

A blue line-art illustration of a landscape. In the foreground, there are various plants and trees. In the middle ground, there is a building with several windows. In the background, there are rolling hills and a cloudy sky.

Warm Mix Asphalt in Europe

20/10/2015, Dr Ian M Lancaster, NABIn Oslo

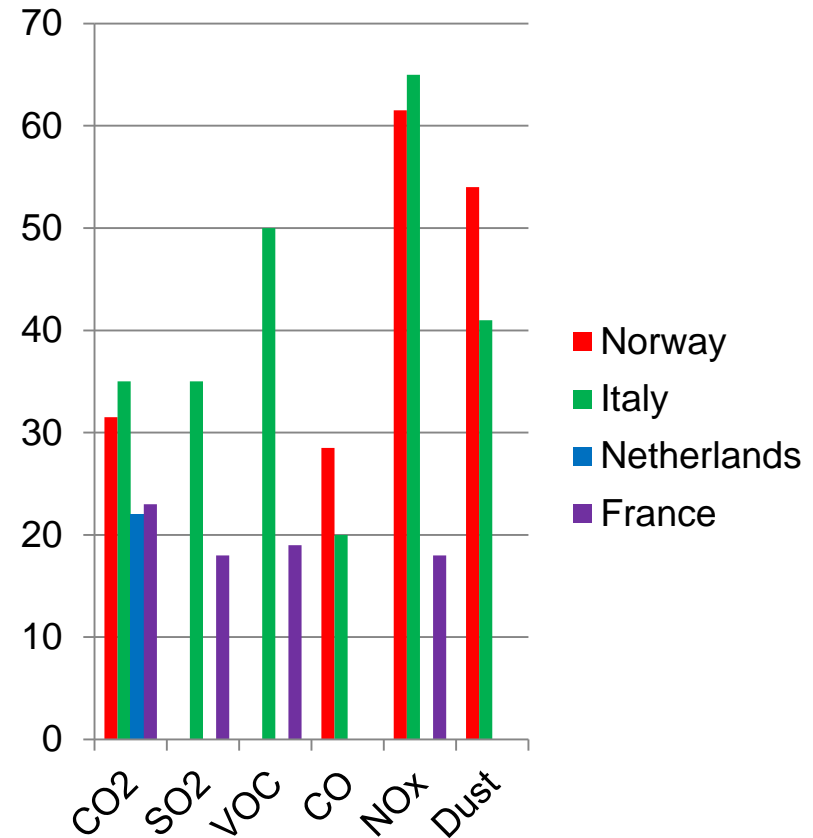


Norge er i forkant igjen!



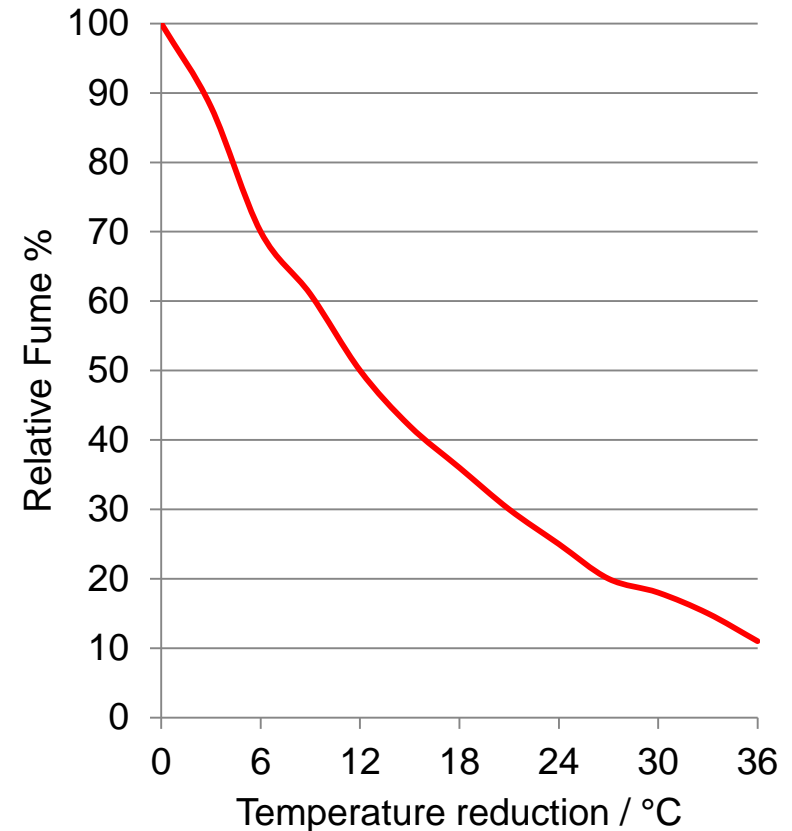
Why warm mix?

- ▶ Lower fume
 - ▶ ~10°C lower temp – 50% less fume
- ▶ Lower energy costs
 - ▶ 30°C lower temp – 9kWh/Te less energy
 - ▶ 30°C lower temp – 0.9litres less fuel / Te
- ▶ Lower carbon emissions
- ▶ Less hardening of binder
- ▶ Better compaction
- ▶ Higher RAP contents
- ▶ Use of existing asphalt plant



Legislative Drivers

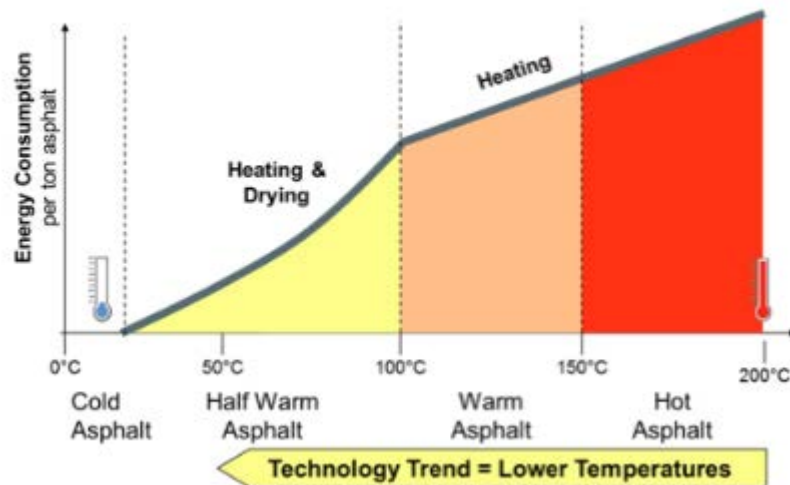
- ▶ Kyoto Protocol
- ▶ US CAIR
 - ▶ SO_x / NO_x reduction in 28 states
- ▶ Sustainable development principles
- ▶ REACH
 - ▶ Exposure reduction



Fume reduction



Definitions



- **Cold mixes** are produced with unheated aggregate and bitumen emulsion or foamed bitumen
- **Half Warm Asphalt** is produced between approximately 70 °C and roughly 100 °C.
- **Warm Mix Asphalt** is produced and mixed at temperatures roughly between 100 and 150 °C.
- **Hot Mix Asphalt** is produced and mixed at temperatures roughly between 120 and 190 °C The production temperatures of Hot Mix Asphalt depend on the bitumen used.

Technologies

- ▶ Hot mix modification
- ▶ Foaming
- ▶ Additives



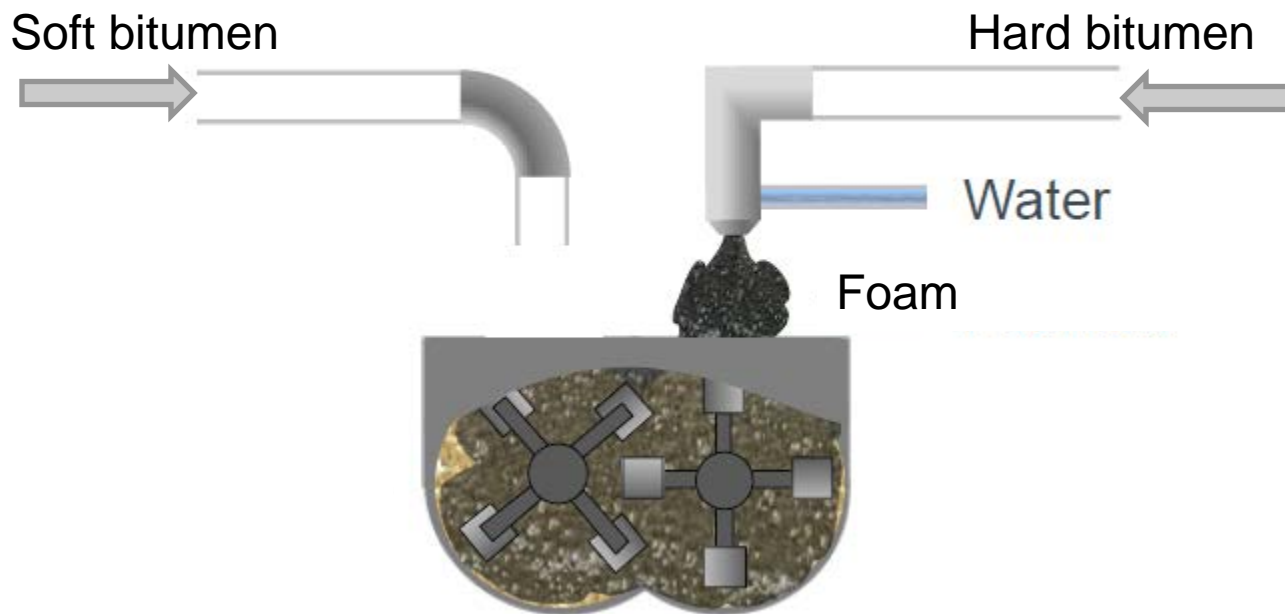
Hot mix modification

- ▶ KGO process
 - ▶ Bitumen & coarse aggregate introduced simultaneously
 - ▶ Filler
 - ▶ Fines
 - ▶ Advantages
 - ▶ Lower bitumen content
 - ▶ Mixing at 130-140°C
- ▶ www.kgo.se



Two phase mixing

- ▶ Soft bitumen followed by hard bitumen
- ▶ Coarse aggregate / bitumen followed by cold, wet aggregate
- ▶ Foaming?

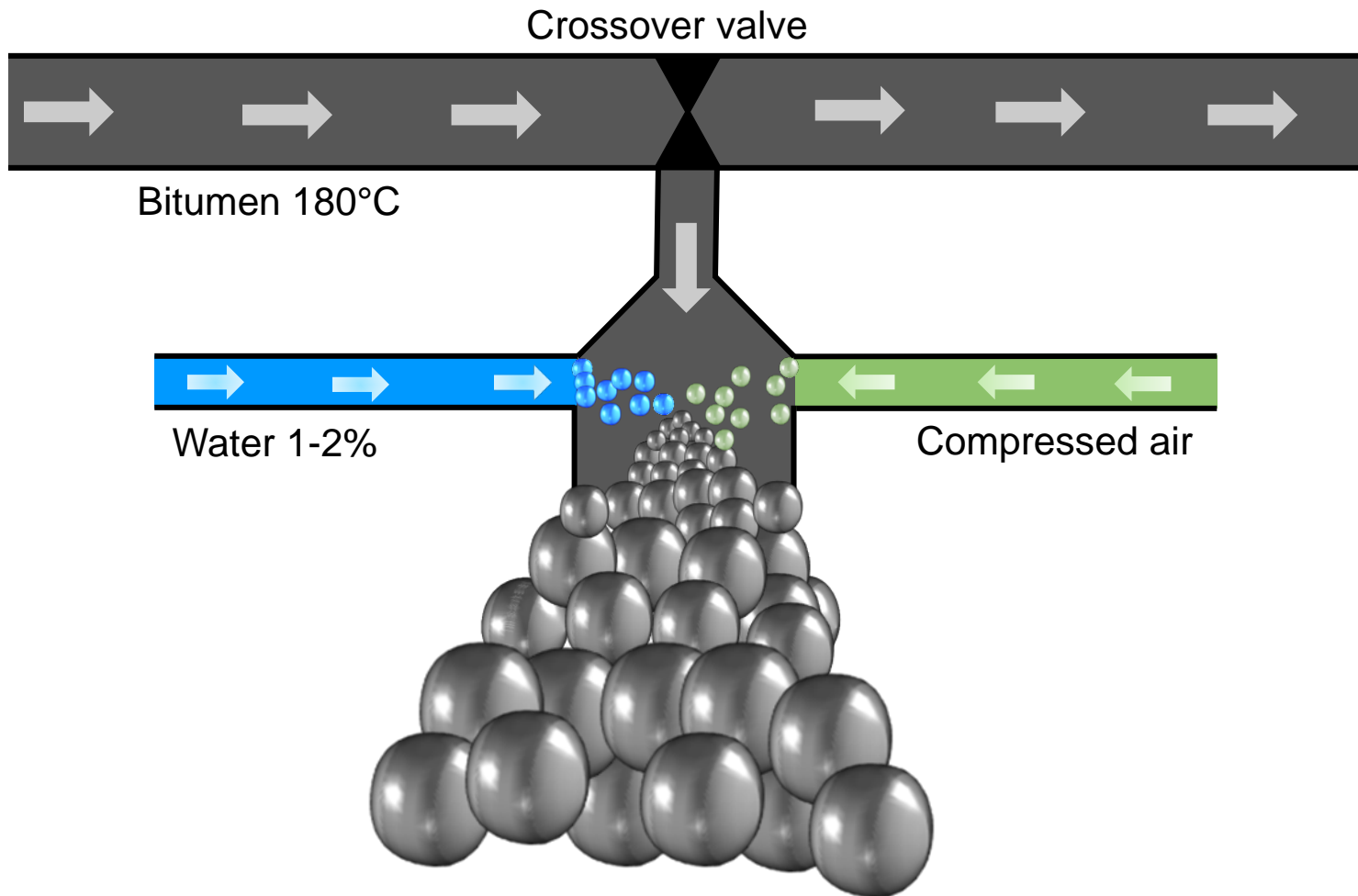


Direct Foaming

- ▶ Conventional foam
 - ▶ Origins in 1950s
 - ▶ High pressure water injection into bitumen
 - ▶ Surfactant additives?
 - ▶ Water expands ~1500 in volume
 - ▶ Foam has a low viscosity
 - ▶ Proven technology
 - ▶ Bitumen origin important
 - ▶ Capital costs



Foaming plant

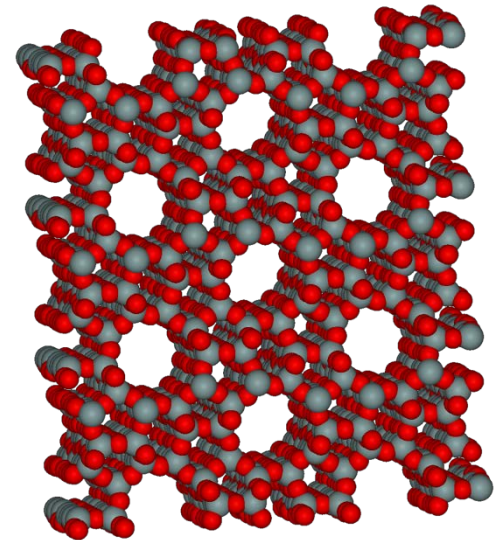


Warm mix additives

- ▶ Viscosity modifiers
 - ▶ Organic
 - ▶ Fisher Tropsch waxes
 - ▶ Fatty amides
 - ▶ Montan waxes
 - ▶ Mineral
 - ▶ Zeolites
- ▶ Chemical additives
 - ▶ No effect on viscosity or bitumen properties
 - ▶ Reduce surface tension between aggregate & bitumen
- ▶ USA 86.7MTe WMA (~25% of all asphalt)
 - ▶ 10% using additive technology
- ▶ UK showing significant appetite

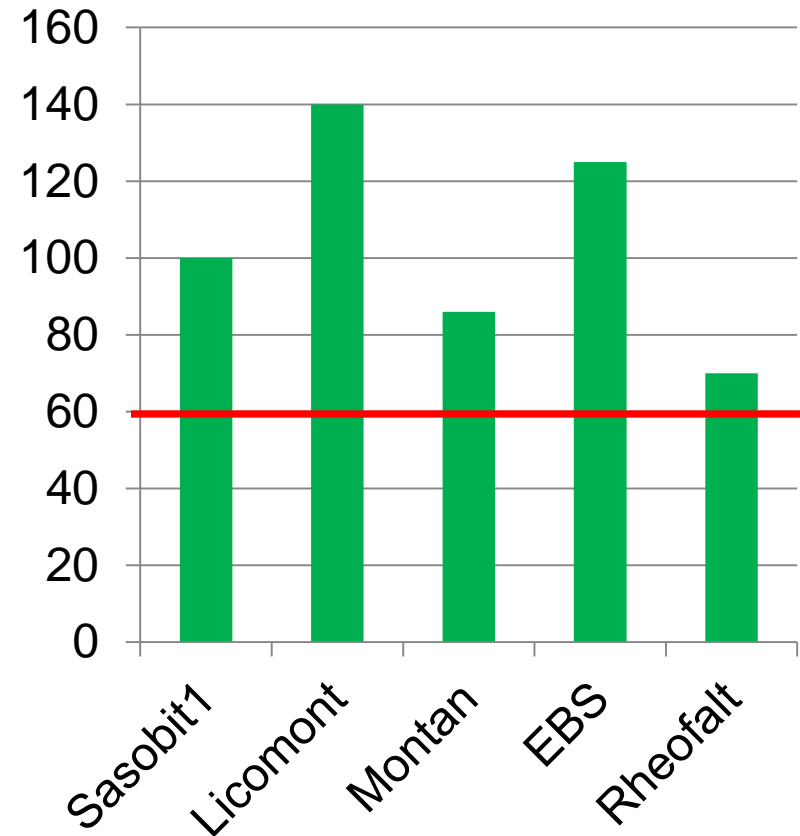
Indirect Foaming

- ▶ Moisture present in aggregates
- ▶ Hygroscopic fillers
- ▶ Zeolite additives
 - ▶ Alumino-silicate minerals
 - ▶ Typically 20-25% water
 - ▶ $\text{Na}_2\cdot\text{Al}_2\text{Si}_3\text{O}_{10}\cdot 2\text{H}_2\text{O}$
 - ▶ Release water on a micro scale.
- ▶ Do not alter asphalt grading
 - ▶ Addition rate 0.3%
- ▶ 6-7h improved workability
- ▶ Products
 - ▶ Asphamin
 - ▶ Advera



Organic additives

- ▶ Characterised by sharp melting point
- ▶ Liquid above DP
- ▶ Can increase stiffness below DP
- ▶ Viscosity / temperature reduction depends on type / concentration of additive
- ▶ Addition rate: 1.5-3%
- ▶ Plant addition possible
- ▶ Temperature reduction: 20-40°C
- ▶ No specification for organic modified binders

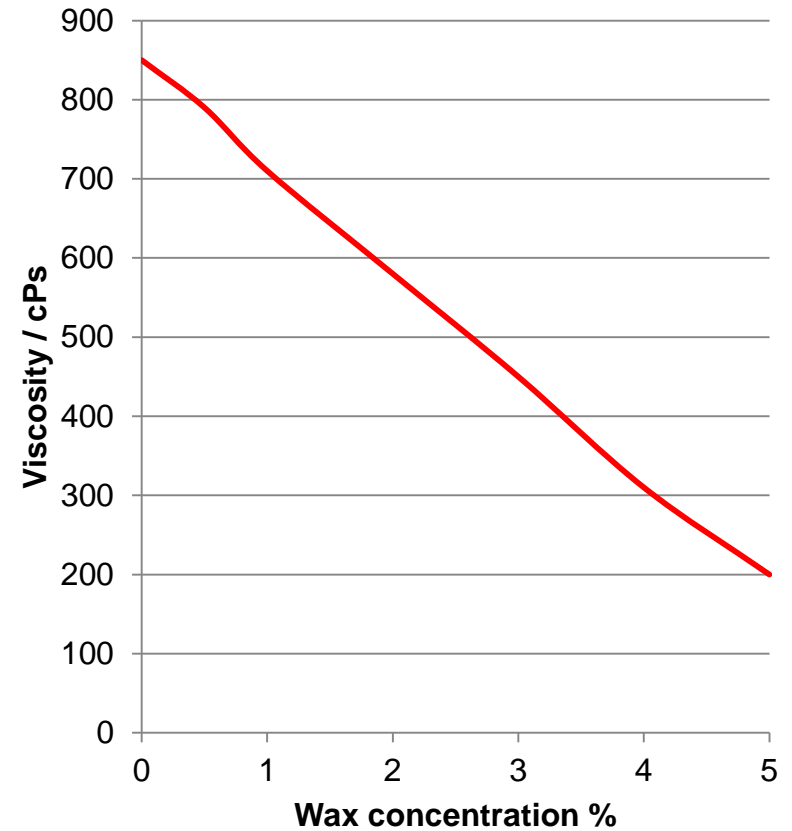
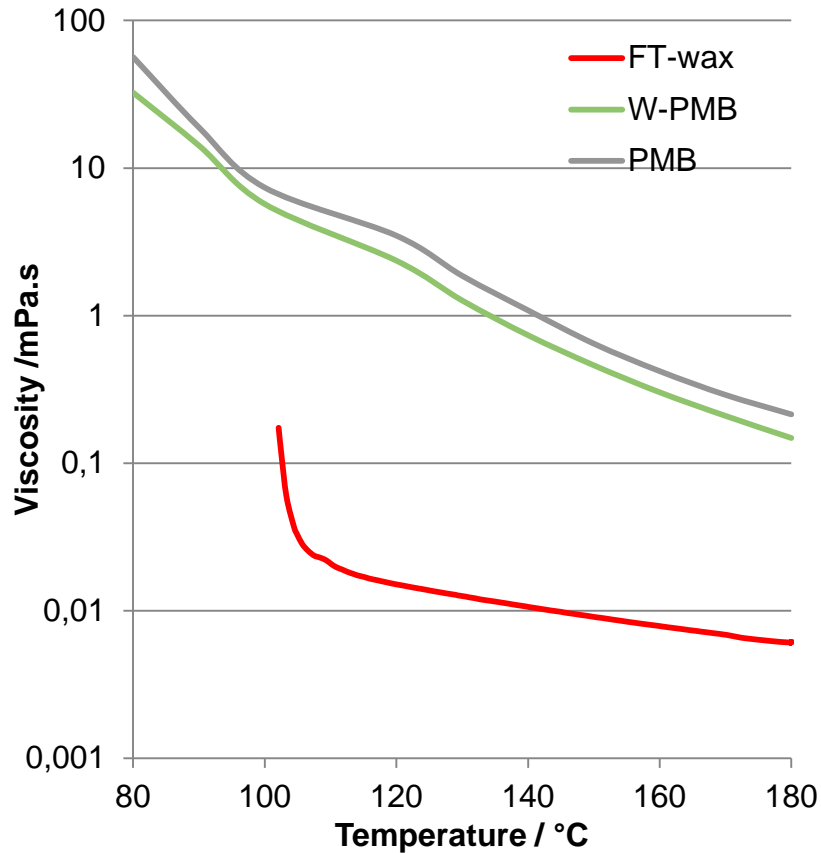


Chemical Additives

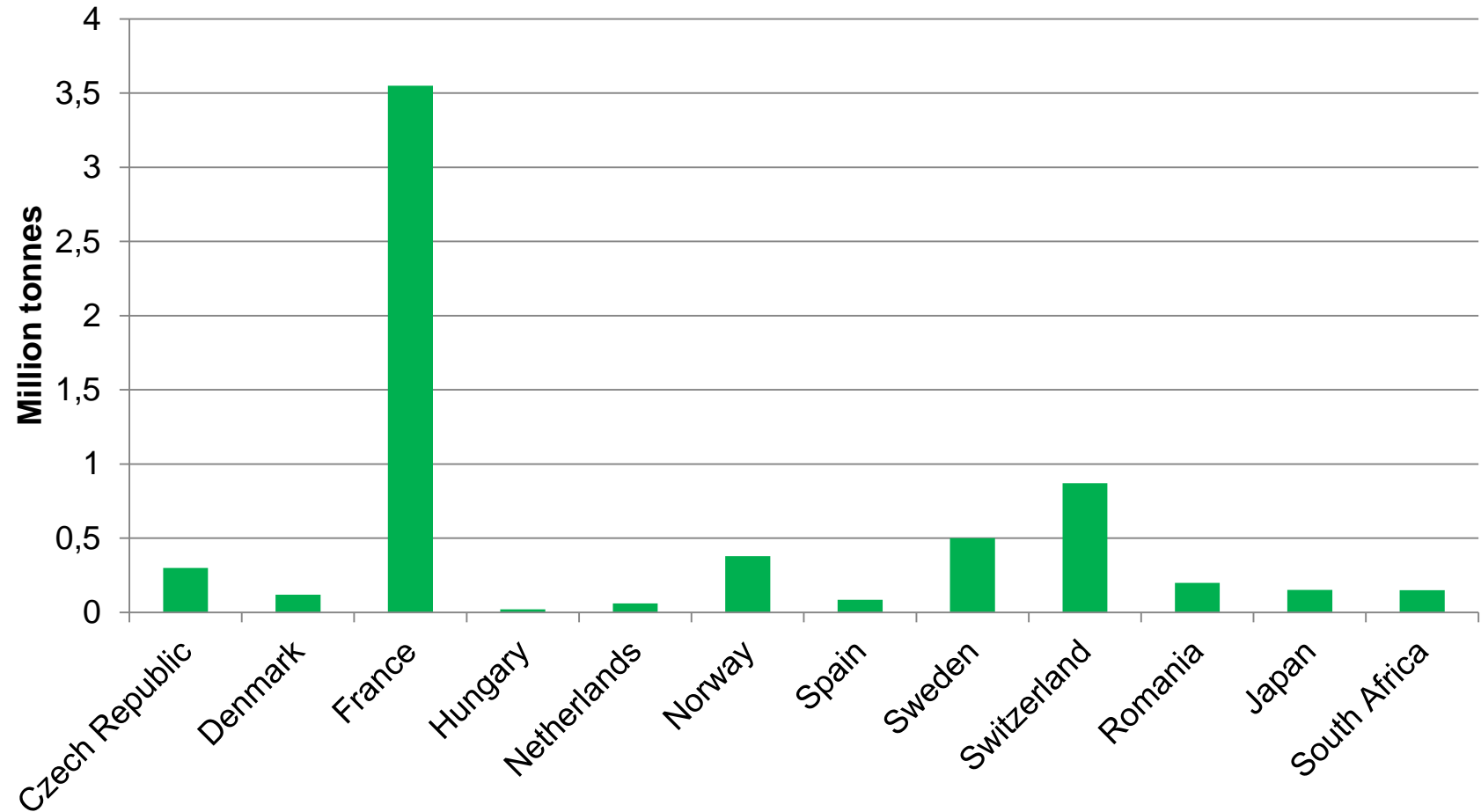
- ▶ No effect on bitumen properties
- ▶ Effect on asphalt is very difficult to prove in laboratory
- ▶ Reduction in interfacial tension between aggregate & bitumen
- ▶ Improved adhesive bond
- ▶ Products
 - ▶ MWV: Evotherm
 - ▶ Zydex: Zycotherm
 - ▶ Arkema: Cecabase
 - ▶ Akzo-Nobel: Rediset
 - ▶ Iterchimica: Iterlow
- ▶ Addition rates typically 0.1-1.0%



Organic additives

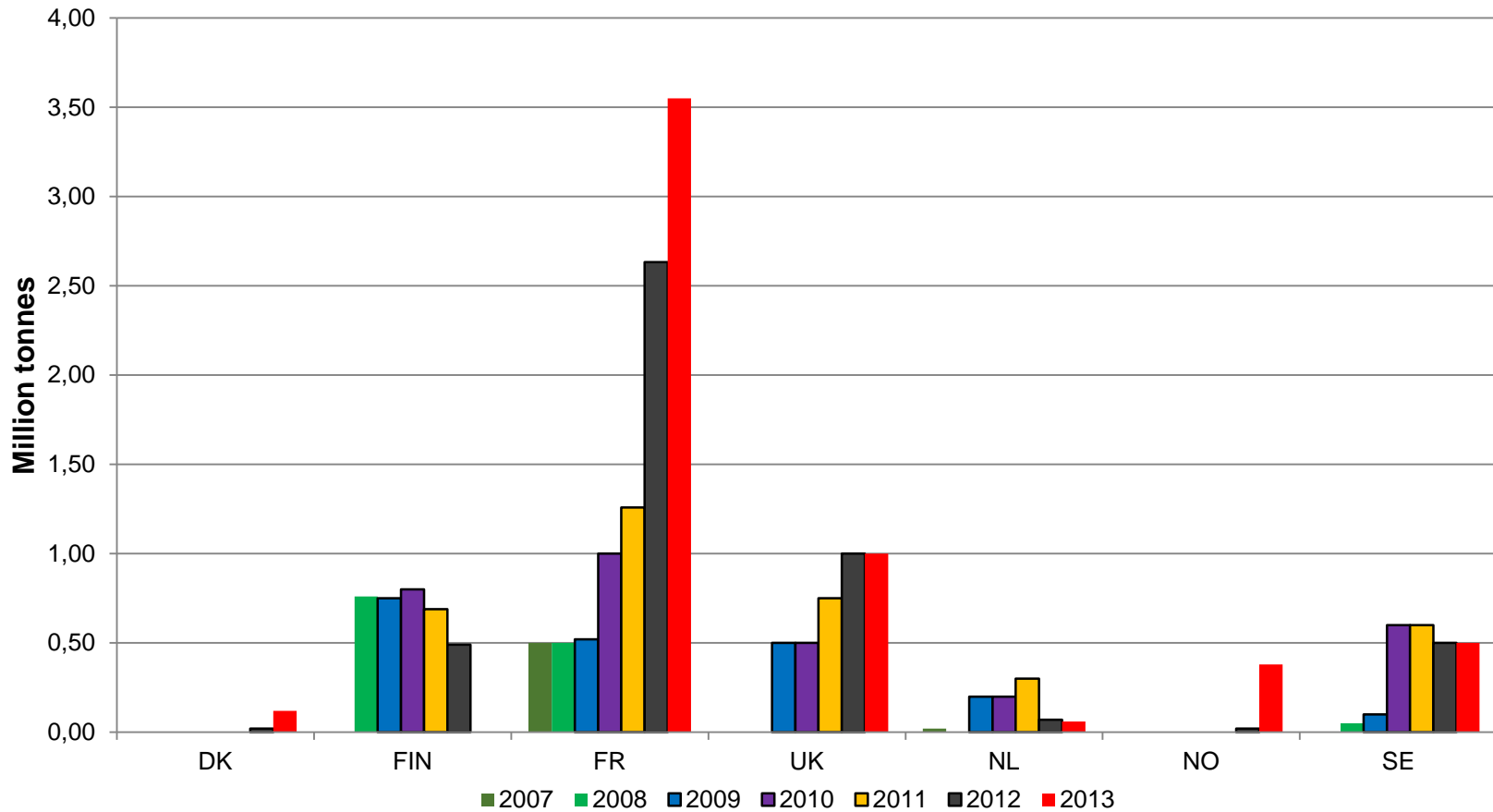


Warm mix asphalt 2013

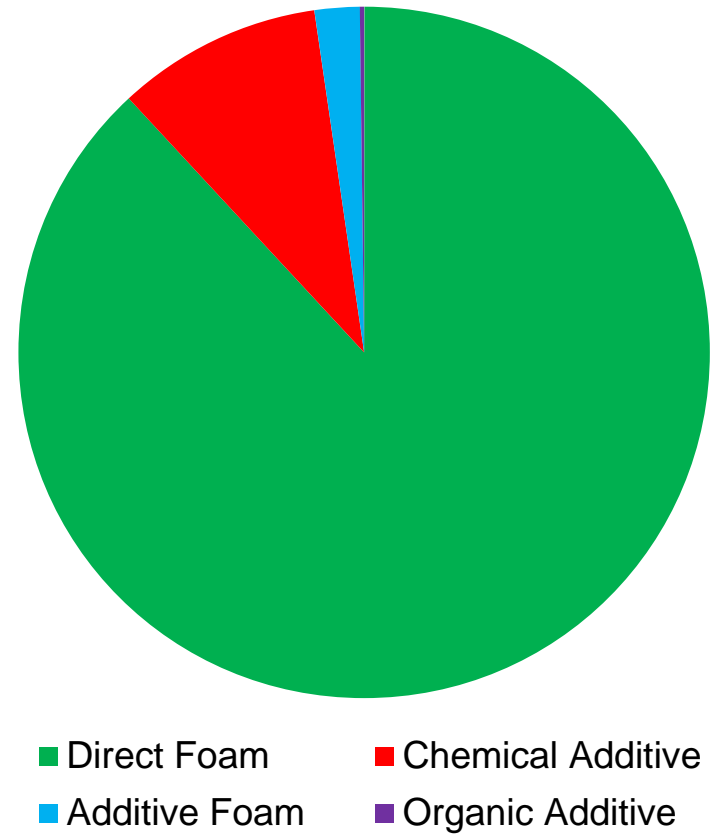
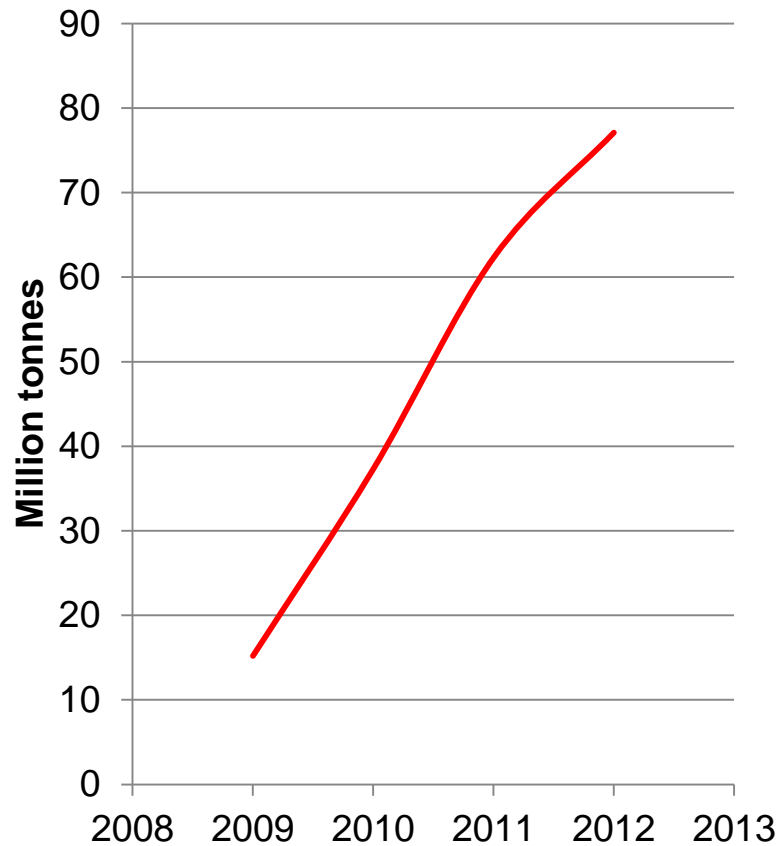


Source: EAPA "Asphalt in Figures 2013"

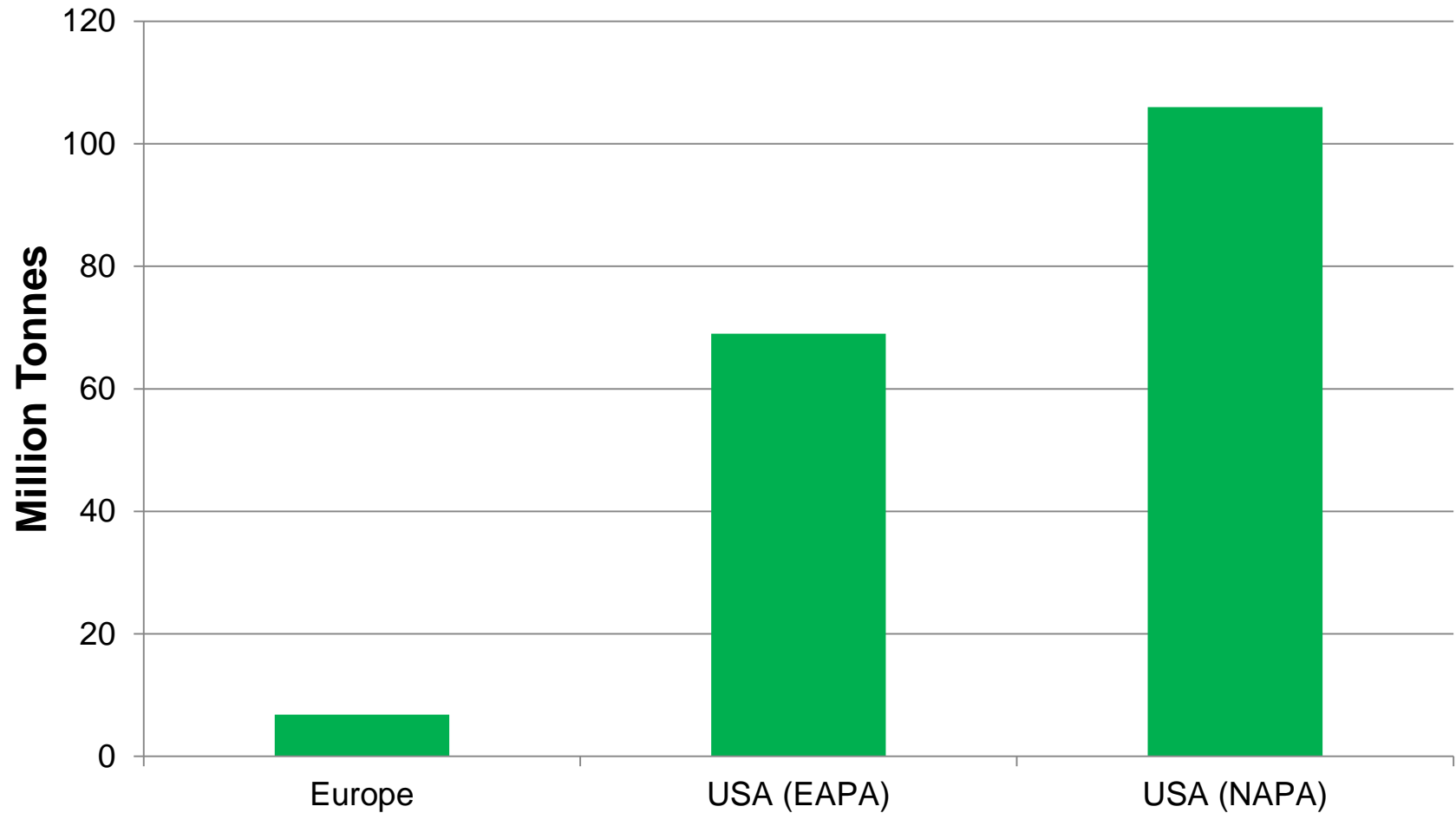
Warm mix asphalt production



Warm mix in the USA



Warm mix asphalt 2013



Source: EAPA "Asphalt in Figures 2013"
NAPA "Annual Asphalt Pavement Industry Survey 2013"

Specifications

- ▶ Asphalt standards EN 13108-1–7
 - ▶ Limit max temperature
 - ▶ Min temperature
 - ▶ Provision for additives
 - ▶ “Should not be seen as a barrier to the introduction of WMA”
- ▶ TRL PPRS666 “Specification for low temperature asphalt mixtures”
- ▶ Test methods for warm mix asphalt?

Case Study #1

- ▶ UK Asphalt producer using RAP
- ▶ Desire to double RAP content in most asphalt mixes
- ▶ Old asphalt plant with inefficient heating
 - ▶ RAP content limited with conventional binders
- ▶ Solution : Nytherm 85
 - ▶ 70/100 bitumen modified for warm mix applications
 - ▶ Normal RAP content 5-10%
 - ▶ Increased to 10-20%
 - ▶ Mixes produced at 110°C
 - ▶ No difficulty with compaction

Case study #2

- ▶ Årsunda, Sweden
 - ▶ Re-surfacing using RAP
- ▶ Solution: Foam-mix using Nyfoam 85
 - ▶ Mix temperature lowered to 120°C
 - ▶ 20% less fuel
 - ▶ 30-70% less emissions



Case study #3



Acknowledgements

- ▶ Helene Odelius, Bitumen Technology Manager, Nynas
- ▶ Dennis Day, Product Support Manager, UK & Ireland, Nynas

For more information

<http://www.nynas.com/>

<http://www.eapa.org>

<http://www.eurobitume.eu/>

<http://www.warmmixasphalt.com/>

<http://www.asphaltpavement.org/>

<https://www.fhwa.dot.gov>

www.asphaltadvantages.com

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