLD UPR PRODUCTION 2005-2015

1,000 Metric Tons

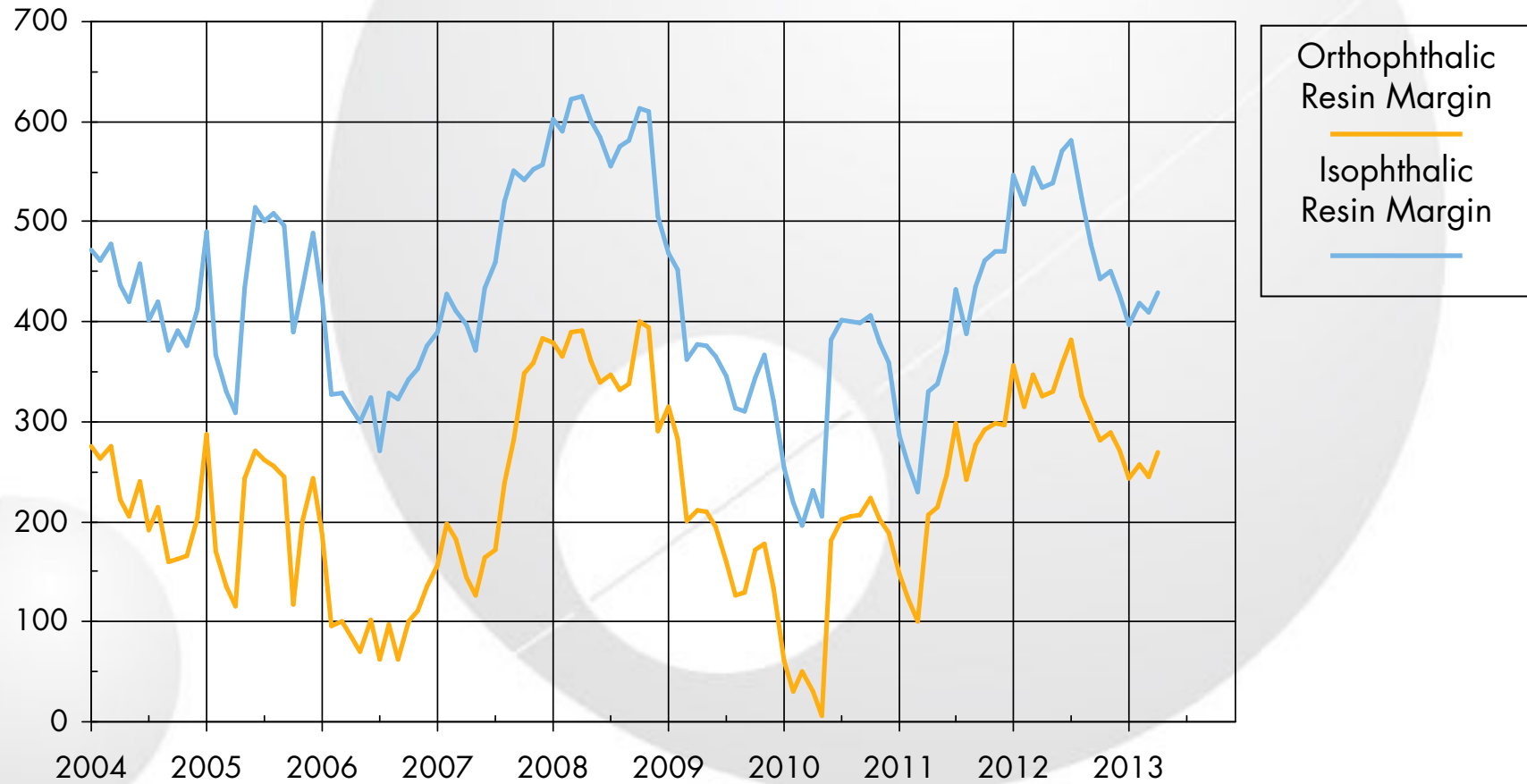


Source: Tecnon OrbiChem

## APIC 2013

# WEST EUROPE UPR PRICE MARGINS over MAIN RAW MATERIALS COSTS (0.34/0.35 Styrene)

Euro/ton

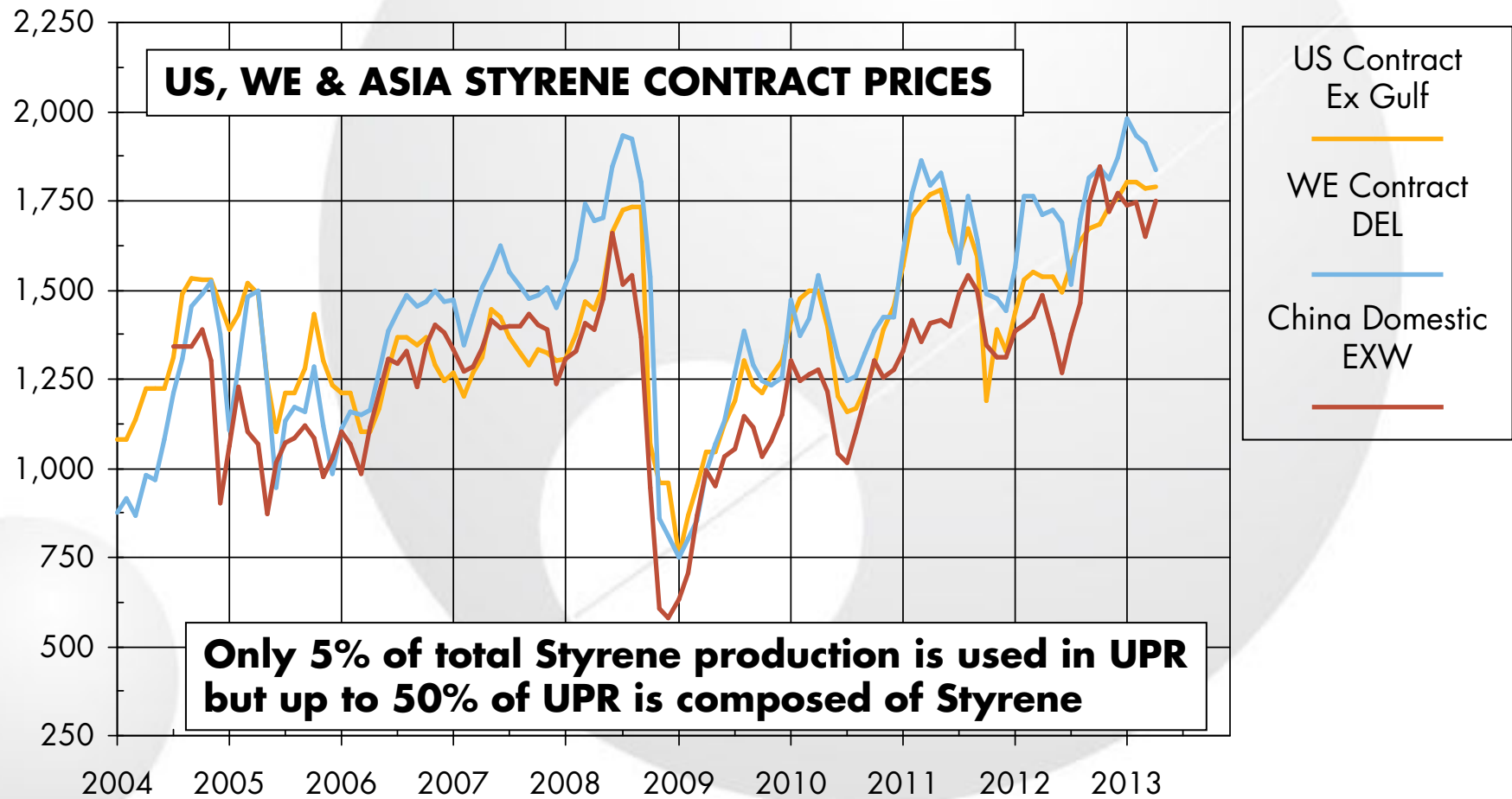


Source: Tecnon OrbiChem

# APIC 2013

## EXTREME VOLATILITY CAUSED BY BENZENE

Dollars per Ton

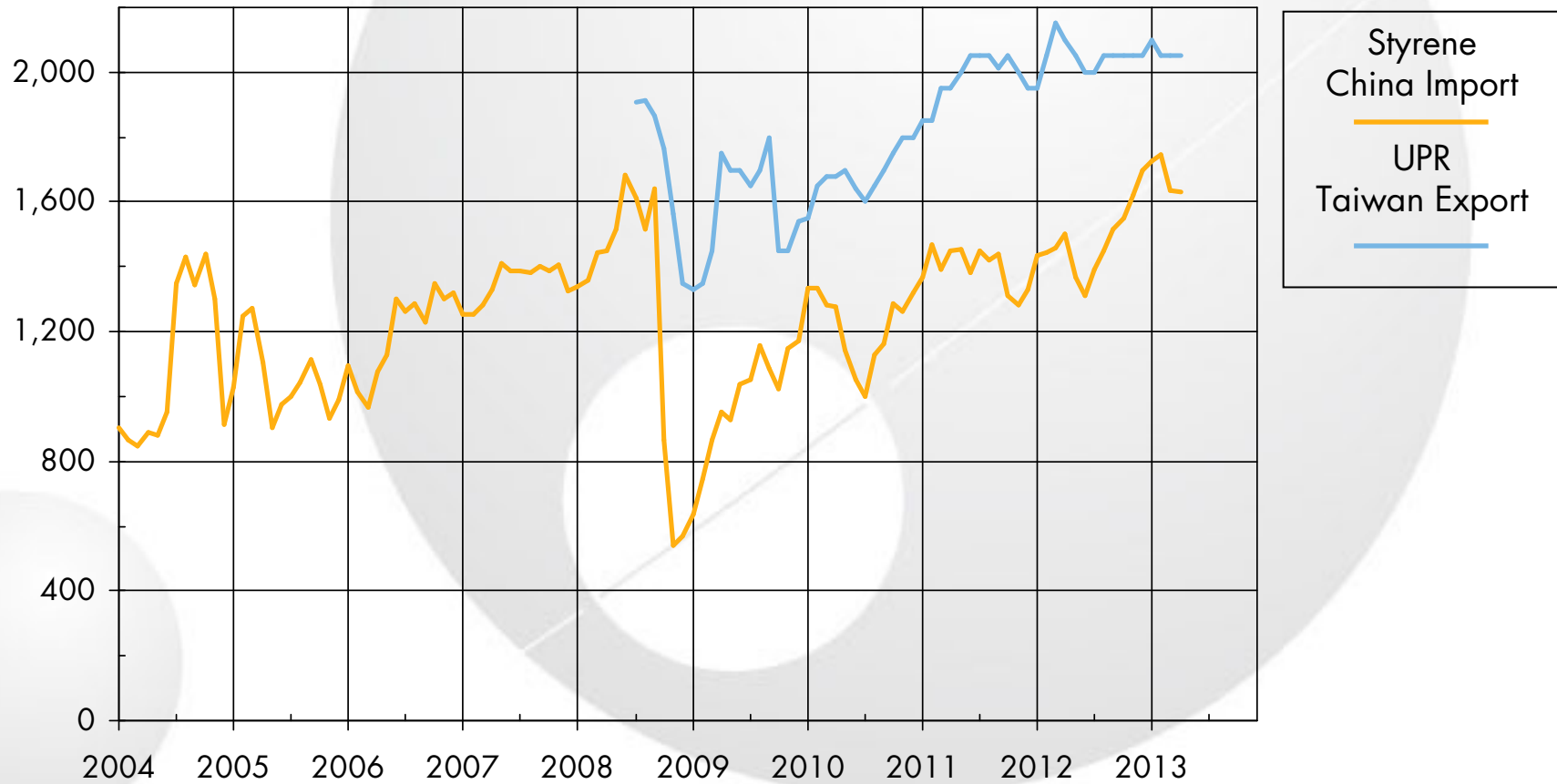


Source: Tecnon OrbiChem



# APIC 2013 ASIA STYRENE vs UPR PRICES

Dollars per Ton



Source: Tecnon OrbiChem

## APIC 2013

# WHY IS STYRENE USE IN UPR FALLING?

- OEMs and consumers do not want styrene odour in automobiles and other applications
  - This means use in vehicle interiors is excluded
- Some pipe applications (about 18% of total UPR) do not allow for styrene-based formulations. (Eg. Drinking water pipes)
- Workers and manufacturing employers want to keep styrene emissions in the manufacturing process at minimal levels for health reasons
  - The US Occupational Safety and Health Administration allows 100ppm (8hours weighted average) but the industry stipulates 50ppm and SIRC, the Styrene advocacy organisation, recommends 20ppm

Source: Tecnon OrbiChem

## APIC 2013

# WHY IS STYRENE USE IN UPR FALLING?

- Renewed interest by regulatory bodies in Europe and US in potential health hazards of styrene monomer



- In June 2011, the US National Toxicology Program (NTP) listed styrene as "reasonably anticipated to be a human carcinogen"
- In December 2012, the Committee for Risk Assessment (RAC) of the European Union upheld some parts of a Danish recommendation that classified styrene as a substance causing damage to the hearing organs through prolonged or repeated exposure via inhalation and as a substance suspected of damaging the unborn child.
- These factors are increasing public awareness and concern over styrene toxicity/ exposure risks

Source: Tecnon OrbiChem

## APIC 2013

# WHAT DOES THIS MEAN FOR THE INDUSTRY?

- The heightened concern over possible risks related to exposure to styrene mean that interest in low-styrene emission, styrene-free and alternate resins are growing
- Styrene free resins permit employers to ensure worker safety while saving on capital outlay on respirators and extractor fans in the workshop
- At the same time, the cost of these alternatives - at about 2-3 times the cost of styrene - makes these new technologies a tough sell
- Epoxy resins, an alternative resin, is also more expensive and does not share all the properties of UPR (notably, stability)

Source: Tecnon OrbiChem

## APIC 2013

# WHAT DOES THIS MEAN FOR THE INDUSTRY?

## What are the alternatives for reactive diluents for UPR?

1. Epoxy resins substitution for UPR
  - Pros: Reduces toxicity issues
  - Cons: More expensive than UPR  
Stability is an issue
2. Vinyl Toluene substitution for styrene in UPR
  - Pros: Reduces odour and toxicity  
Drop-in replacement
  - Cons: Limited availability of material  
Cost is about 1.5 times that of styrene

Source: Tecnon OrbiChem

## APIC 2013

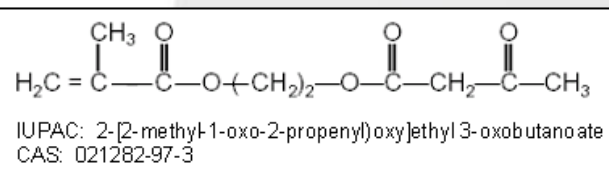
# WHAT DOES THIS MEAN FOR THE INDUSTRY?

### What are the alternatives... (cont.)?

3. (Meth) Acrylate – partial substitution for styrene in UPR
  - Pros: More readily available than vinyl toluene  
Non-HAP (Hazardous Air Pollutant)
  - Cons: Only partial substitution  
– another diluent must be employed as well  
More expensive than Vinyl Toluene (1.5-2.5 x styrene)

- **Eastman**

- Acetoacetoxyethyl Methacrylate
- CAS: 021282-97-3
- Molecular Weight: 214.22
- Physical Form: 100% active, low viscosity liquid



Source: Tecnon OrbiChem

## APIC 2013

# WHAT DOES THIS MEAN FOR THE INDUSTRY?

### What are the alternatives?

4. New Low-Styrene and Styrene-Free developments:
  - **Ashland** reports that it has developed a 13% styrene reduced resin that has been successfully tested by customers in laminate and casting resins applications



Source: Tecnon OrbiChem

## APIC 2013

# WHAT DOES THIS MEAN FOR THE INDUSTRY?

### What are the alternatives?

#### 4. New Low-Styrene and Styrene-Free developments:

- **DSM** has developed styrene free resins without vinyl toluene or acrylates, which it says can cover about 75% of all UP resins applications. The cost is higher than for traditional alternate diluents. Offering includes formulations safe for pipes for drinking water.

The DSM Atlac ® Brand UP resins boast:

- High flash point:  
Safe working / processing environment
- Smell Friendly:  
Static and dynamic emissions close to zero
- Good mechanical performance  
at elevated temperatures
- Good level of chemical resistance



Source: Tecnon OrbiChem



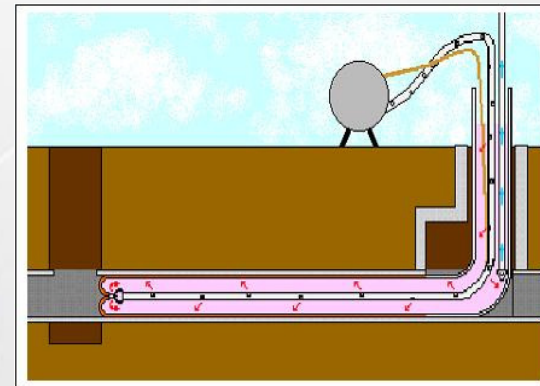
## APIC 2013

# WHAT DOES THIS MEAN FOR THE INDUSTRY?

### What are the alternatives?

#### 4. New Low-Styrene and Styrene-Free developments:

- **CCP** has introduced its ENCORE PRIME resins, which are styrene-free, low odour, and offer the same mechanical properties as standard unsaturated polyester resins
  - The range is mainly targeted at high temperature moulding and more specifically SMC and Cured In Place Pipe (CIPP) applications.
  - Styrene free resins for pipe re-lining
  - Appropriate for pipes near residential areas to avoid smell
- **AOC** is also offering styrene-free UP resins for many applications, notably CIPP applications where several alternatives are available



Source: Tecnon OrbiChem

## APIC 2013 CONCLUSIONS

- The UPR market is widely diversified in applications and growing, despite recent challenges
- Most formulations will likely continue to include about 35% styrene in future but partial styrene replacement with acrylate or other diluents is likely to grow
- Styrene is the biggest single feedstock for UPR, therefore its price is key and the price of any possible substitute is also crucial
- There are already signs of changes in the definition of styrene in the US and Europe in 2011 and 2012 that mean all UPR producers recognize they need to expand their styrene-free/low-styrene offerings. (These go along with partly bio (MPG) and cobalt free resins, in many cases

Source: Tecnon OrbiChem

## APIC 2013 CONCLUSIONS

- Consumers are more and more sensitive to green issues. Low styrene and styrene free resins will have a growing place in the UPR market but with costs at about 1.5-2.5 x those of formulations with styrene, growth will be limited. Availability of vinyl toluene will also limit growth of styrene free resins – low-styrene content resins may be more realistic solution
- The impact on the global styrene market is limited. At the moment, styrene in UP represents only about 5% of all styrene used. Currently about 3% of that 5% is styrene-free

Source: Tecnon OrbiChem



.....your source of expert  
chemical industry knowledge