

The background of the slide is a blue line drawing sketch of a landscape. It shows rolling hills, a body of water, a small building with a chimney, and various trees. The drawing is done in a simple, sketchy style with blue ink on a white background.

# Warm Mix Asphalt in Europe

15/10/2015, Dr Ian M Lancaster, NABIn Oslo

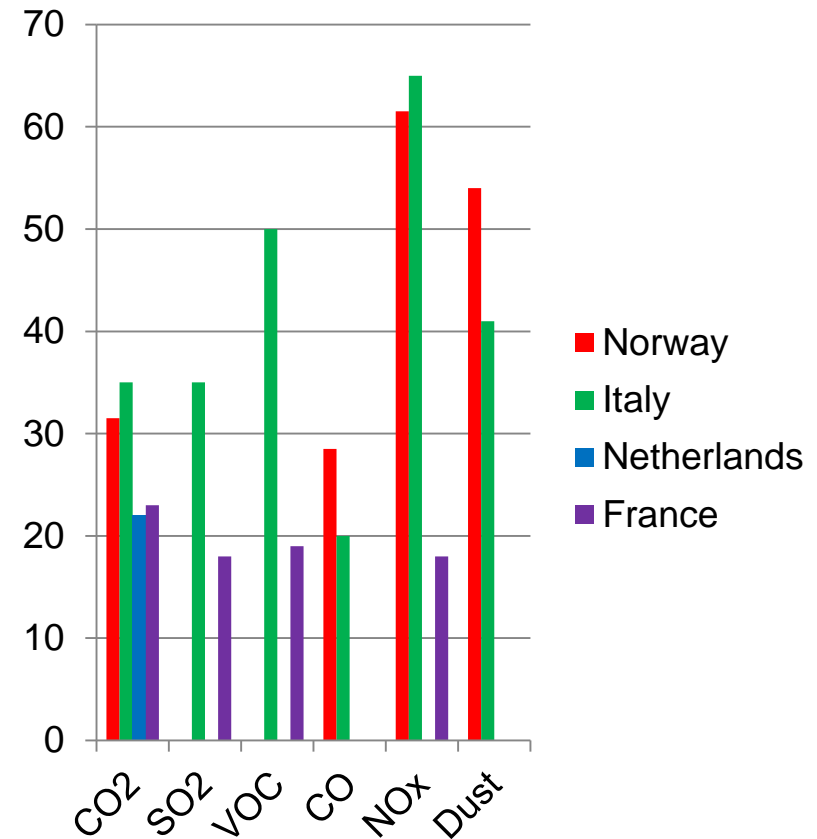


**Norge er i forkant igjen!**



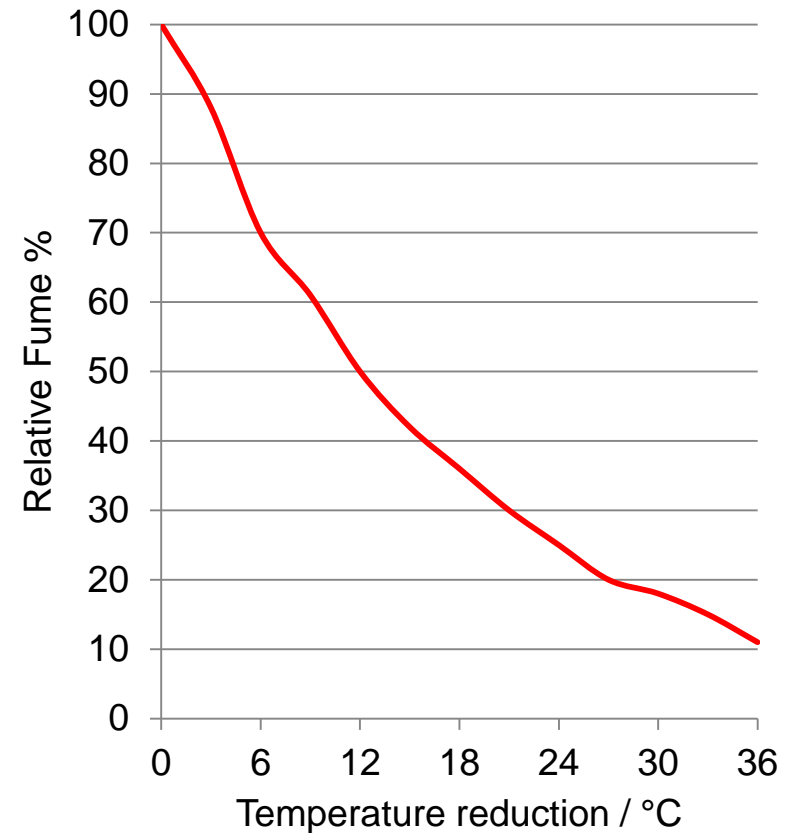
# Why warm mix?

- ▶ 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

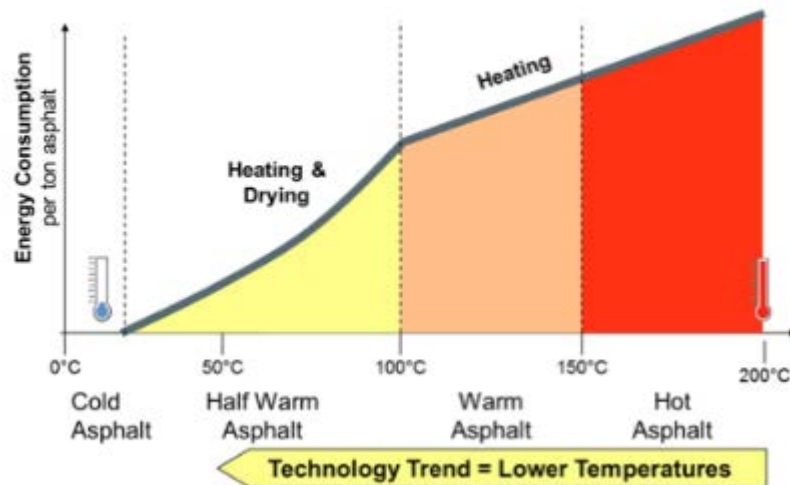
- ▶ Kyoto Protocol
- ▶ US CAIR
  - ▶  $\text{SO}_x$  /  $\text{NO}_x$  reduction in 28 states
- ▶ Sustainable development principles
- ▶ REACH
  - ▶ Exposure reduction



# 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

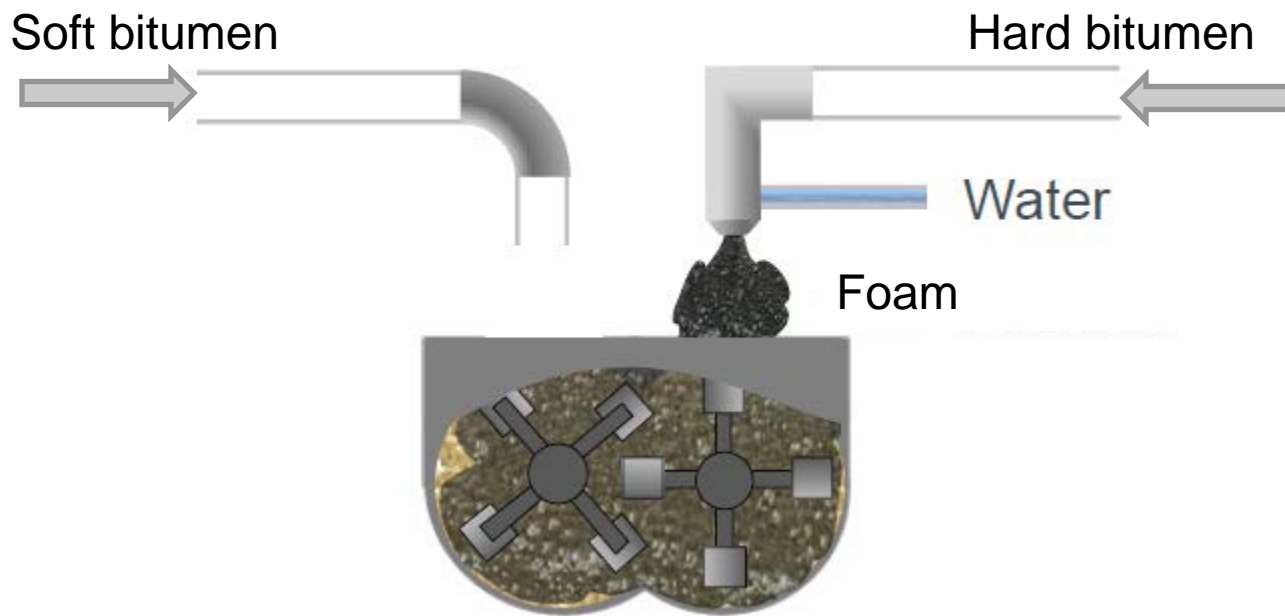
- ▶ KGO process
  - ▶ Bitumen & Coarse aggregate introduced simultaneously
  - ▶ Filler
  - ▶ Fines
  - ▶ Advantages
    - ▶ Lower bitumen content
    - ▶ Mixing at 130-140°C
- ▶ [www.kgo.se](http://www.kgo.se)





# Two phase mixing

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

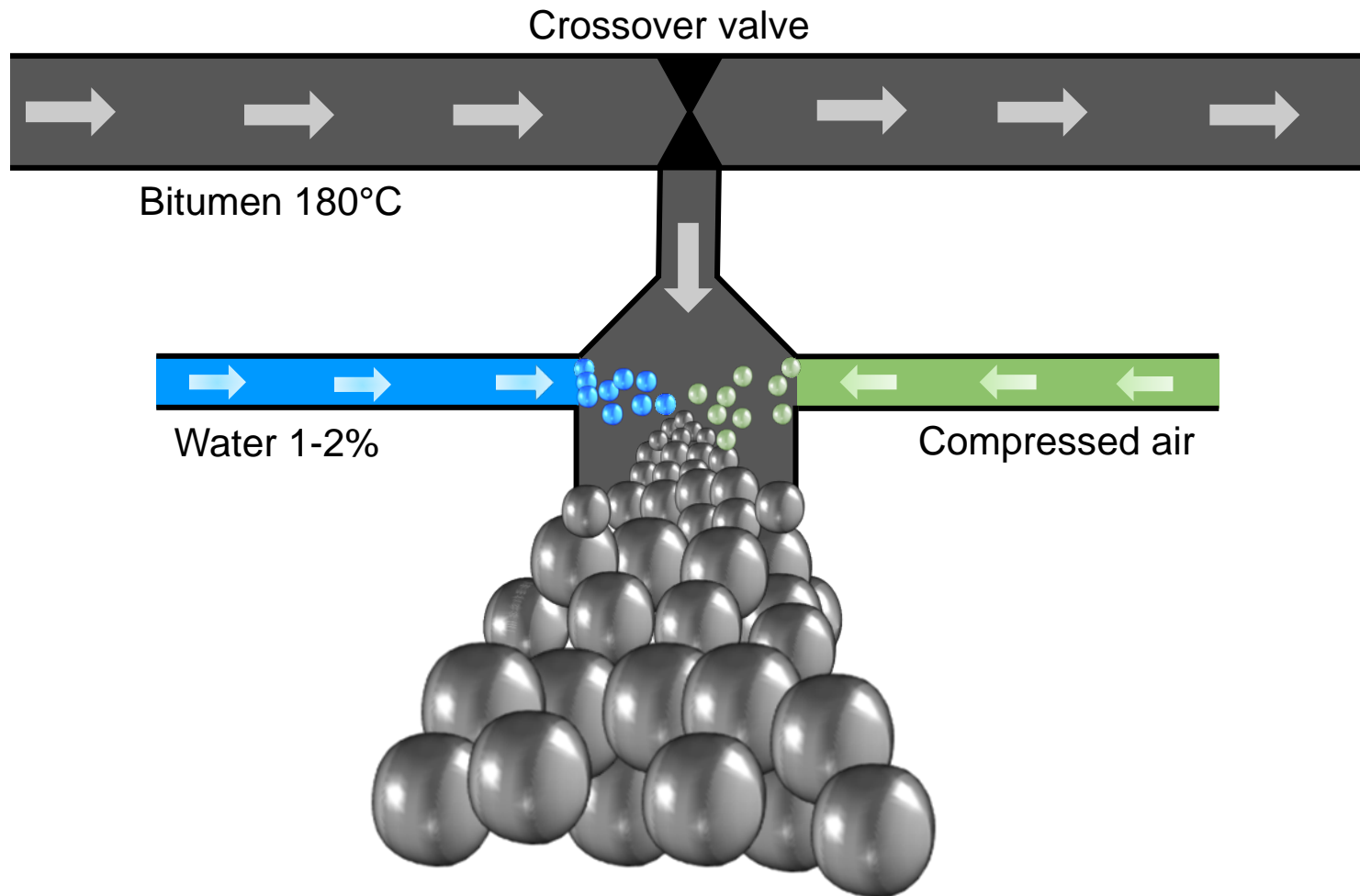


# Direct Foaming

- ▶ 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

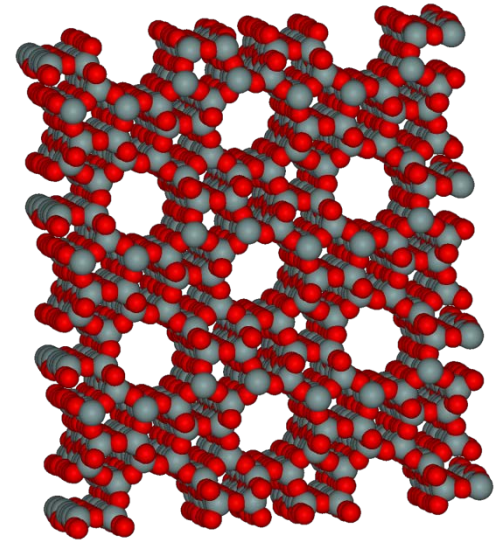


# Warm mix additives

- ▶ 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

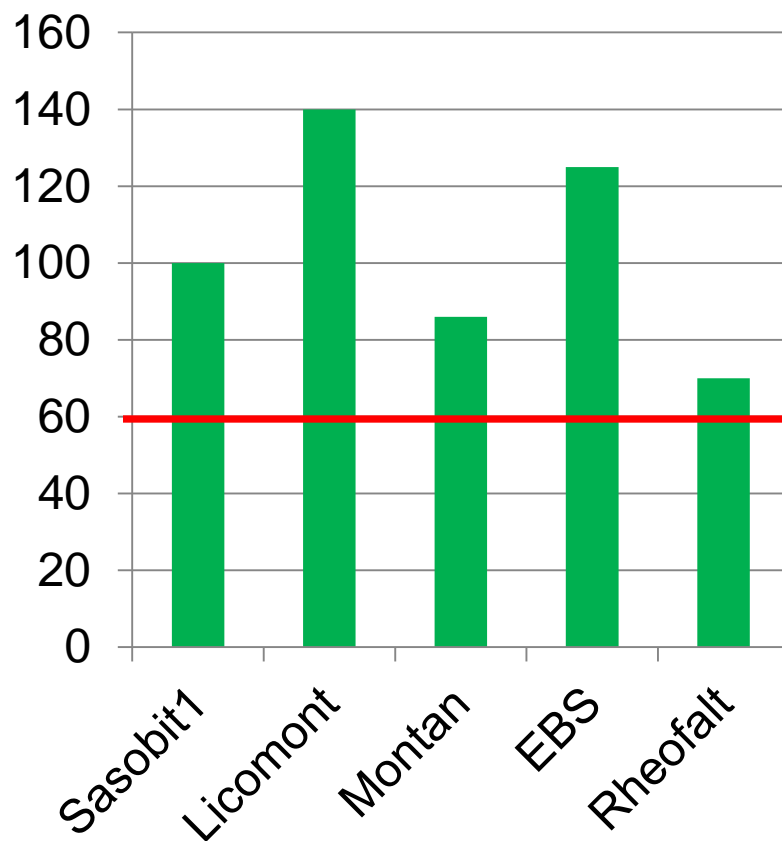
# Indirect Foaming

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

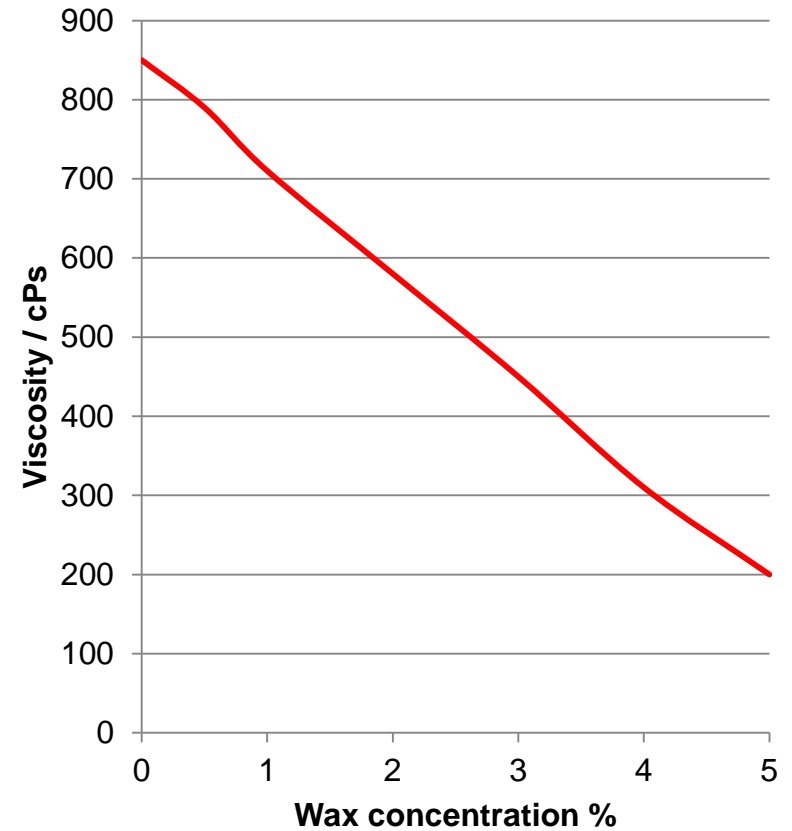
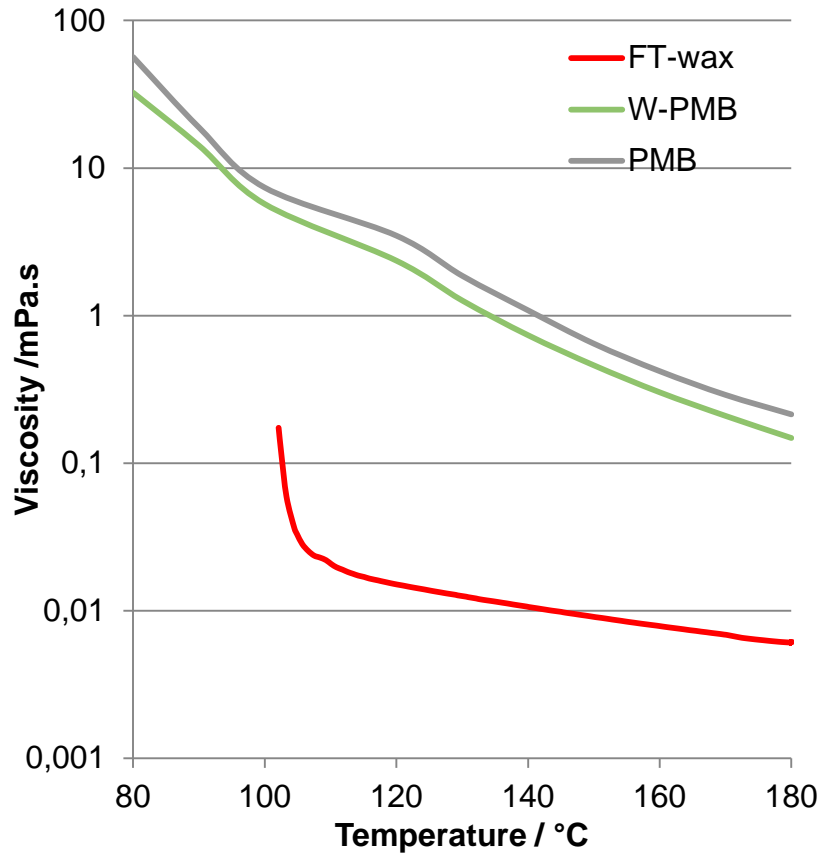


# Organic additives

- ▶ 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



# Organic additives



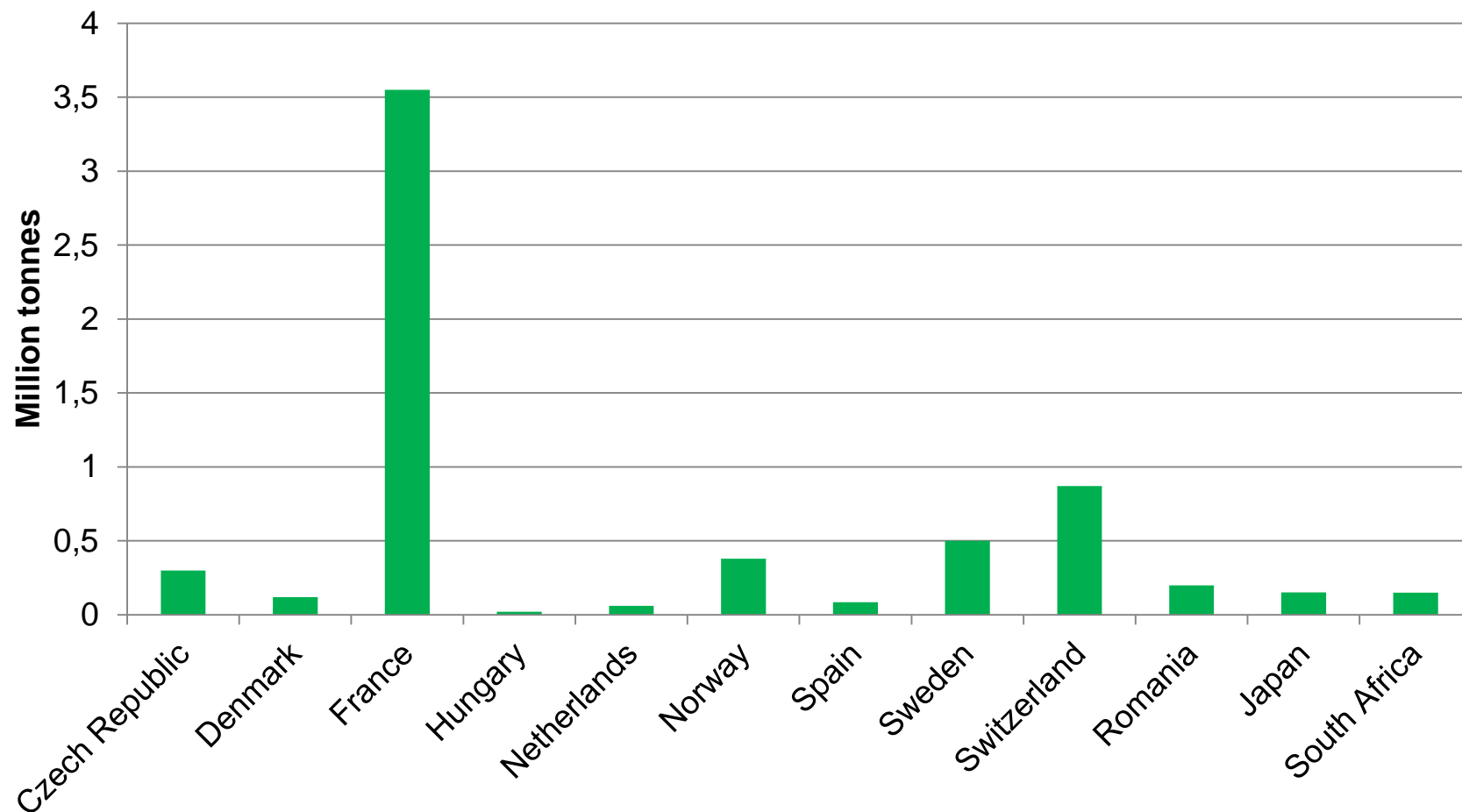


# Chemical Additives

- ▶ No effect on bitumen properties
- ▶ Effect on asphalt is 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%

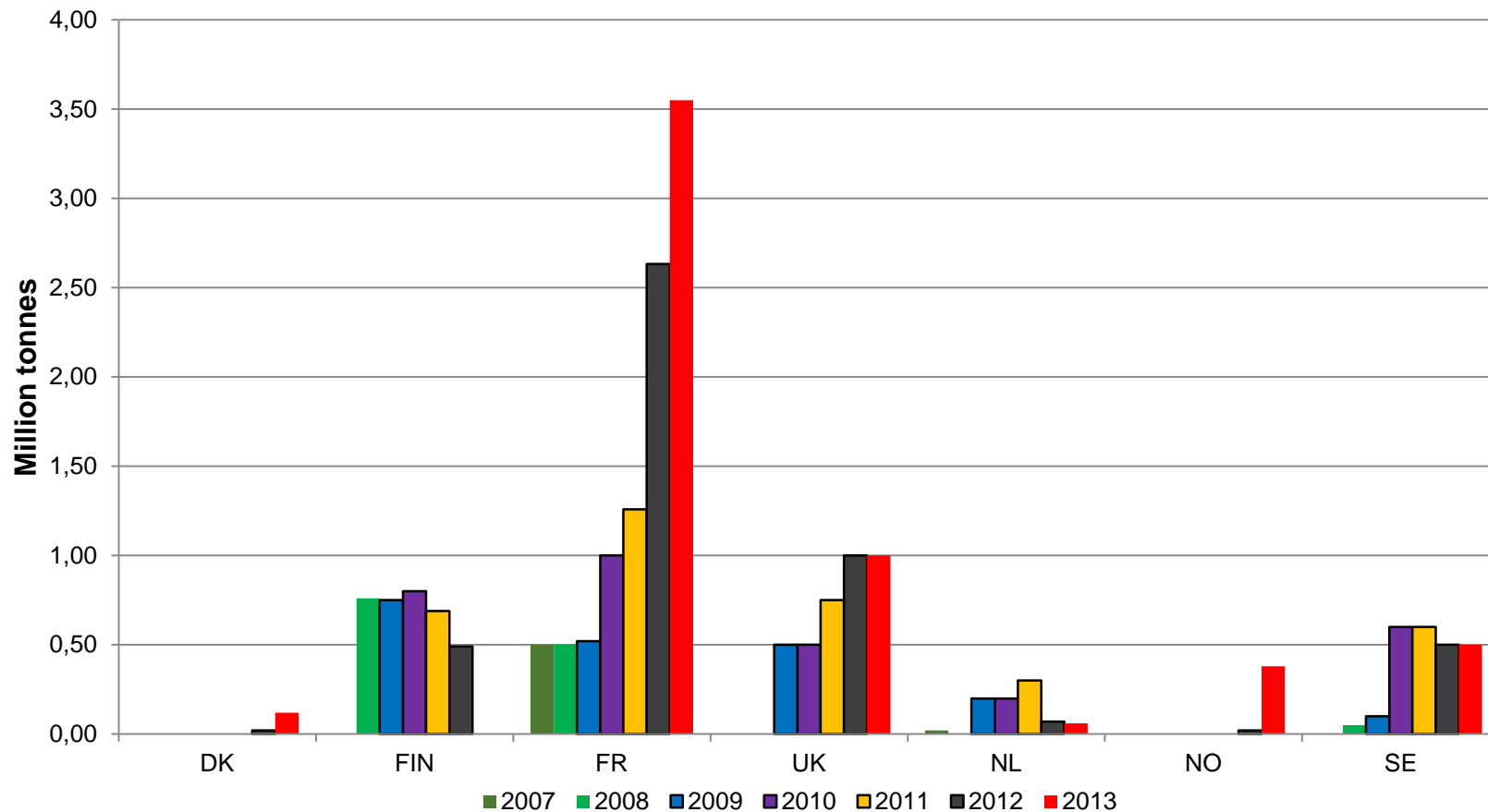


# Warm mix asphalt 2013

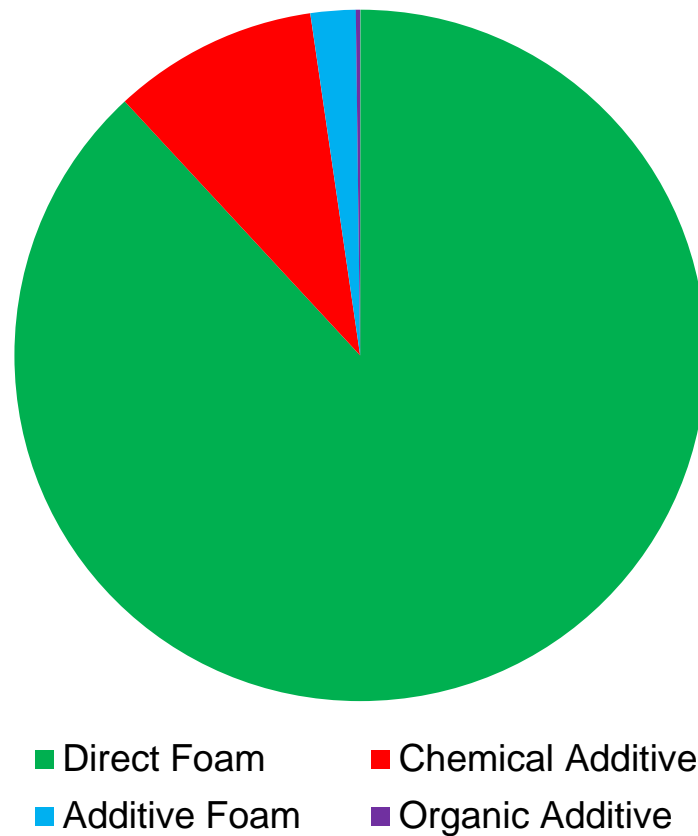
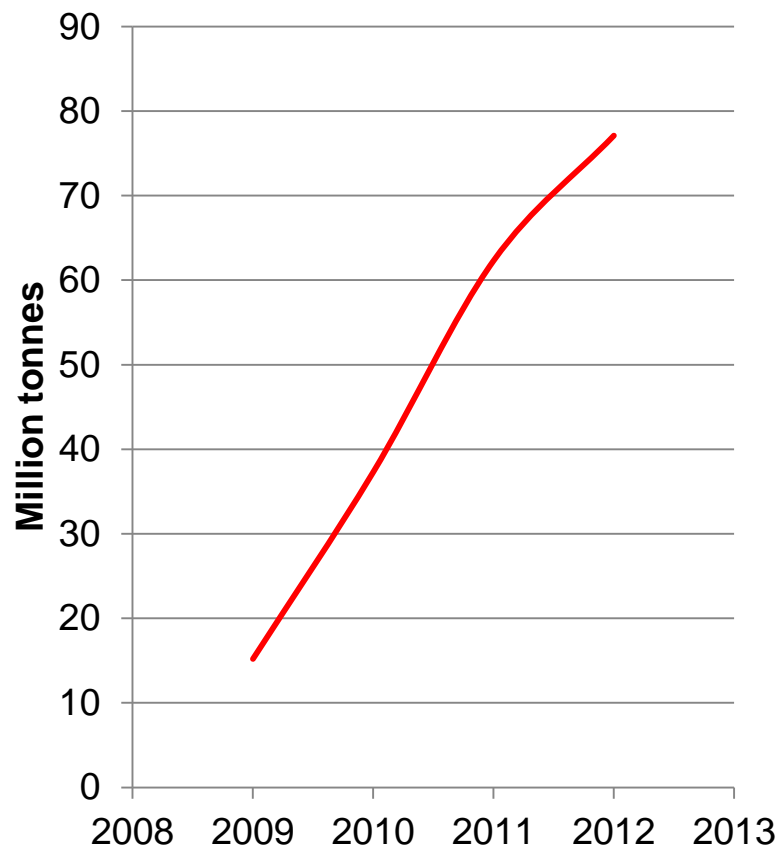


Source: EAPA "Asphalt in Figures 2013"

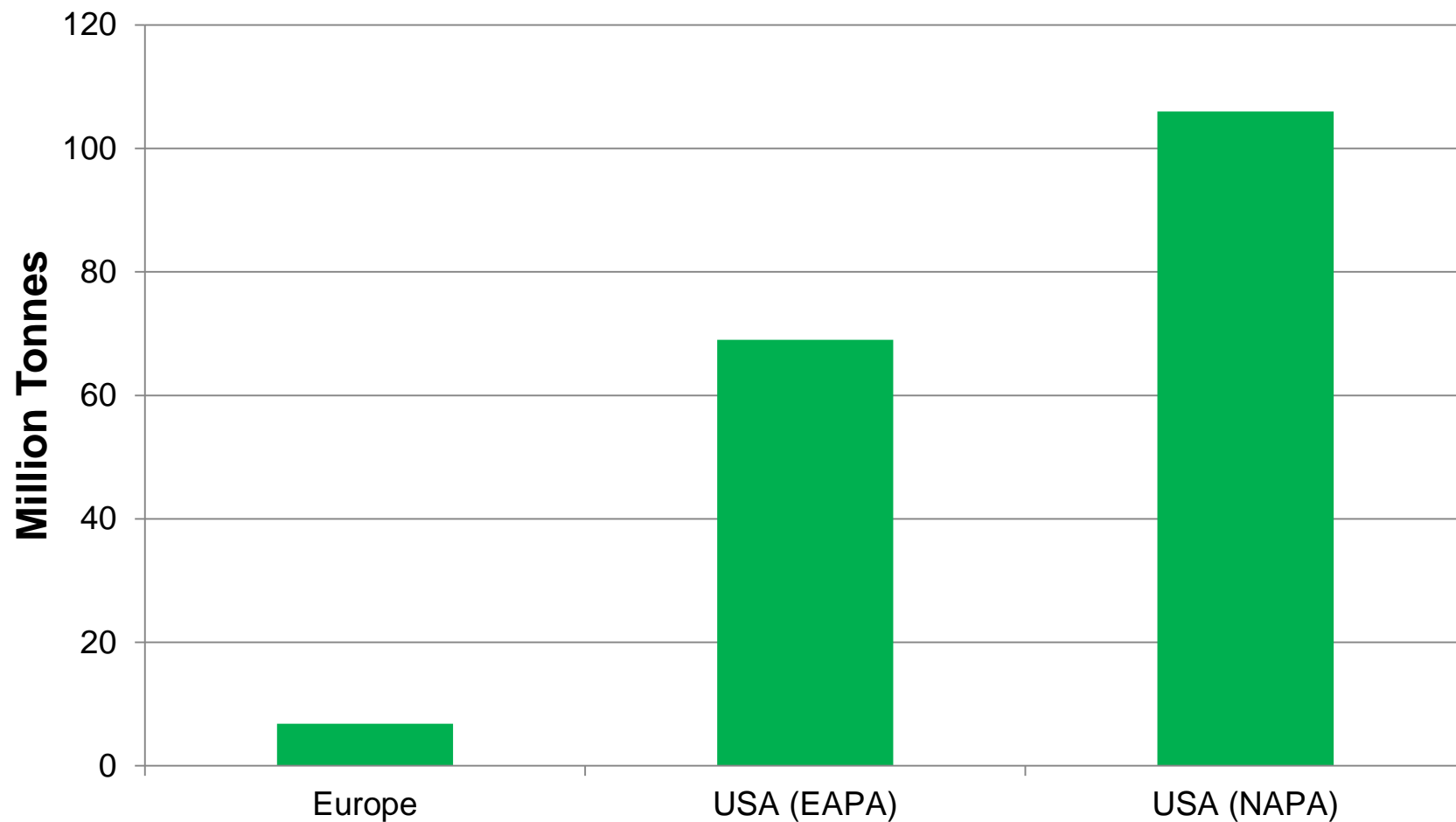
# Warm mix asphalt production



# 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”

# 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
  - ▶ RAP content increased to 30%
  - ▶ 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](http://www.asphaltadvantages.com)



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