Global PVC Stabilizer Trends for Pipes – Challenges and Practical Experience

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BÆRLOCHER

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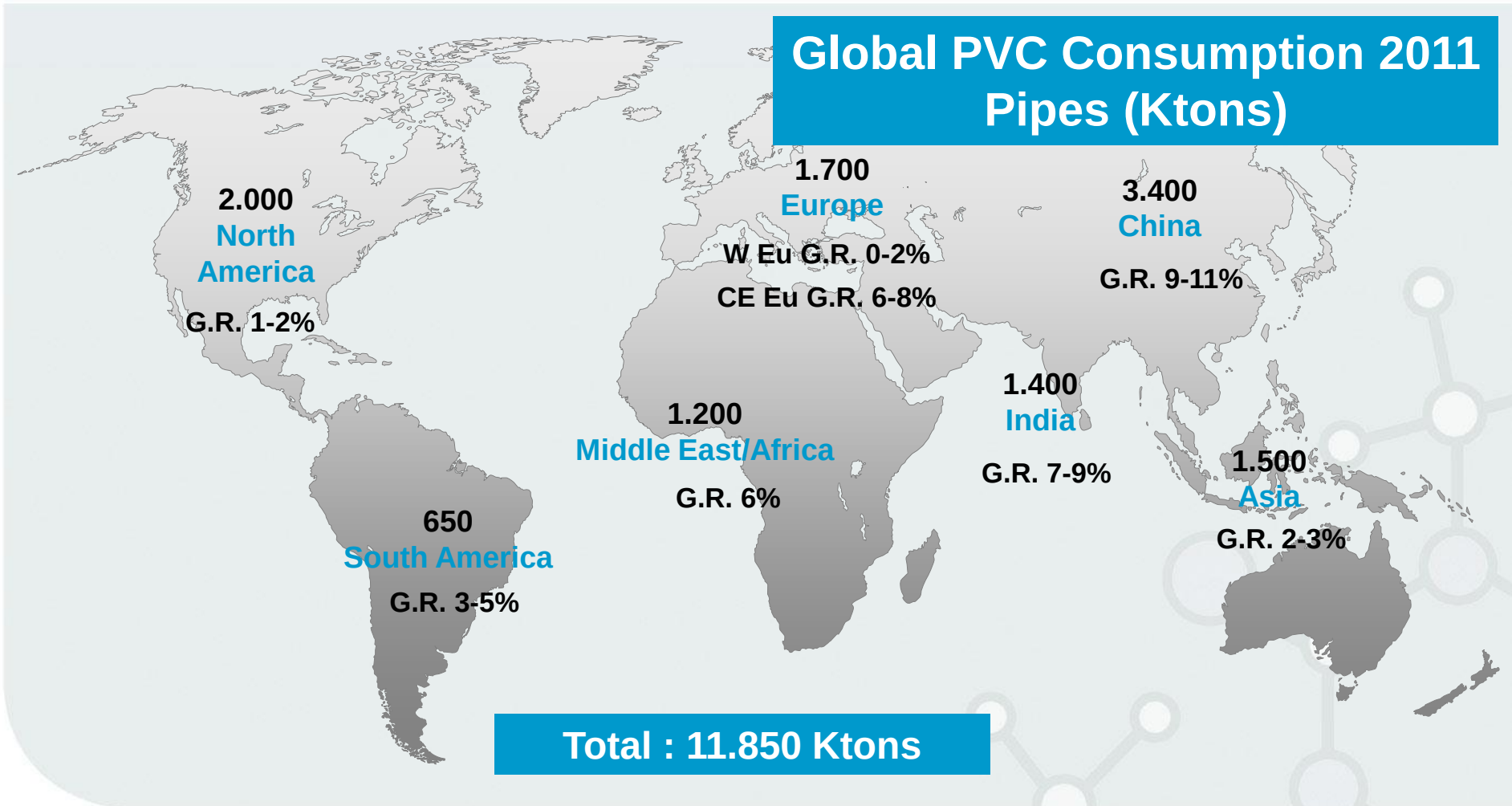
Agenda

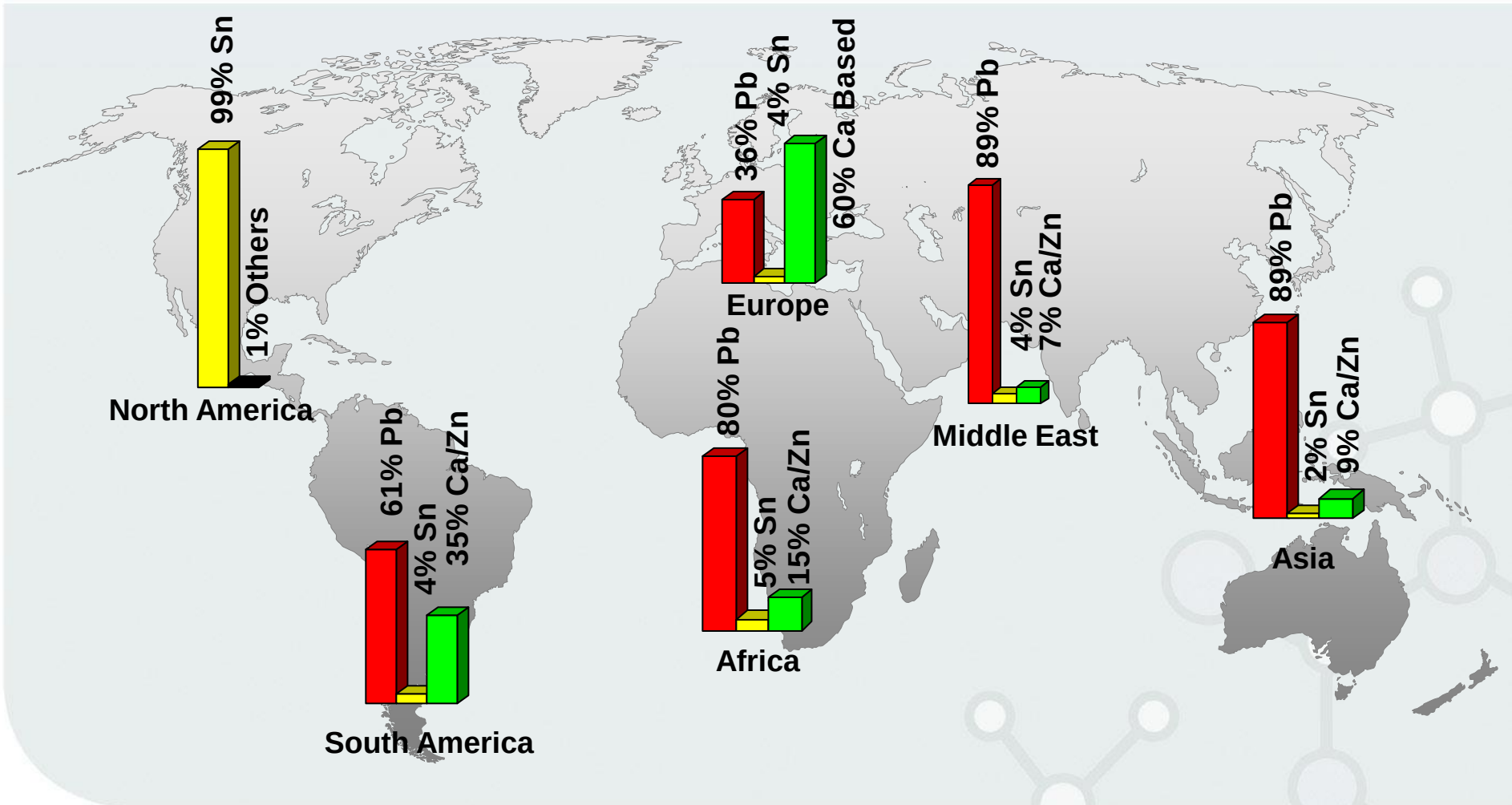
- Overview PVC pipes, stabilizers and markets
- Worldwide trends for PVC pipes
- Cost as critical driver
- Market trends for cost reduction
  - → High filler level
  - → Multi-layer pipe
  - → More effective use of onepacks
- Summary

Growth has come in the Developing Markets



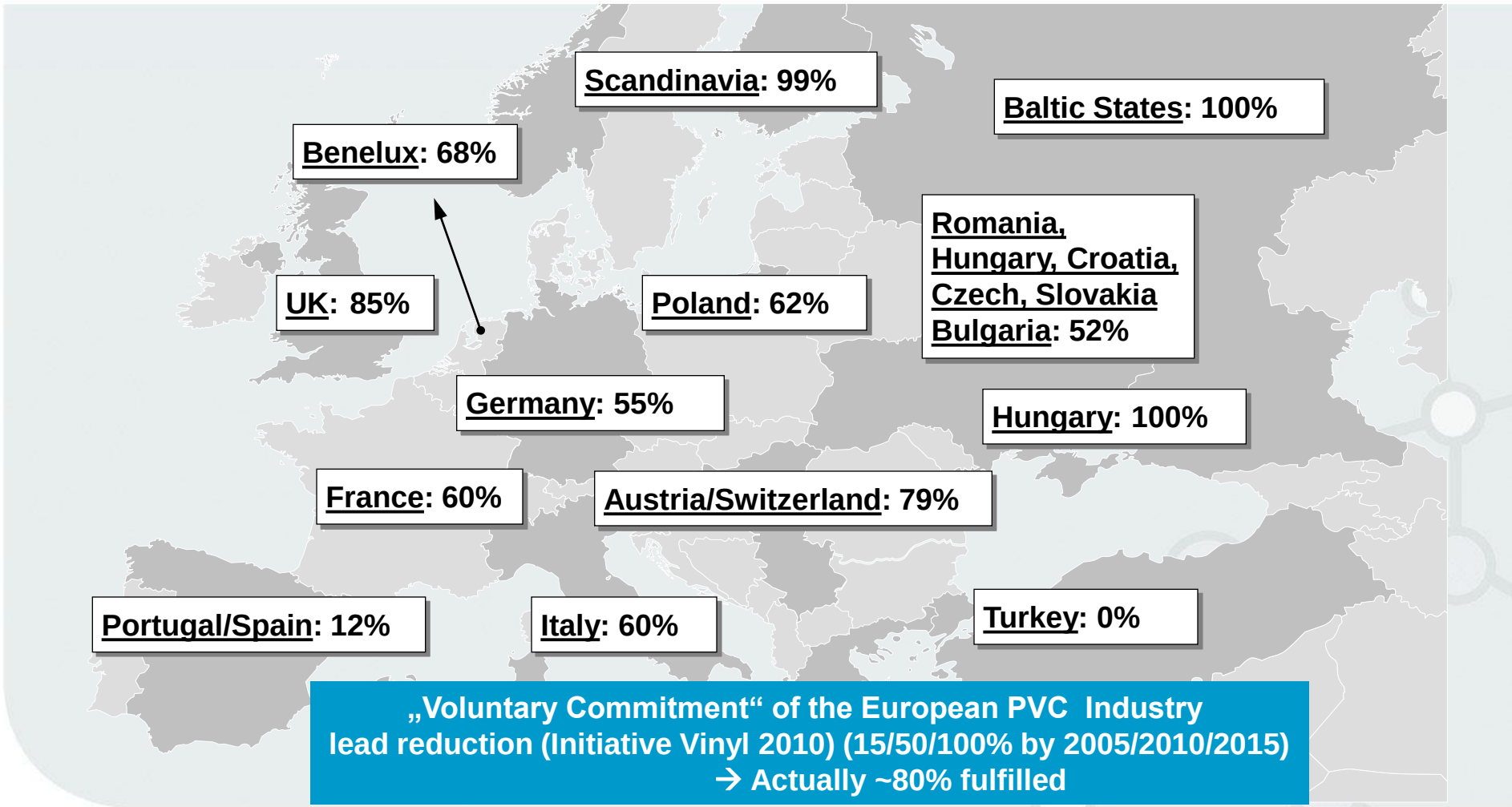
Source: Baerlocher Estimate/approximations

Pb-Stabilization dominates PVC pipe systems globally



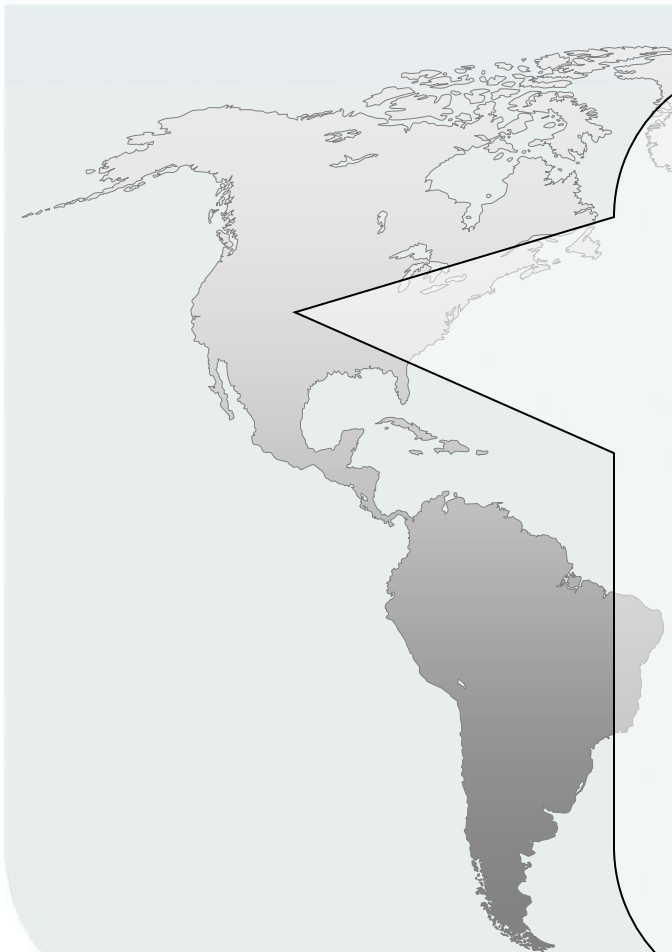
Source: BAERLOCHER ESTIMATE

Ca-based systems are now the standard in Europe



Source: BAERLOCHER ESTIMATE

Tin stabilizers still dominate in North America

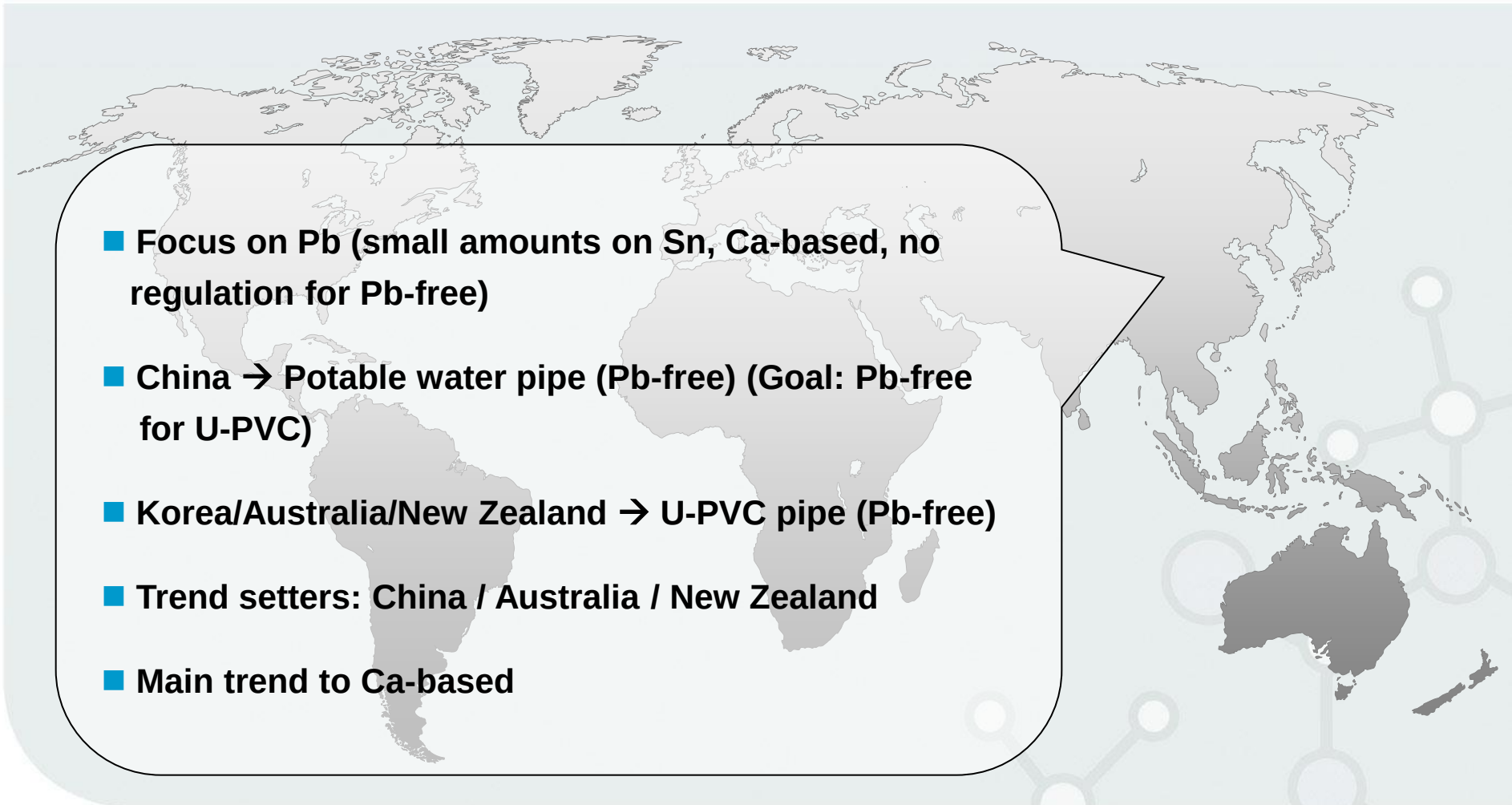


- Tin stabilizers
  → Best price/performance ratio for white coloured pipes
- FDA regulates material for food contact application
  → NSF-standard and certification for pipes
- Drinking water pipes → Max 1 part of Sn per 100 parts of resin
- California as leader in material restriction
- Rarely tests with Ca-based systems

Trends towards Ca-based stabilisers in South America

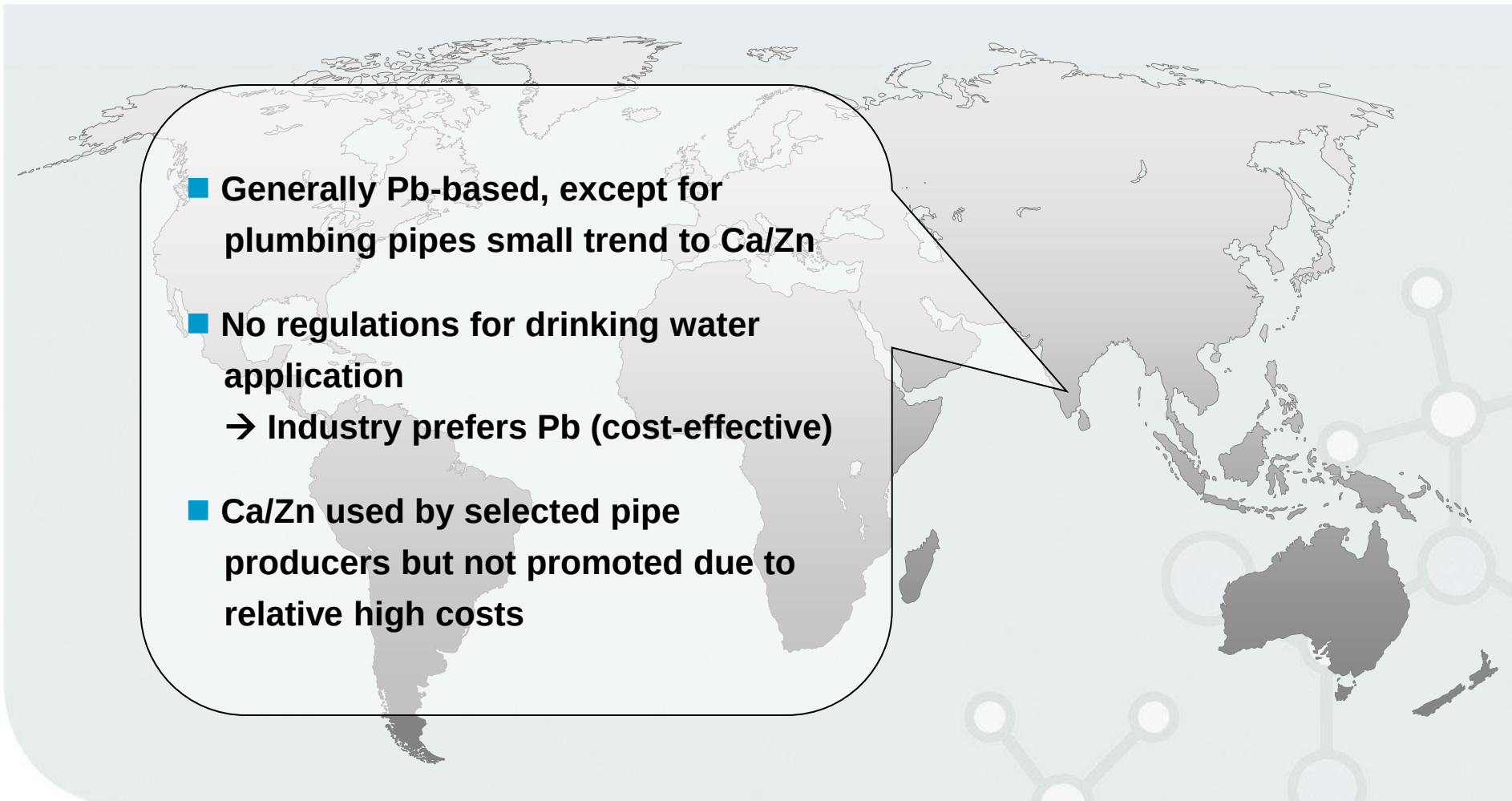
- Pb-based systems dominating in Uruguay, Argentina, Paraguay, Bolivia → Trend however to Ca/Zn
- Columbia, Venezuela, Ecuador using Sn
- Peru is using Pb, Ca/Zn as well as Sn depending on the company
- Brazil: Ca-based systems dominate
- Health authority is pushing against Pb for potable water

Pb systems dominate in Asia
(but with some trends to Ca-based)



- Focus on Pb (small amounts on Sn, Ca-based, no regulation for Pb-free)
- China → Potable water pipe (Pb-free) (Goal: Pb-free for U-PVC)
- Korea/Australia/New Zealand → U-PVC pipe (Pb-free)
- Trend setters: China / Australia / New Zealand
- Main trend to Ca-based

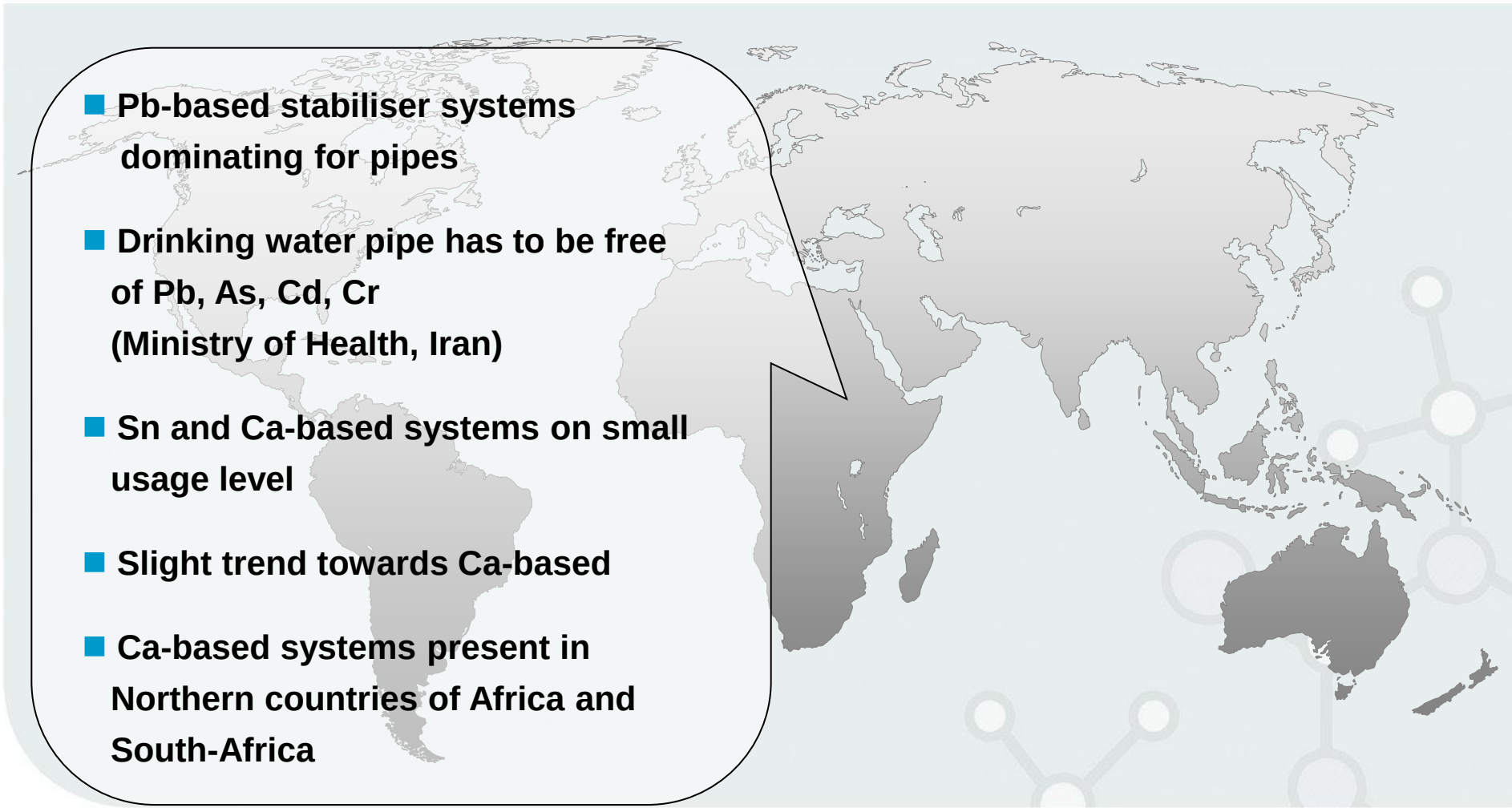
Pb systems dominate in India
(limited volumes in Ca-based)



- Generally Pb-based, except for plumbing pipes small trend to Ca/Zn
- No regulations for drinking water application
  → Industry prefers Pb (cost-effective)
- Ca/Zn used by selected pipe producers but not promoted due to relative high costs

In general Pb stabilisers are used in M. East/Africa

(certain regions trending to Ca-based)



- Pb-based stabiliser systems dominating for pipes
- Drinking water pipe has to be free of Pb, As, Cd, Cr (Ministry of Health, Iran)
- Sn and Ca-based systems on small usage level
- Slight trend towards Ca-based
- Ca-based systems present in Northern countries of Africa and South-Africa

Cost is driving development in PVC pipes

- **Worldwide trends to more cost-efficient production of PVC pipes**
  → Cost is the critical driver
- **Possibilities for cost reduction**
  → High filler level
  → Multi-layer pipe
  → More effective use of onepacks

Increased filler content can reduce cost

Pipe markets with high filler level applications

- **Europe**
  - → e.g. Italy: up to 60 phr
- **MEA**
  - → Middle East: up to 50 phr
  - → Africa: up to 30 phr
- **China**
  - → filler level up to **several hundred phr !?!**

Increased filler content effects preparation and performance

Aspects of high filler levels in PVC-U applications

- **Preparation of dryblend**
  - → Homogeneity / Free-flowing properties / Deposits / Segregation
- **Processability**
  - → Bridging / Gelation behaviour / Abrasion
- **Products**
  - → Mechanical Properties / Colour / Cost

Stabiliser systems can be modified to allow for increased filler loadings

Development trends for high filler formulations

→ Adaptation of stabilizer sytem to high filler level

- **Internal / external lubricants**
  (e.g. waxes, paraffins, ester waxes)

  → Incorporation of filler

  → Improved processing

- **Adaptation of dosage for pigmentation**

The type of filler utilised effects performance

Filler – Types and Effects

- **Positive effects of fine grades**
  - → Promoted gelation behaviour
  - → Higher quantity of $CaCO_3$ particles
  - → Higher regularity of foam structure
- **Positive effects of coated filler**
  - → Improvement of free flowing properties
  - → Lower friction of the polymer melt
- **Mechanical properties**
  - → Increase of stiffness through higher $CaCO_3$ content (E-modulus, ring stiffness)

Cost reductions by use of multi-layer extrusion is widely seen

Facts

- 3-layer pipe: usage of recycled material in the intermediate layer (1st extruder: inner/outer skins, 2nd extruder: foam)
- Reduction in weight (density: ~ 1,4 → ~ 1,0 g/ccm)
- Lack of recycled PVC → usage of virgin PVC and introduction of foaming process → saving of raw material
- Main Application: Pressureless sewage pipes

Easy melt flow necessary for skin-layer

Extrusion Process I

- **Two extruders: different requirements for plastification and viscosity for foam and skin layer:**
- **Skin:**
  - **Low melt viscosity to guarantee easy melt flow in tight die-head channels**
  - **High external lubrification to ensure good metal release, due to long flow paths**
  - **But: high external lubrification prevents good plastification**
    → solution: oxidised waxes

Foam layer requires balanced processing conditions

Extrusion Process II

- **Two extruders: different requirements for plastification and viscosity for foam and skin layer:**
- **Foam:**
  - **Perfectly balanced viscosity (lubricants / processing aid) to ensure easy foaming and high bubble stability**
  - **Adequate energy absorption (torque) to ensure good dispersion of blowing agent**
  - **Relative high melt pressure to ensure good foaming**

    → Adjustment of perfect gelation time, depending on type of blowing agent and type of extruder/screws!

Low foam density is a key factor in multi-layer pipes

Adjustment of multi-layer foam core formulations

- **Foam layer:**

Define a perfect balance of …

- **dosage of chemical foaming agent**
- **plastification time**
- **mass pressure and temperature**
- **amount of PVC in the foam layer**
- **amount and type of processing aid**

… to achieve low foam density (costs!)

→ Baerlocher provides tailor-made solutions

Higher filler level in foam core pipes can improve performance of processing and pipes

High filler level in foam core pipes

- **Effects of high filler level in foam (16 → 30 phr) and skin layer (16 → 20 phr)**
  - → **Stable foaming process**
  - → **Well-balanced ratio of skin & foam layer thickness**
  - → **Disappearance of slight waves in the inner layer**
  - → **Good foam density (0,75 g/cm³)**
- **Filler level of 40 phr in Foam → Bridging effect of the dryblend**

Higher filler levels as trend in multi-layer pipes

Trends in multi-layer pipes

- **Basic stabilizer for compact pipe can be used as starting base for foam core pipe**
  - → **Adjustments (internal/external lubricants) necessary for foam core pipes**
- **Increased filler level / direct addition of filler for (foam core) pipes**
  - → **Positive effects not only to reduce raw material cost but also on processing and properties of pipes**

Basic stabilizer onepacks can reduce cost and improve flexibility in production

- **Trend of pipe and fitting producers to use colourless Baeropan onepacks for more flexibility in regards of colouration**
- **Ca-based core stabiliser for dark colours + booster for light coloured applications**
- **Basic stabiliser for compact pipe can be used as starting base for other pipe applications**

Summary

- Pipe market growing in Developing Markets
- Europe: Clear Ca-based
- Critical driver: Cost → Solutions to reduce cost:
  - → High filler level
  - → Multi-layer pipe
  - → More effective use of stabiliser onepacks

Baerlocher provides tailor-made solutions for your pipe application

static/dynamic thermostability

rheology

initial colour

colour hold

…

… from dark …

… to light coloured applications …