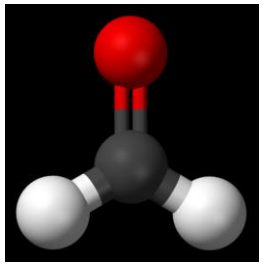
Outlook for Formaldehyde and Impact on Methanol Demand



33'rd Annual IHS Chemical World Methanol Conference

IHS - World Methanol Conference
11'th – 12 'th November 2015,
Sheraton Munich Arabellapark Hotel

Lars Axelsen, Dynea
General Manager, Technology Sales & Licensing,

dynea®

Company overview

- Norwegian Corporate
- Sales 950 mill NOK (2014)
- 210 employees
- 3 own production sites ★
- 4 tolling sites ★

Dynea History

Innovation and expansion –Dyno period (1947 – 2000)
Milestones:

- 1947: Norske Kunstharpikser (formaldehyde and resins) established in Lillestrøm
- 1971- 1999: Driving force behind growth and internationalization of the chemical activity of Dyno Industrier.

Development of the Dynea Group (2000 – 2013)
Milestones:

- 2001: Dynea company name and identity launched worldwide
- 2002-2007: Streamlining of business and operations.
- 2007-2014: IK implementing divestment strategy through a split of the Dynea Group, with assets and activities sold in parts.

Back to the roots – Independent Dynea period (2013 -)
Some milestones:

- 2013: Acquisition by Eltek Holding,
- 2014: Full ownership of and rights to the Dynea name

1947 - Norske Kunstharpikser

1952 – Gullaug Kjemiske Fabrikker

1971 - DYNO

2000 – dynea

2014 - dynea®

EWS
Engineered Wood Solutions

IWS
Interior Wood solutions

WBPR
Wood Based Panel Resins

Dynoadd
Industrial Coating Additives

Technology Sales & Licensing
Formaldehyde plants

Powder Resins

Regulatory Services

Formaldehyde

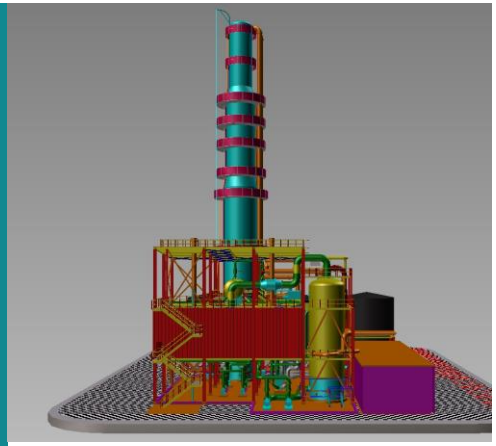
Analytical Services

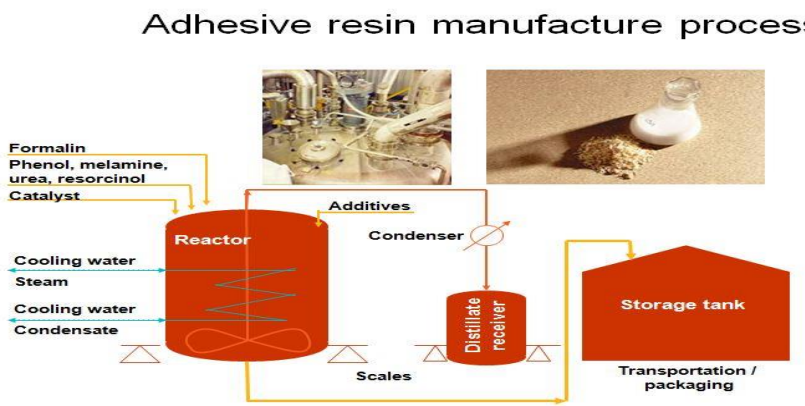
Speciality Adhesives and Polymers

Tank Cleaning Services

Technology Sales & Licensing

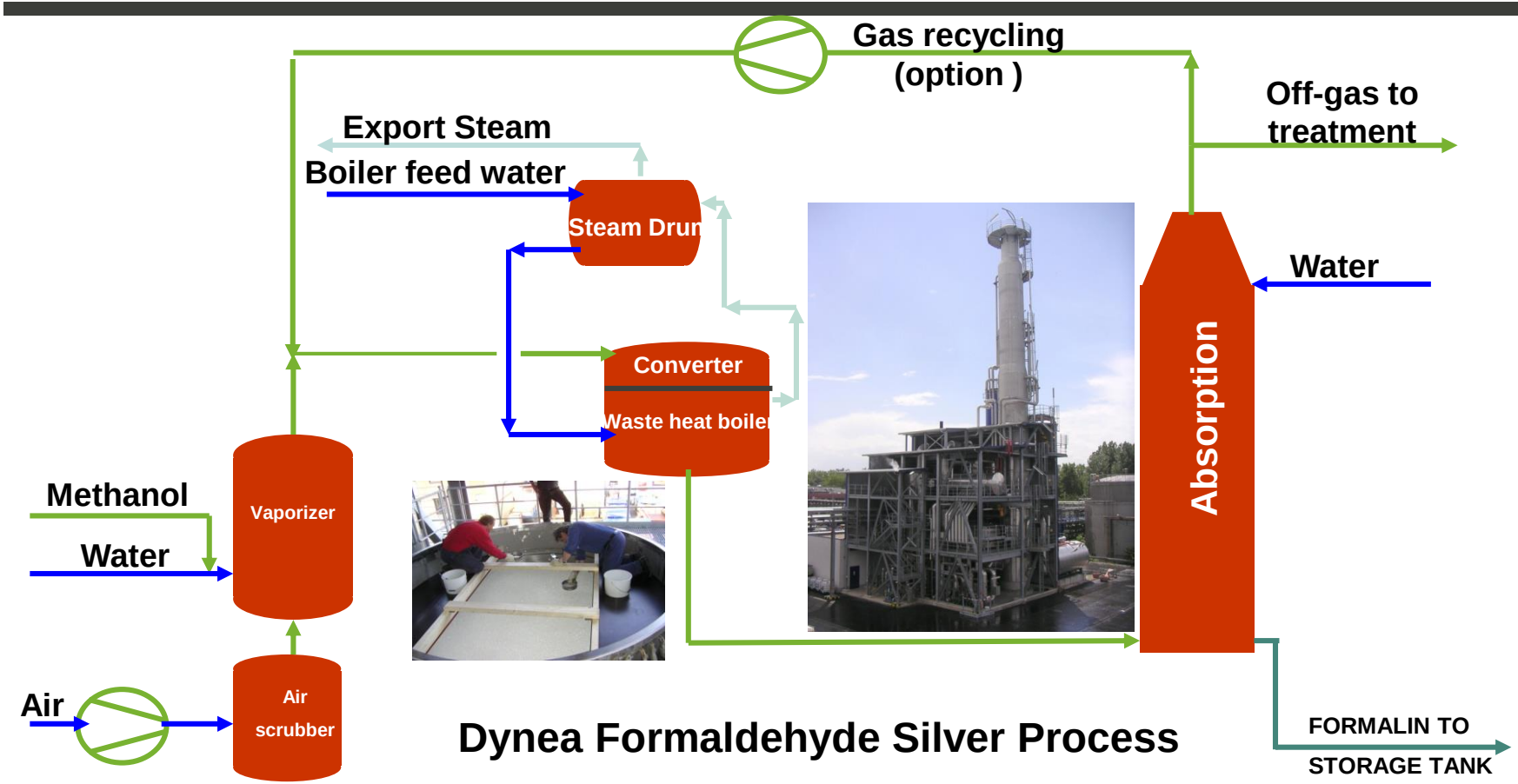
- **Silver Catalyst Formaldehyde technology (FASIL) for new plants and revamps.**
  - License and Engineering
  - Proprietary equipment & Catalyst
  - Commissioning and Start-up services.
- **Metal Oxide Formaldehyde technology (METOX) for revamp and upgrade.**
- **Resin Batch Reactors for the production of UF, MF, MUF and PF**





Formaldehyde and Resin Process Technology

- Dynea have more than 60 years of experience in process development, design and operation of both Synthetic resin production, Formaldehyde Silver and Metal-oxide plants
- Batch reactor deign for of UF,MF and PF icluding sophisticated tailor-made simulation tools Phenolsim ® and UF Visualizer ®
- For formaldehyde production, Dynea have technologies for:
  - Silver Contact plants, FASIL ®
  - Metal Oxide plant, METOX
- Dynea have designed, constructed and started up more than 40 Formaldehyde plants world-wide.
- Dynea are a producer of formaldehyde for its own internal use, all improvements are tested in our own plants before offering them to our external customers.



Dynea Formaldehyde Silver Process

dynea

Key Benefits - Dynea Formaldehyde Silver Process

Large Range In Plant Capacity

From 15 000 – 150 000 TPA FA 100 wt %.

Selective Absorber

No Distillation. Selective Formaldehyde absorption, recycling of methanol and water.
Result; Improved yield and product quality

Product Quality

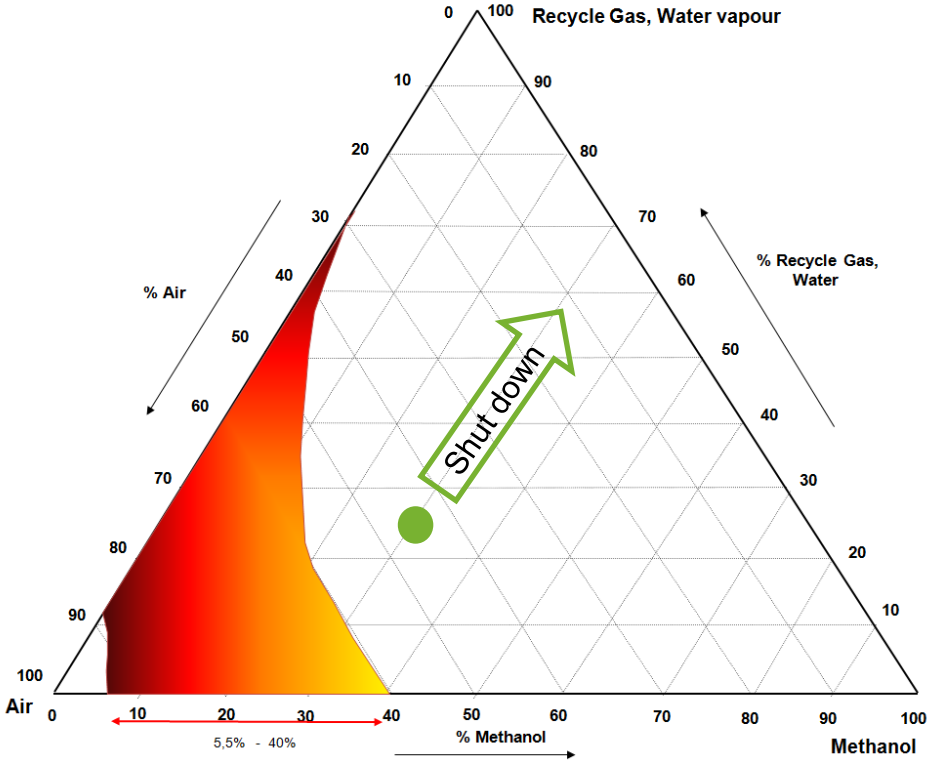
High formaldehyde concentration, up to 56 w% .
Low formic acid concentration in final product.
Low methanol concentration in final product.

Operational Costs/consumption Figures

Inexpensive catalyst
The low electricity consumption and cooling demand more than compensates the higher methanol consumption
compared to the metal oxide technology.

A Safe Process

	Characteristics for Silver catalyst and Metal oxide catalyst (Formox)					
	Pro	Con				
Silver catalyst	Low catalyst & energy cost	Yield				
Metal oxide (Formox)	Yield	High catalyst & energy cost				
		MANUFACTURING COST COMPARISON 100 % FA wt basis				
Raw material & Energy	Unit Cost	Formaldehyde Silver Contact Process		Formaldehyde Metal Oxide (Formox)		
	Euro	per metric ton FA	Euro/ton 100 % FA	per metric ton FA	Euro/ton 100 % FA	
Methanol (tonne)	300,00	1185 - 1218 kg	360,00	1146 - 1154 kg	345,000	
Process water (m3)	0,79	1,21	0,95	1,08	0,851	
Boiler feed water (m3)	0,79	2,16	1,71	1,89	1,495	
Electrical energy (Kwh)	0,10	97	9,70	189	18,919	
Cooling water (m3)	0,10	68	6,76	135	13,514	
Instrument compressed air (Nm3)	0,02	36,8	0,74	36,8	0,736	
Catalyst cost [€]			0,41		8,405	
Oxidiser catalyst and HTF		0	0,00		1,802	
Excess Steam value (€/tonne)	30,00	-2162	-64,86	-1892	-56,757	
Total costs € / tonne	(@ 100% Formaldehyde)		315,39		333,96	
Yearly production; 50 000 TPY 100 w%	Op. Cost/Savings with Silver vs Metal oxide is ;		-928 527	Euro/year		



DYNEA Formaldehyde Silver
Focus on HSE

Safe during:

- During Start-up phase
- In Operation
- During Shutdown

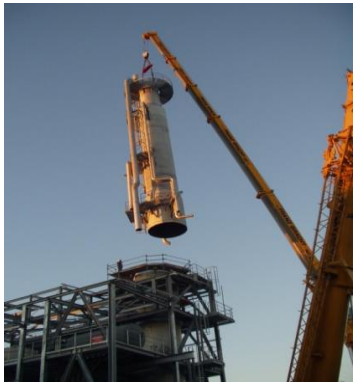
Safe in Design:

- No hot oil
- Only water/steam cooling which mitigates risks of fire.
- No oxygen in absorber
- Catalyst can be removed without dust and waste in a few hours. Re-catalysation takes less than 24 hours : Small holding tanks are needed to serve customers during re-catalysation

The Green spot shows the typical operation point:
30 % methanol
45 % air
25% recycle gas or water

Shutting down the plant will move the process from “Safe to Safer”

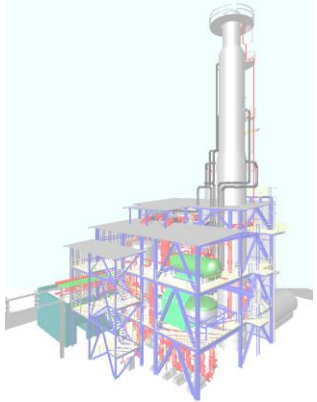
Dynea Plant Tour



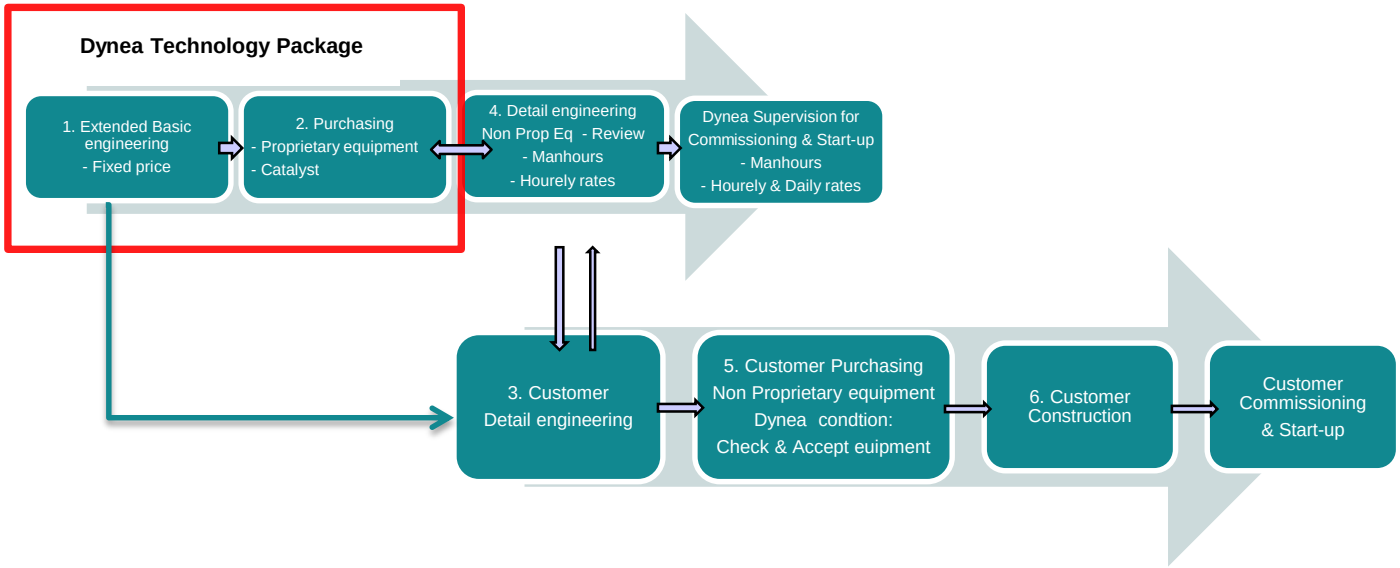
Dynea World of Formaldehyde

Production based on Dynea AS Formaldehyde and Resin technology

Silver Formaldehyde plant



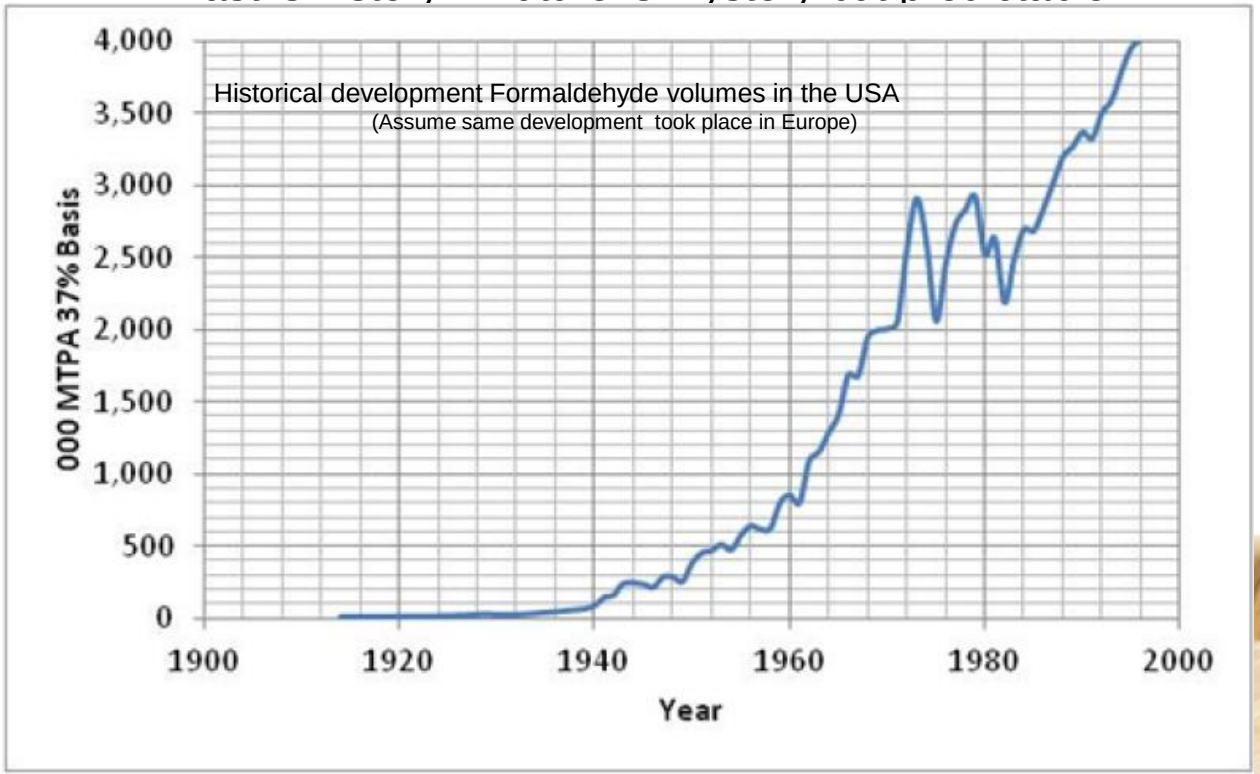
Typical contract and project phases for Dynea Licensing projects



Formaldehyde Outlook

A view in to the future

What visions of the future came out of the situations of the past
Past is history – Future is mystery but predictable

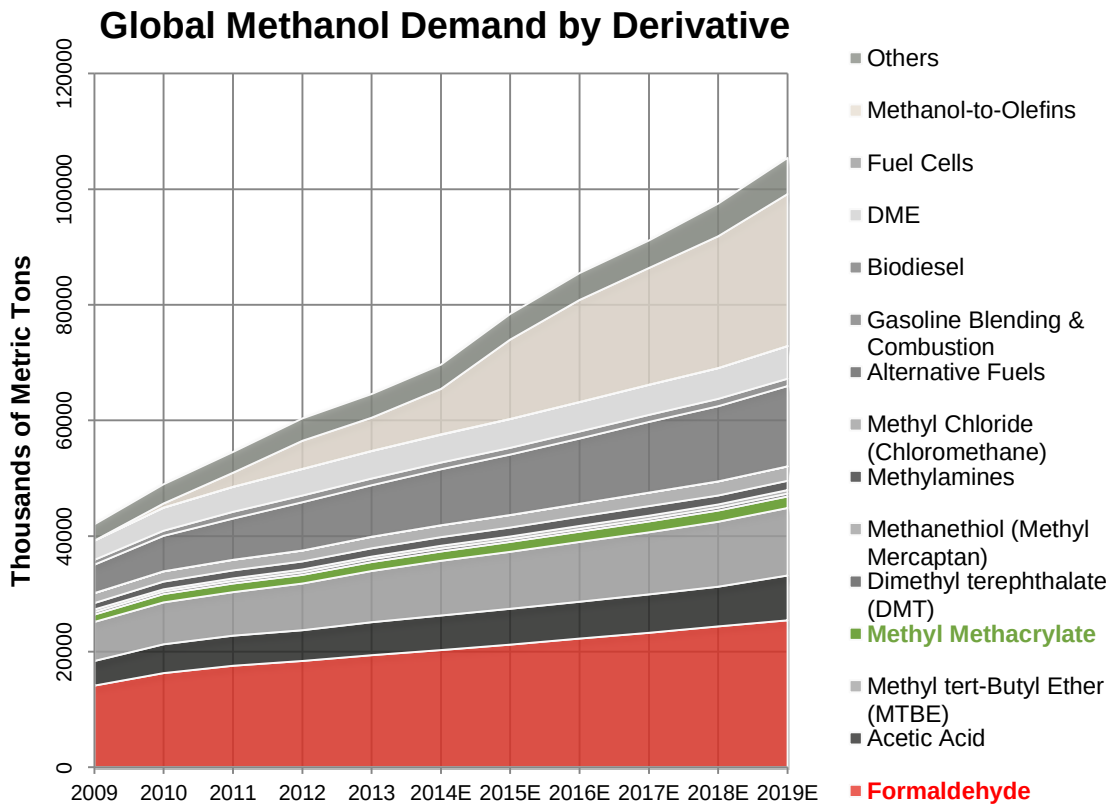


Formaldehyde to continue as a significant methanol consumer

Predominantly as a primary derivative

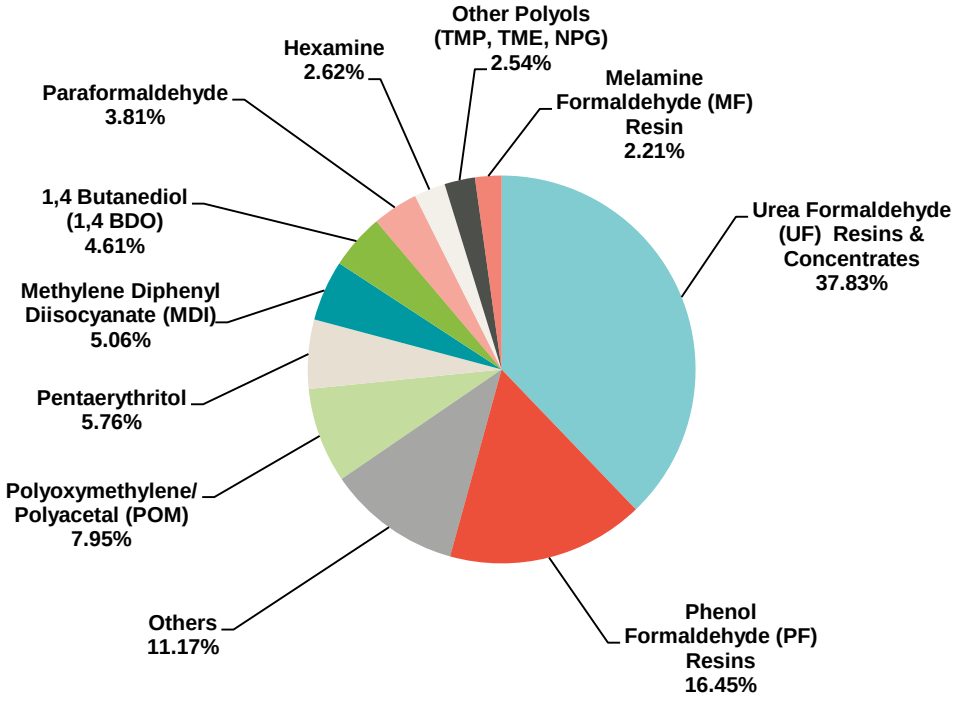
Also as an independent feedstock to other primary methanol derivatives of which MMA is only one example

Actual formaldehyde demand may thus exceed forecasts that do not take these inter-derivative relationships into account



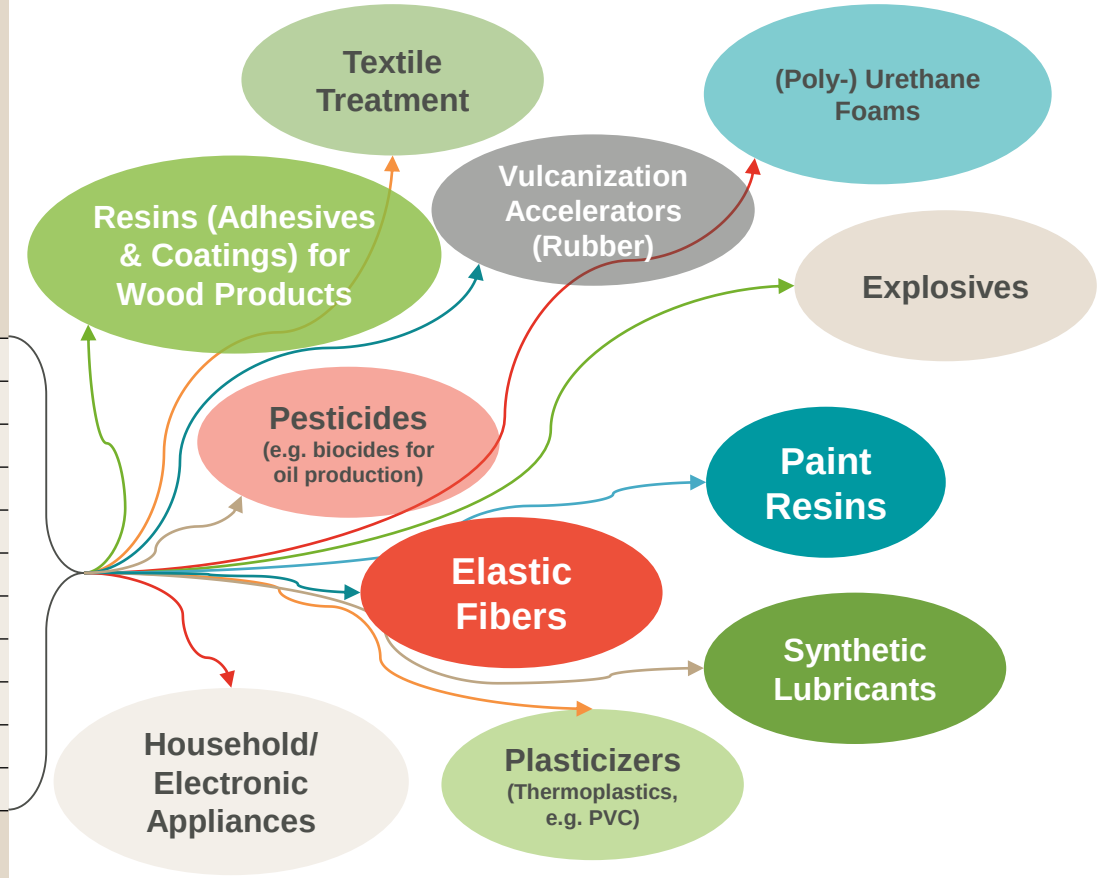
Expected Global Formaldehyde Demand by Derivative	2015	2019
Urea Formaldehyde (UF) Resins & Concentrates	6610	8041
Phenol Formaldehyde (PF) Resins	2874	3393
Others	1951	2291
Polyoxymethylene/ Polyacetal (POM)	1388	1624
Pentaerythritol	1006	1212
Methylene Diphenyl Diisocyanate (MDI)	885	1047
1,4 Butanediol (1,4 BDO)	805	921
Paraformaldehyde	665	824
Hexamine	457	555
Other Polyols (TMP, TME, NPG)	444	518
Melamine Formaldehyde (MF) Resin	386	463
Total 100% formaldehyde (kMT)	**17472**	**20889**

19,6%



Formaldehyde Derivatives and End Use Applications

Urea Formaldehyde (UF) Resins & Concentrates	37,83 %
Phenol Formaldehyde (PF) Resins	16,45 %
Others	11,17 %
Polyoxymethylene/ Polyacetal (POM)	7,95 %
Pentaerythritol	5,76 %
Methylene Diphenyl Diisocyanate (MDI)	5,06 %
1,4 Butanediol (1,4 BDO)	4,61 %
Paraformaldehyde	3,81 %
Hexamine	2,62 %
Other Polyols (TMP, TME, NPG)	2,54 %
Melamine Formaldehyde (MF) Resin	2,21 %



Expected Growth in Formaldehyde Demand

NORTH AMERICA

- North American demand has recovered since global financial crisis (2013 construction activity)
- Demand primarily from UF & PF resins

There currently are no alternative resins that provide overall better technical performance, versatility and cost effectiveness than formaldehyde-based resins.

-American Chemistry Council

- Demand include 1,4-BDO, POM & MDI
- Markets generally more mature than in Asia, thus slower growth expected

SOUTH AMERICA

- Local formaldehyde production necessitated by impracticalities of shipping
- Mostly used in UF, PF and MF resins
- Relatively small but accelerating demand growth
- Expansion in infrastructure for urethanes and polyesters may render investments in MDI and BDO feasible

Expected Growth in Formaldehyde Demand

EUROPE

- Recovery expected to continue
- New world scale facilities not expected
- Capacity expansions & revamps (less developed countries)
- Formaldehyde buyers tendency to install own facilities
- Demand will grow along with wood industry

Thanks to formaldehyde- based resins, an increasing amount of wood waste is being recycled both for the good of the planet and for the good of consumers.

– Phil Hope, Formacare Secretary General, August 2013

RUSSIA*

***Also includes states that became independent from USSR**

- Recovery expected to continue along with that of wood industry
- Significant demand from UF & PF resins, also isoprene manufacturing

Expected Growth in Formaldehyde Demand

MIDDLE EAST

- Relatively small formaldehyde vs. methanol demand
- Traditional wood-related uses for formaldehyde uncommon (no forrestry)
- Swift growth in other formaldehyde-derivative facilities, e.g. paraformaldehyde and slow release fertilizers, amongst others

AFRICA

- Consumption limited to basic and traditional uses in resins
- Imports of formaldehyde derivatives such as UF and other resins are heavily relied on by wood product manufacturers

Expected Growth in Formaldehyde Demand

ASIA

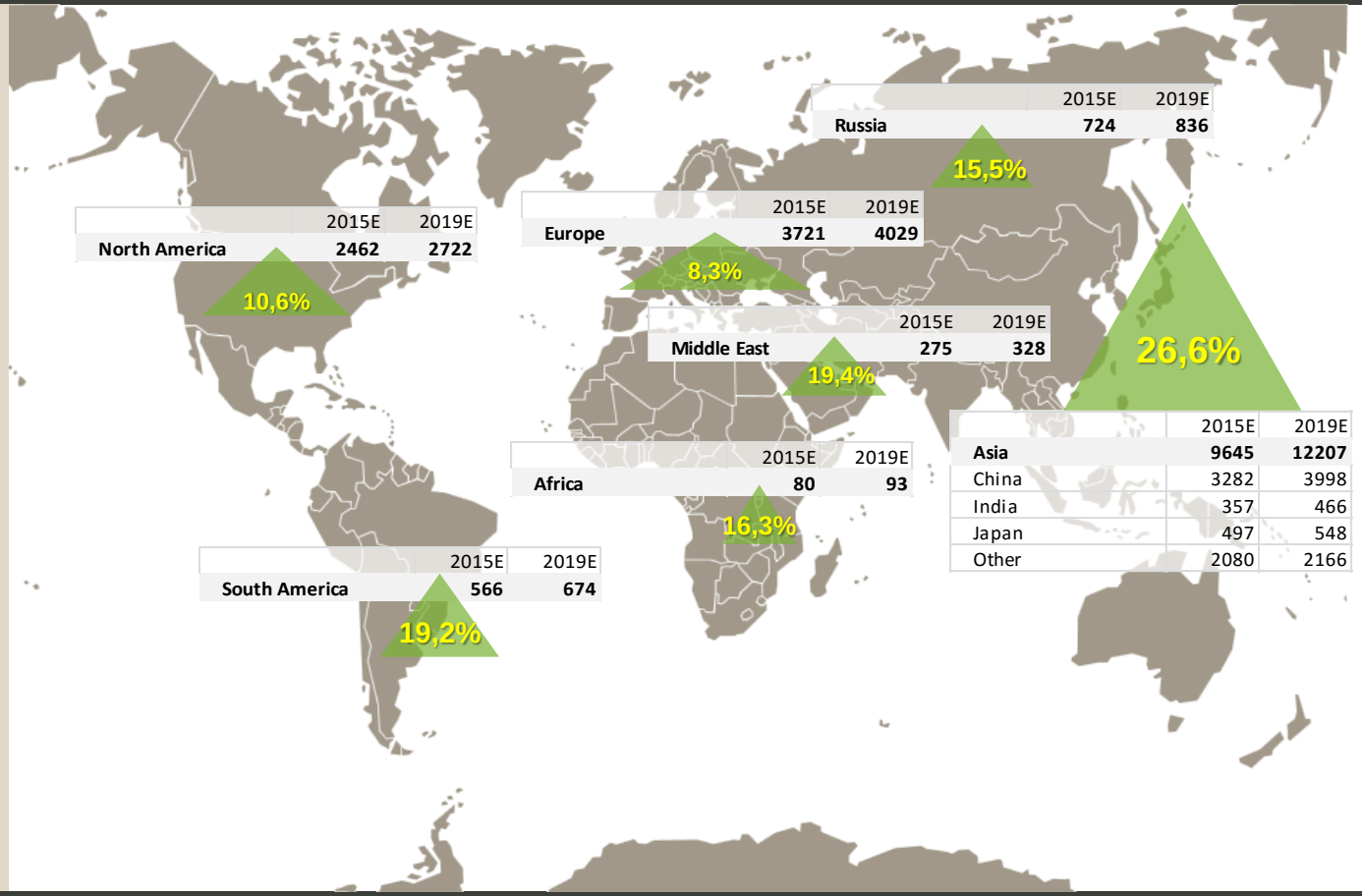
- Growth primarily from UF & PF resins
- BDO & MDI sectors also contributes increasingly
- MMA may contribute to a more significant extent than expected, depending on the production technology
- China remains center of global formaldehyde demand
- Chinese demand to grow at slightly lower pace than previous 5 yrs

At present, China's economy has entered a state of new normal – the gear of growth is shifting from high speed to medium to high speed.

– Li Keqiang, January 2015

- Indian growth rates expected to increase, though no big announcements yet
- **Demand still outpaces capacity addition**

Expected Growth in Formaldehyde Demand*



*Thousands of Metric Tons as 100% Formaldehyde

References

- Methanol and Derivatives Analysis 2014, Methanol Market Services Asia Pte Ltd, Singapore
- www.formaldehydefacts.org
- https://agenda.weforum.org
- http://blog.americanchemistry.com/2014/01/how-formaldehyde-contributes-to-a-sustainable-future-for-wood-products-infographic/

New EU classification for formaldehyde

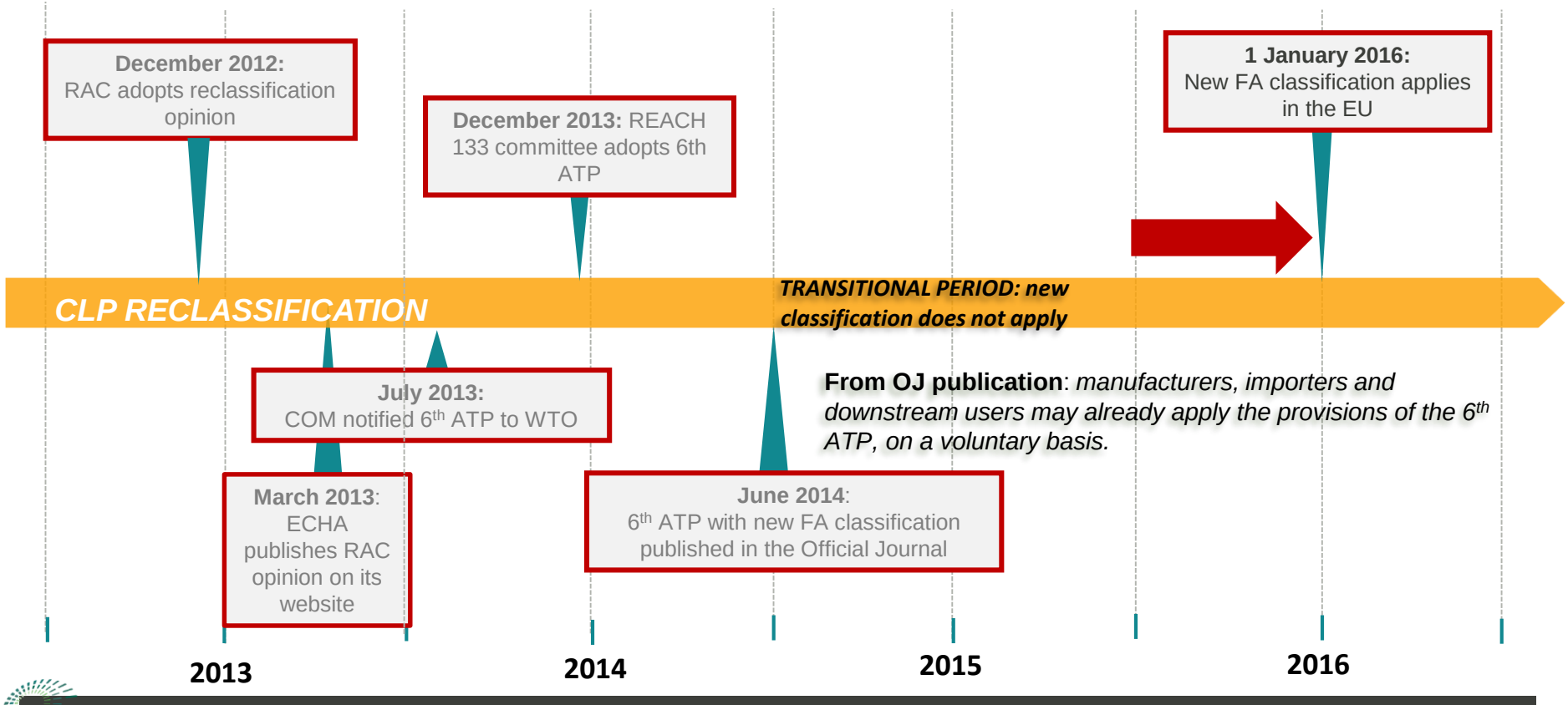
An association between FA exposure and carcinogenicity has been studied globally for decades. What has changed?

New classification from 1.1.2016

- **Carcinogenicity: cat. 2 → cat. 1B** (“suspected of causing” to “may cause”)
- **Mutagenicity: cat. 2**

The rational for this classification was not based on new evidence but was due to a change of the classification criteria and their interpretation under REACH.

Formaldehyde Reclassification timeline



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Which legislations are affected?

From entry into force of CMR 1B classification (01.01.16)

REACH

- Carcinogen 1B can lead to proposal as SVHC “substance of very high concern” under REACH
- Possible “fast-track” restrictions on consumer uses

CLP

- New labelling and Safety Data Sheet requirements for mixtures

Other Legislations

- Carcinogen and Mutagen Directive
- Biocidal Products Regulation
- Cosmetics Regulation
- National Regulations

What are the current practical safe levels?

- Formaldehyde has been Registered under REACH with a DNEL (Derived No-Effect Level) for inhalation, workers, 8h shift of 0.4 ppm. Formaldehyde can be handled safely.

- Based on the most recent scientific research, industry supports an occupational exposure limit of:
  - 0.3 ppm Time-Weighted Average (TWA)
  - 0.6 ppm Short-Term Exposure Limits (STEL)
  -

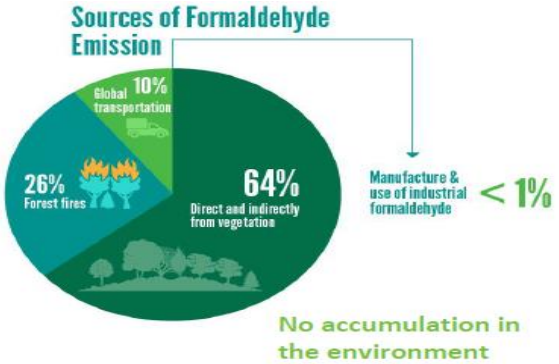
Workplace Safety - Sensory Irritation in Human Volunteers:
http://www.formacare.org/index.php?page=workplace-safety

Formaldehyde occurs naturally

Formaldehyde is produced naturally by all living organisms; it is a critical molecule for the formation of proteins, DNA and RNA. Formaldehyde is quickly metabolised.

Formaldehyde is present in many different foodstuffs, such as apples (up to 20 mg/kg), pears (up to 60 mg/kg), and lobster (up to 100 mg/kg).

Formaldehyde is naturally emitted by vegetation (leaves and wood) – up to 10 million t/a globally; less than 1% of the emissions come from manufacture & use of industrial formaldehyde.



Every day, people benefit from products that contain formaldehyde. This chemical is a critical, commercially valuable, and basic building block in our modern society.

http://www.formaldehydefacts.org/economy