

Germanium under Pressure

How Geopolitics and CRM Nationalism Challenge Recycling Pathways

17 June, Frankfurt/Germany

E-Waste Expo /
Metals Conference
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Agenda

- **Company introduction**
- **Where it comes and ends**
- **Known obstacles**
- **Challenges**

Company introduction

Product Portfolio

TRADIUM offers a wide portfolio of Minor Metals, Rare Earths and Precious Metals and acts as representative and distributor for some major players in these markets.

MINOR METALS



- Gallium
- Hafnium
- Indium
- Rhenium
- **Germanium**
- Titanium
- Boron
- Zirconium
- Antimony
- Bismuth
- Cadmium
- Chromium
- Cobalt & Nickel
- Manganese
- Molybdenum
- Niobium
- Rubidium
- Selenium
- Silicon
- Tantalum
- Tellurium
- Tin

RARE EARTHS



- Terbium
- Dysprosium
- Neodymium
- Praseodymium
- Yttrium
- Europium
- Gadolinium
- Cerium
- Erbium
- Holmium
- Lanthanum
- Lutetium
- Samarium
- Scandium
- Ytterbium

PRECIOUS METALS



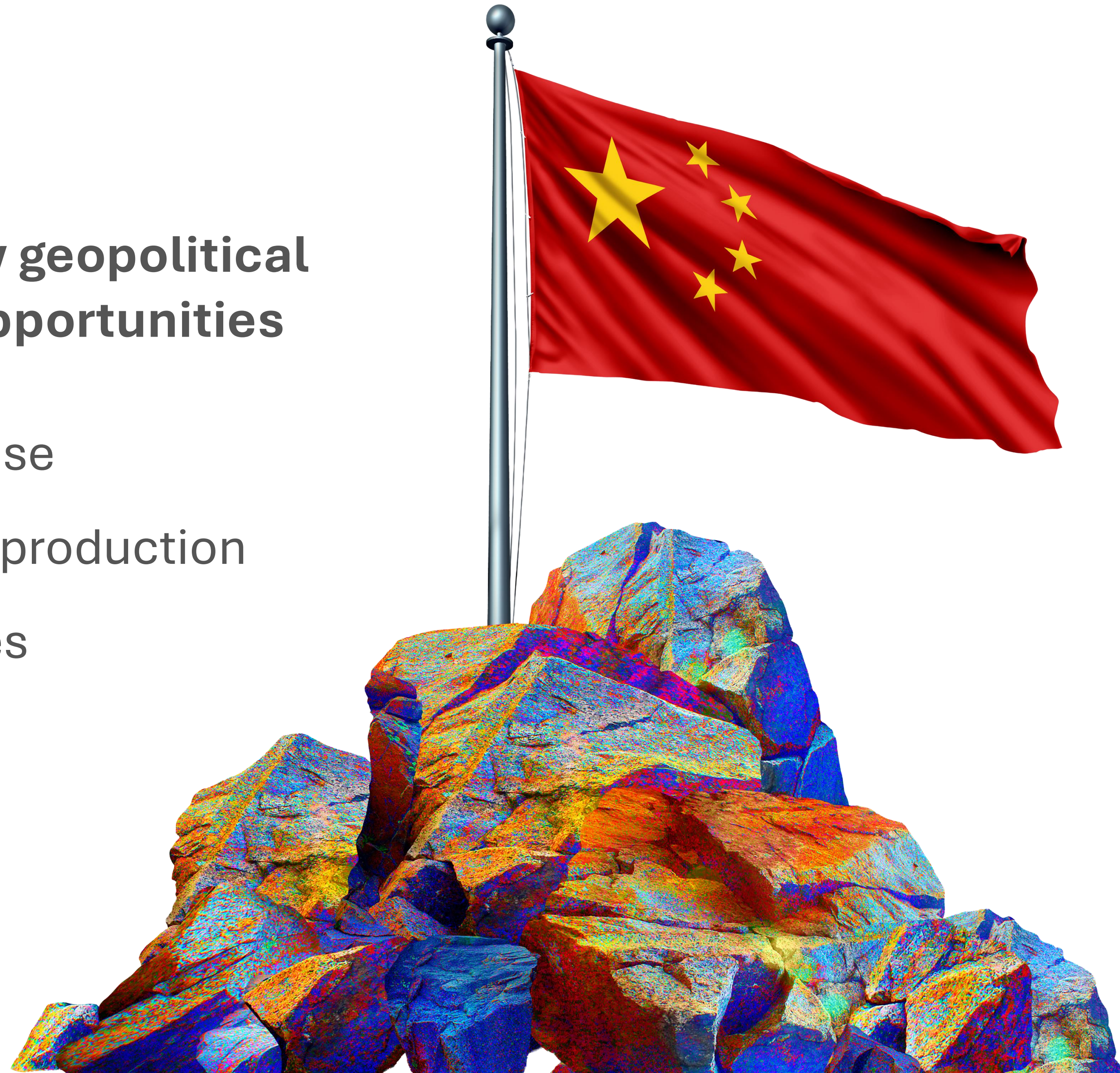
- Gold
- Silver
- Platinum
- Palladium
- Rhodium
- Ruthenium
- Iridium
- Osmium

Where it comes and ends

Where it comes and ends – 1/5

Germanium is a good example how geopolitical dependencies restrain recycling opportunities

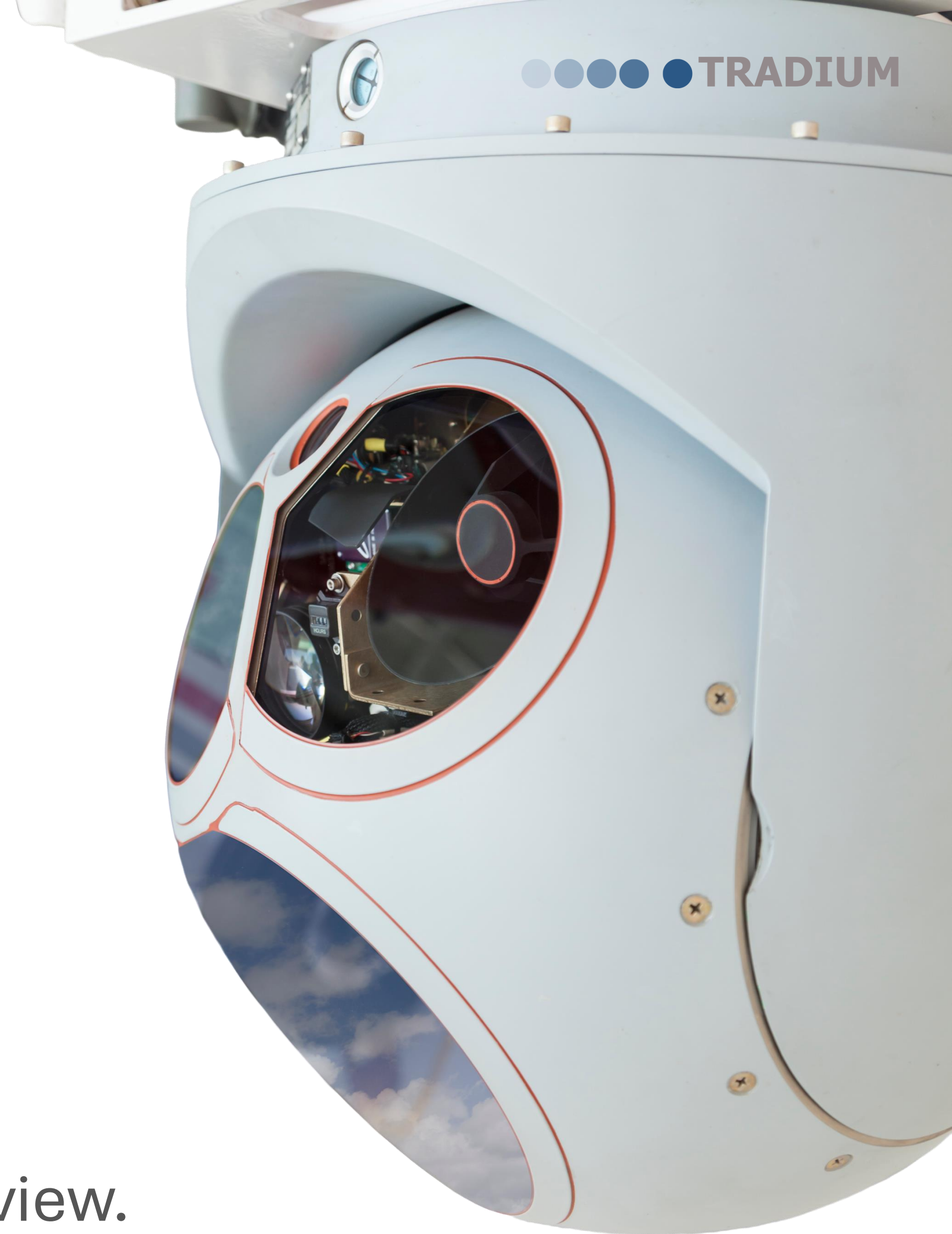
- Critical raw material with strategic use
- High local concentration of primary production
- Rising demand in sensitive industries
- Recycling is stipulated politically, but is disabled or hindered



Where it comes and ends – 2/5

First half of the germanium value chain is centered in China

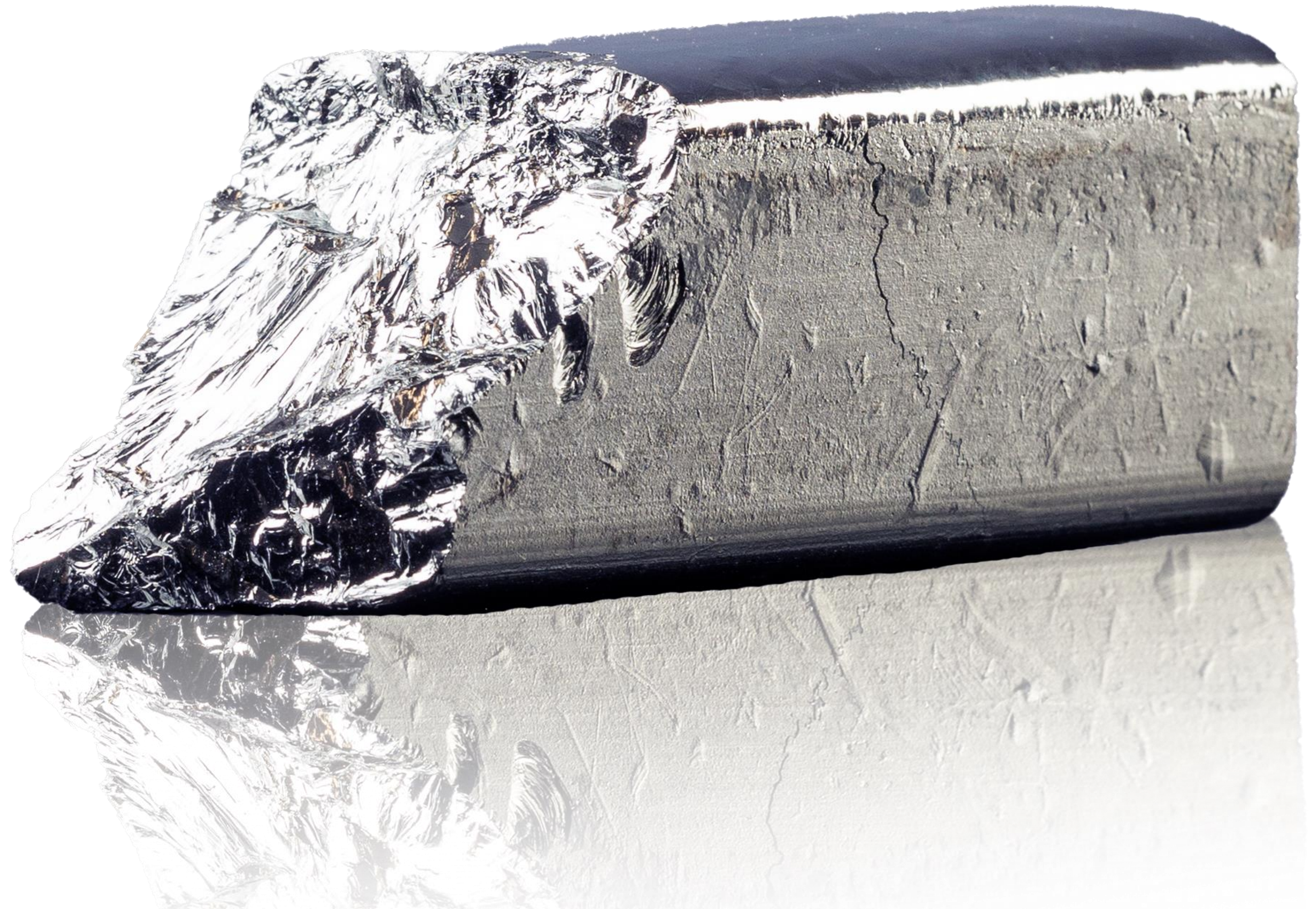
- Production of finished goods is mainly in Europe.
- Return at end of life is strongly fragmented.
- Usage in High end IR optics, fiber optics, catalysts.
- End products mostly get destroyed or thrown away.
- The material flow is a one-way street from European view.



Where it comes and ends – 3/5

Germanium

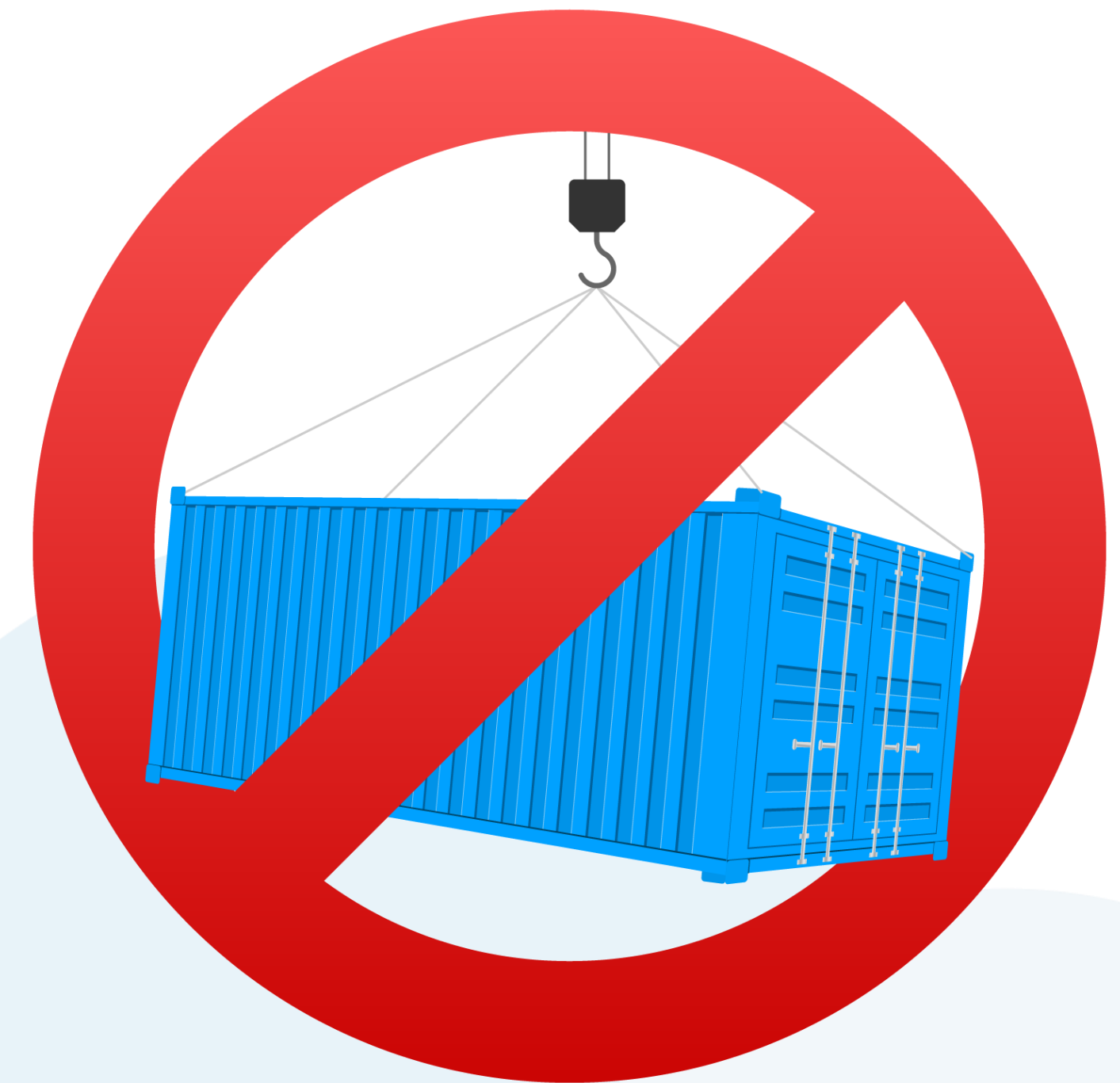
- IR: +20%
- Fiber Optics: +3%
- Semi: +2%



Where it comes and ends – 4/5

CRM nationalism and geopolitics

- Export controls and dual use regulations.
- Strategic stockpiling in China.
- National attentions dominate material streams.
- Secondary material is affected indirectly, as recycling does not take place in geopolitical no man's land.



Where it comes and ends – 5/5

What happens with germanium at end-of-life?

- Most of it disappears from accessible value / production streams.
- Sensitive applications and integration in more complex systems makes it almost invisible.
- No mono-fraction material stream makes it more difficult.
- Material gets technically “invisible”.

Known obstacles

Known obstacles – 1/4

Hidden secondary deposits

- Germanium is mostly integrated in functional devices.
- Classic applications: Infrared lenses, optical modules, wafer, coatings, sputter targets, thin-film applications.
- Big amounts can be found in industrial side streams, production rejects or residues from machining.

These deposits are not used because:

- Low volume, no visible value.
- No knowledge about material and processes

Known obstacles – 2/4

Why recycling fails until today

- No knowledge about the material stream.
- No awareness on waste management.
- In comparison to gold, material looks worthless.
- Low amounts at different production stages.



Known obstacles – 3/4

Recycling is far beyond end-of-life

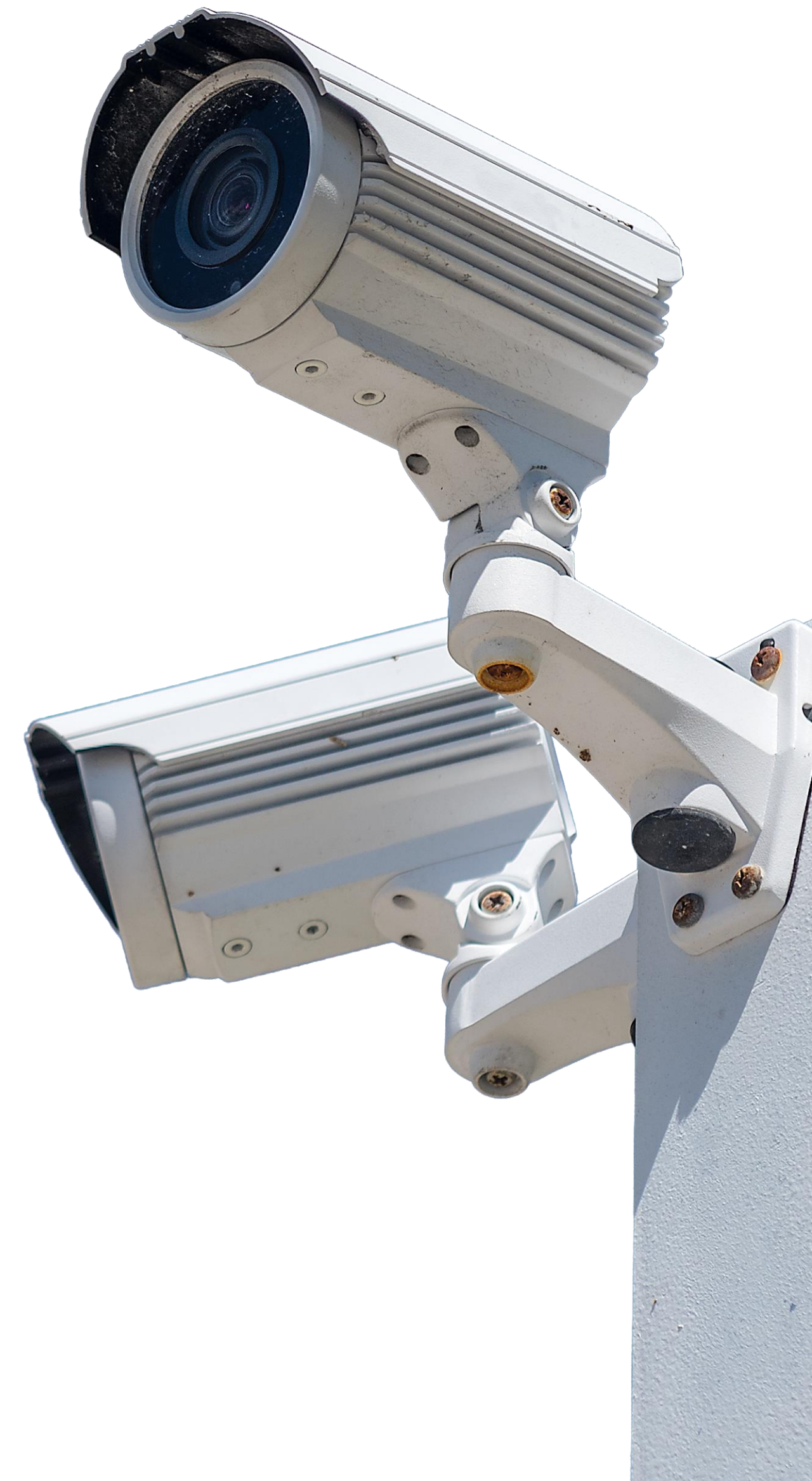
- Critical material streams need more attention.
- Complete view over all production and usage stages: Rejects, semi-finished products, overproduction, returns, defective parts, non-used parts.
- Return to manufacturer at end-of-life: Gold standard in some business units.

Known obstacles – 4/4

Obstacles far beyond know-how and technologies

- Security reasons.
- Protection of know-how.
- Industrial espionage, reverse engineering.
- Convenience issues: Just throw away, no awareness.

Not affordable in any way!



Challenges

Challenges

What we need to get recycling working properly

- Clear statements from market and politics for all stages of value creation
- No spot or one time reactions.

Set the stage:

- Access to end-of-life and industrial side-streams.
- Complete overview (what consists what).
- Offtake and refining know-how.
- Clear conditions.



Challenges

Refining @TRADIUM: Part of the solution

- Material streams and raw material loops need experience.
- Big international network of sourcing, refining and market integration.
- Connection between recycling streams and real needs on the market.
- TRADIUM as interface in market, material and regulations.

Let us unlock the solutions!

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