Metals for Clean Energy:

Pathways to solving Europe's raw materials challenge

SNAPSHOT OF REPORT OUTCOMES

Presentation by

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Eurometaux

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Agenda

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KU Leuven

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Eurometaux

A presentation in two parts

1. The metals demand of Europe's clean energy ambitions

2. Five pillars for bridging Europe's looming metals supply gap

The energy transition is a commodities transition

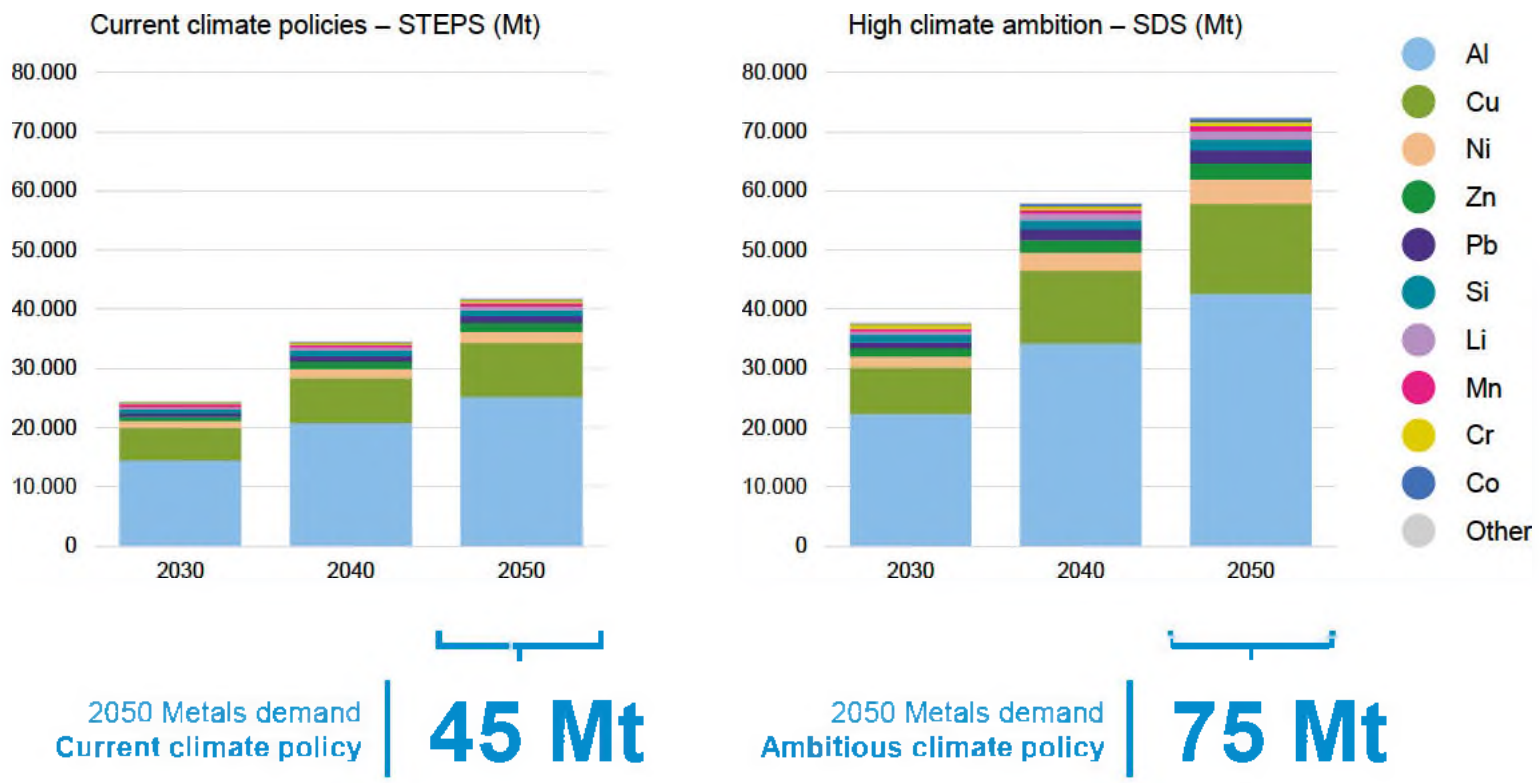
Fact

The faster the world decarbonises, the higher its metals requirements

Question

By how much?

Total metal demand by commodity in a STEPS and SDS scenario respectively (Mt)



2050 Metals demand **Current climate policy** | **45 Mt**

2050 Metals demand **Ambitious climate policy** | **75 Mt**

Clean energy technologies will transform global metals markets

Fact

All based on metals: Batteries, Solar PV, Hydrogen, Magnets, Electric Cars, Wind Turbines, Power cables

Question

How will global demand for metals shift?

% metal required in 2050 for clean energy technologies vs. 2020 overall use (SDS ambitious climate scenario).

Li	Lithium	2109%	Si	Silicon	62%
Dy	Dysprosium	433%	Tb	Terbium	62%
Co	Cobalt	403%	Cu	Copper	51%
Te	Tellurium	277%	Al	Aluminium	43%
Sc	Scandium	204%	Sn	Tin	28%
Ni	Nickel	168%	Ge	Germanium	24%
Pr	Praseodymium	110%	Mo	Molybdenum	22%
Ga	Gallium	77%	Pb	Lead	22%
Nd	Neodymium	66%	In	Indium	17%
Pt	Platinum	64%	Zn	Zinc	14%
Ir	Iridium	63%	Ag	Silver	10%

Aluminium
Copper
Zinc
Silicon

Lithium
Nickel
Cobalt

Dysprosium
Neodymium
Praseodymium

What about demand in Europe?

Until now, batteries, solar panels, magnets have been built elsewhere…

…But Europe has concrete industrial plans to build its own technologies

European Solar Initiative

New European technology production will require a full supply chain

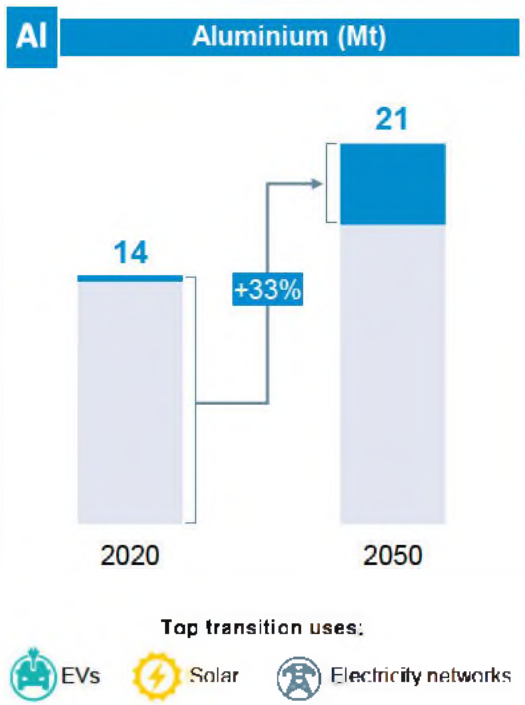
Fact

Europe's accelerated energy goals + concrete domestic technology plans = new metals requirements

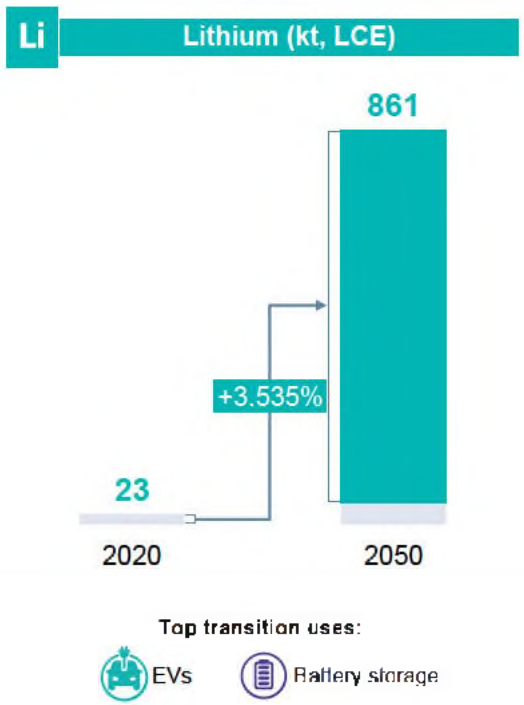
Question

What will happen to Europe's metals markets?

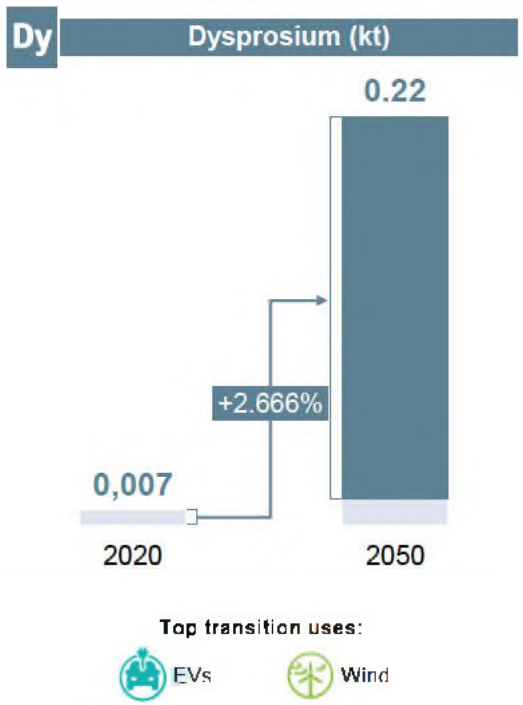
Base metals
main future demand driver



Battery materials
transformation from low level



Rare earths
transformation from low level



Europe must avoid replacing its unsustainable fossil fuels dependency with a similar metals dependency

Challenge 1

Without urgent action now, Europe's ability to secure the right level of strategic autonomy for energy transition metals beyond 2030 is at risk

Challenge 2

Meeting clean energy metals demand only with increased imports from lower regulatory regimes isn't compatible with the EU's sustainability values

Joint question

How can Europe bridge this real supply gap?

Bridging Europe's energy transition metals supply gap

STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

END POINT

2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability

Five necessary pillars for Europe's metals & clean energy bridge

STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

STRONGEST IMPACT: NOW → 2040

PILLAR 1

Fulfil domestic mining potential

PILLAR 2

Maintain and increase domestic refining output

PILLAR 3

Secure sustainable imports from reliable partners

2035 ONWARDS

PILLAR 4

Maximise recycling, including new streams

PILLAR 5

Drive technological & behavioural change

END POINT

2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability

New primary supply is urgently needed between now and 2040

STRONGEST IMPACTS → 2040

PILLAR 1
Fulfilling domestic mining potential

PILLAR 2
Maintain and increase domestic refining output

PILLAR 3
Securing sustainable imports from reliable partners

Early stages of energy transition → **Primary metals needed for new technologies** → **Europe must find right balance of domestic supply and imports**

Pillar 1: Fulfil domestic mining potential

STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

PILLAR 1

Fulfilling domestic mining potential

END POINT

2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability

New European mines could open this decade, but challenges must be overcome

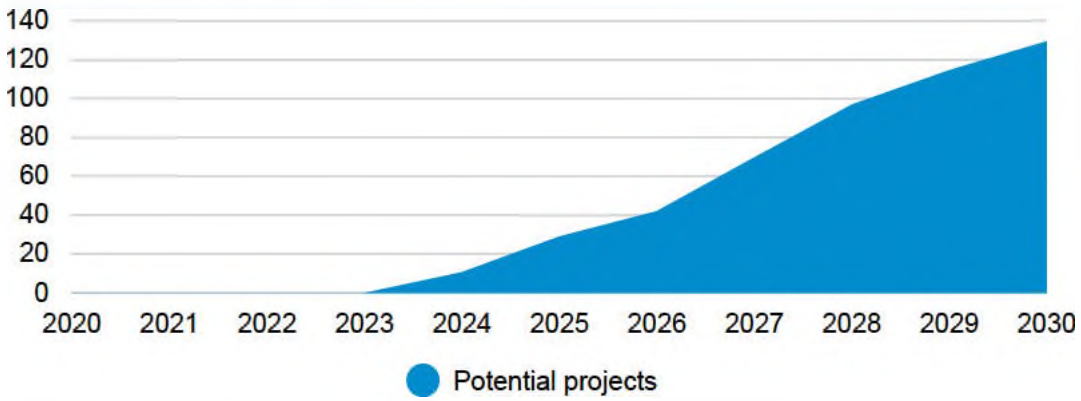
Lithium & rare earths

- Large project pipelines, which could supply:
  - 55% of 2030 cathode plans (lithium)
  - 80% of magnet plans (dysprosium)
- But with a high level of uncertainty

Challenges

Local opposition, challenging economics, permitting, untested technologies

Lithium - European mine output (kt LCE)



Lithium - European self-sufficiency rate

Of Europe's cathode manufacturing needs

Lithium

up to + 55% uncertain projects – 130 kt LCE

% domestic mining of overall 2030 demand

* Based on current EU manufacturing plans for cathodes and permanent magnets

1

Without new mines opening in mature markets, Europe's self-sufficiency will decline

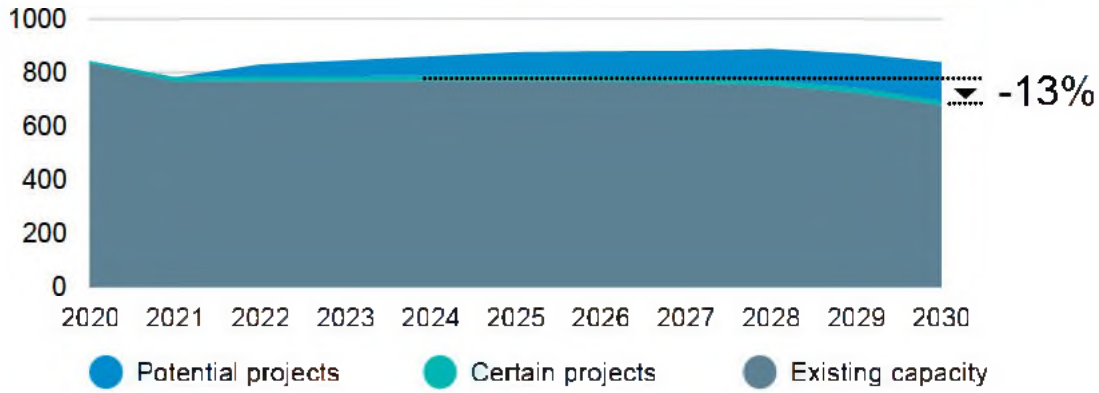
Copper, nickel, zinc, cobalt

- Thinner project pipelines
- Limited 2030 self-sufficiency rate (4-25%)
- 2030 depletion ranges of up to 20%

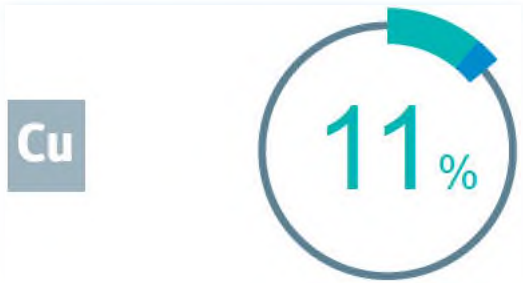
Challenges

Local opposition, challenging economics, permitting, untested technologies

Copper - European mine output



Copper - European self-sufficiency rate



Copper
up to + 3% uncertain projects
% domestic mining of overall 2030 demand

Pillar 1: Fulfil domestic mining potential

STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

PILLAR 1

Fulfilling domestic mining potential

Key takeaway:

Political support + high ESG standards required together

END POINT

2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability

Pillar 2: Maintain and increase domestic refining output

STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

PILLAR 2

Maintain and increase domestic refining output

END POINT

2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability

2

Europe will need more refinery announcements in next 5 years to keep pace with energy transition

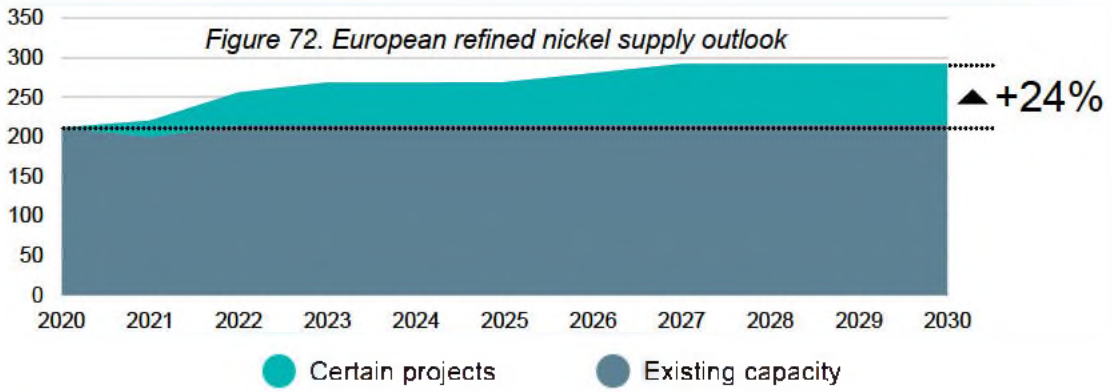
Nickel, lithium, rare earths

- New EU refining projects announced with medium-sized growth potential
- Allows European customers to bypass China route (and CO_2 impacts)

Question

Can Europe create competitive and predictable business conditions for long-term investment?

European metal output



European self-sufficiency rate

Nickel

% primary production of overall 2030 demand

Keeping metals refining in Europe requires a fix to energy crisis

Aluminium, zinc, silicon

- High energy prices have big impact on power intensive smelters, leading to temporary closures (10-40%)
- Low-cost and subsidized China imports, require trade defence measures

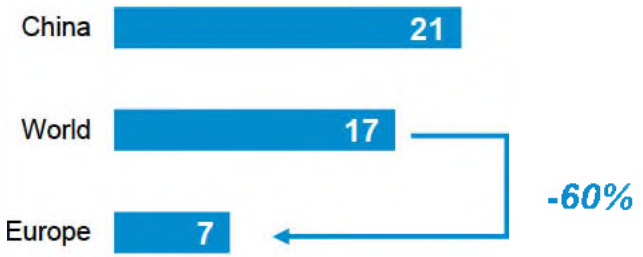
Question

Can Europe stop its existing supply being replaced by more carbon-intensive imports?

European self-sufficiency rate

Aluminium
(-10% offline 2022)*
% primary production of Europe's overall 2030 demand

Average CO_2 footprint of primary production (tCO2/t Al)



** 10% of smelters in extended Europe (EU + UK + NO + IS), vs. 35% in EU only*

Pillar 2: Maintain and increase domestic refining output

STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

PILLAR 2

Maintain and increase domestic refining output

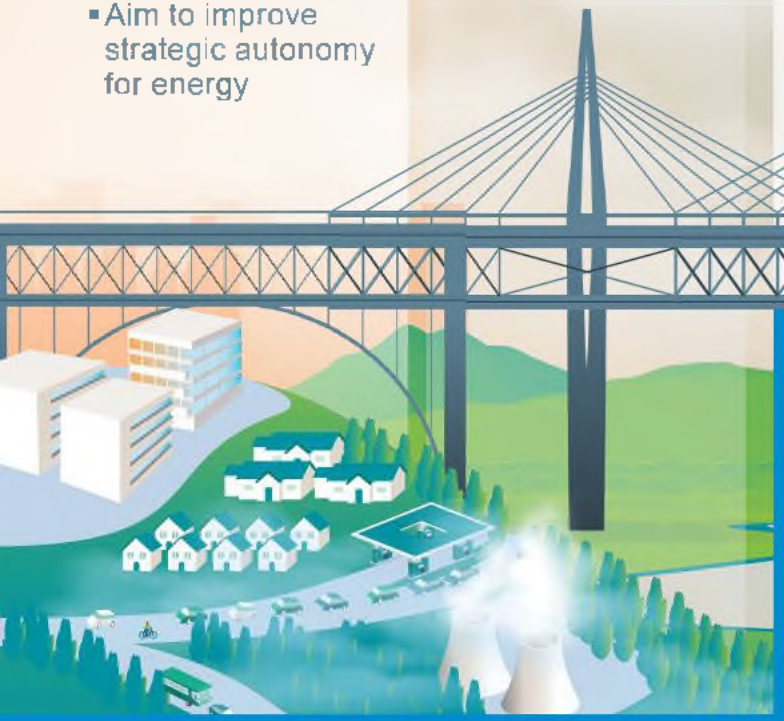
Key takeaway:

New capacity will require stronger business conditions

END POINT

2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability



Pillar 3: Secure sustainable imports from reliable partners

STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

PILLAR 3

Securing sustainable imports from reliable partners

END POINT

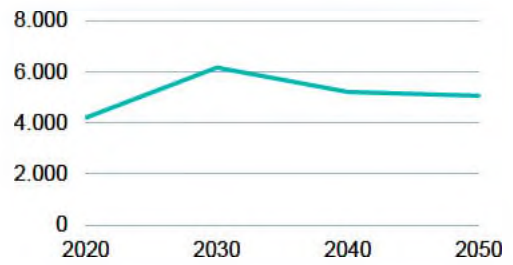
2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability

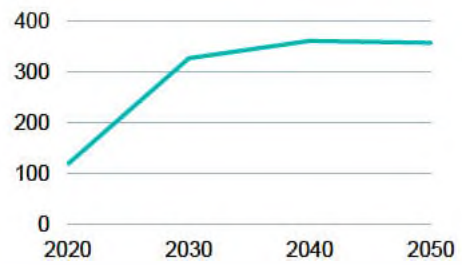
Europe will rely on imports for short-medium term demand growth

More limited import reliance

Al Aluminium (Mt)

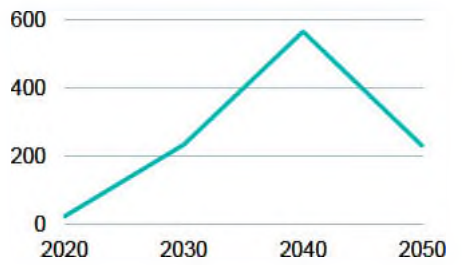


Si Silicon (kt)

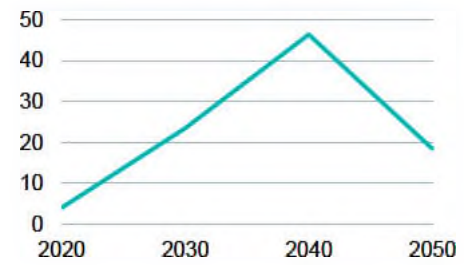


Strongly growing imports

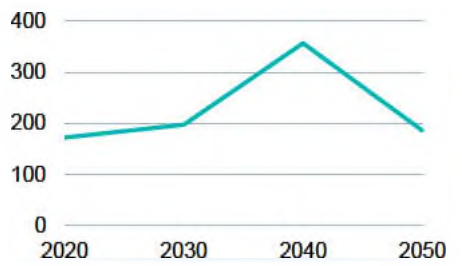
Li Lithium (kt)



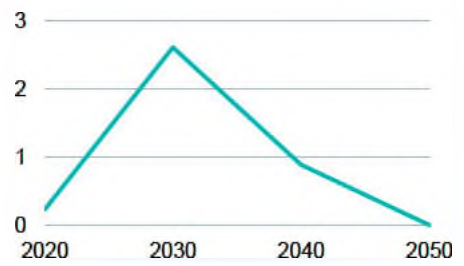
Co Cobalt (kt)



Ni Nickel (kt)



Nd Neodymium (kt)



Three key challenges to secure sustainable imports from reliable partners

Availability

Can Europe secure the imported metals its energy transition needs?

Risk of 2030 supply bottlenecks for copper, lithium, nickel, cobalt, rare earths

Sustainability

Do we want to swap existing fossil fuel dependencies for new metals dependencies at low sustainability standards?

Certified responsible import partners needed

Diversification

Can Europe maintain its currently high diversification as metals requirements increase?

Risk of growing dependency on China, Russia

Pillar 3: Secure sustainable imports from reliable partners

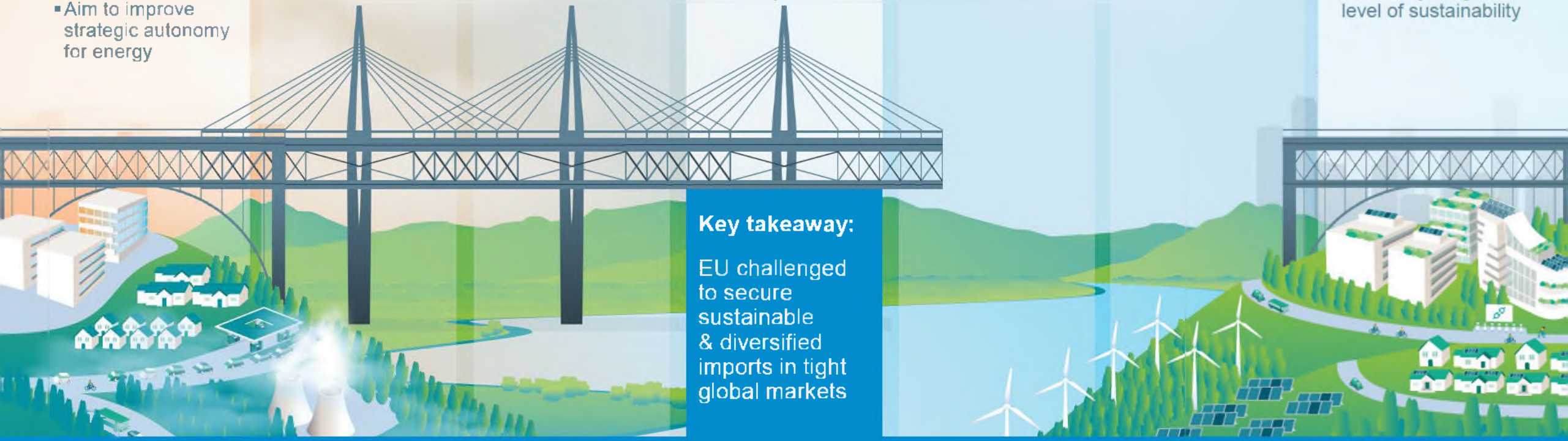
STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

PILLAR 3

Securing sustainable imports from reliable partners



Key takeaway:

EU challenged to secure sustainable & diversified imports in tight global markets

END POINT

2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability

Recycling and technology/behavoural change will take effect after 2035

STRONGEST IMPACTS
→ 2035-2050

PILLAR 4
Maximise recycling, including new streams

PILLAR 5
Driving technological & behavioural change

Later stages of energy transition

→

Metals from 1st generation products to start recycling loop

→

Recycling a permanent supply source to Europe's industries

Pillar 4: Maximise recycling, including new streams

STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

PILLAR 4

Maximise recycling, including new streams

END POINT

2050

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4

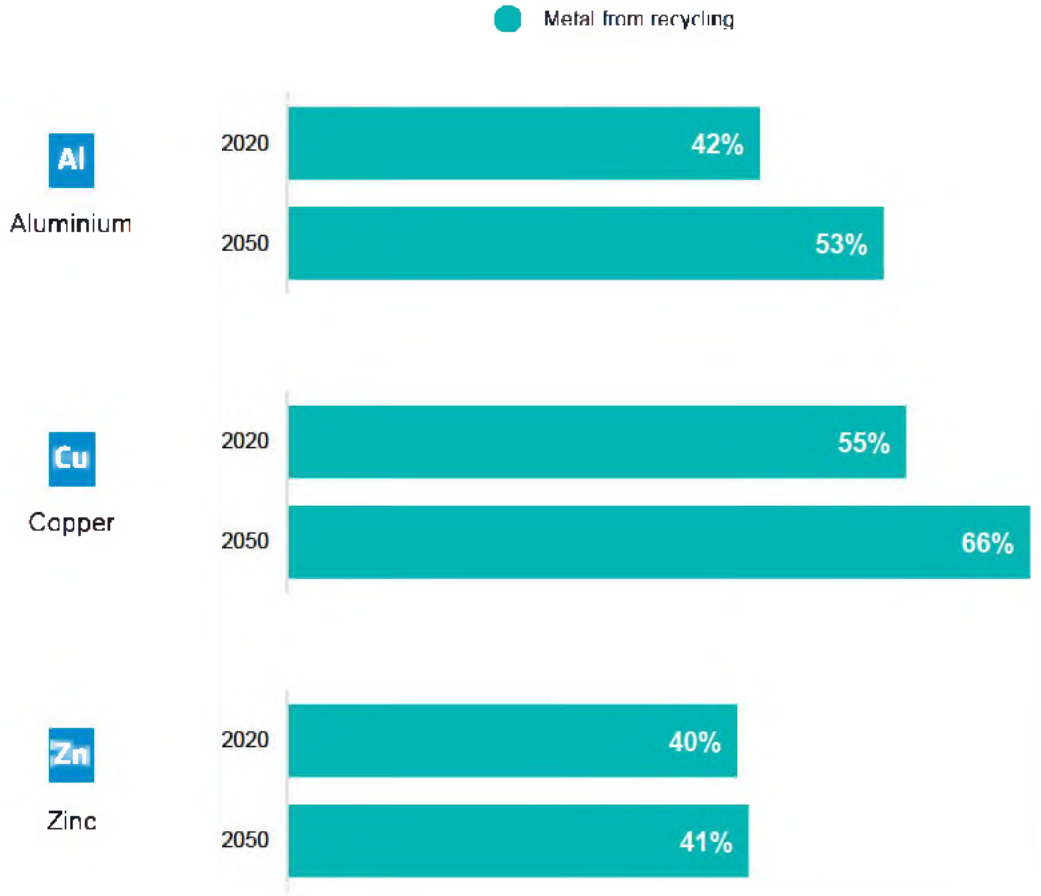
Recycling is Europe's key long-term driver in creating strategic autonomy

Circular Economy actions will raise base metals recycling rates

Mature markets

Aluminium, Copper, Zinc

- Recycling can supply 40-65% of Europe's higher base metals demand in 2050
- Recycling bottlenecks must be addressed to raise rates:
  - Improved collection and sorting systems
  - Smarter product design
  - Control of scrap leakage



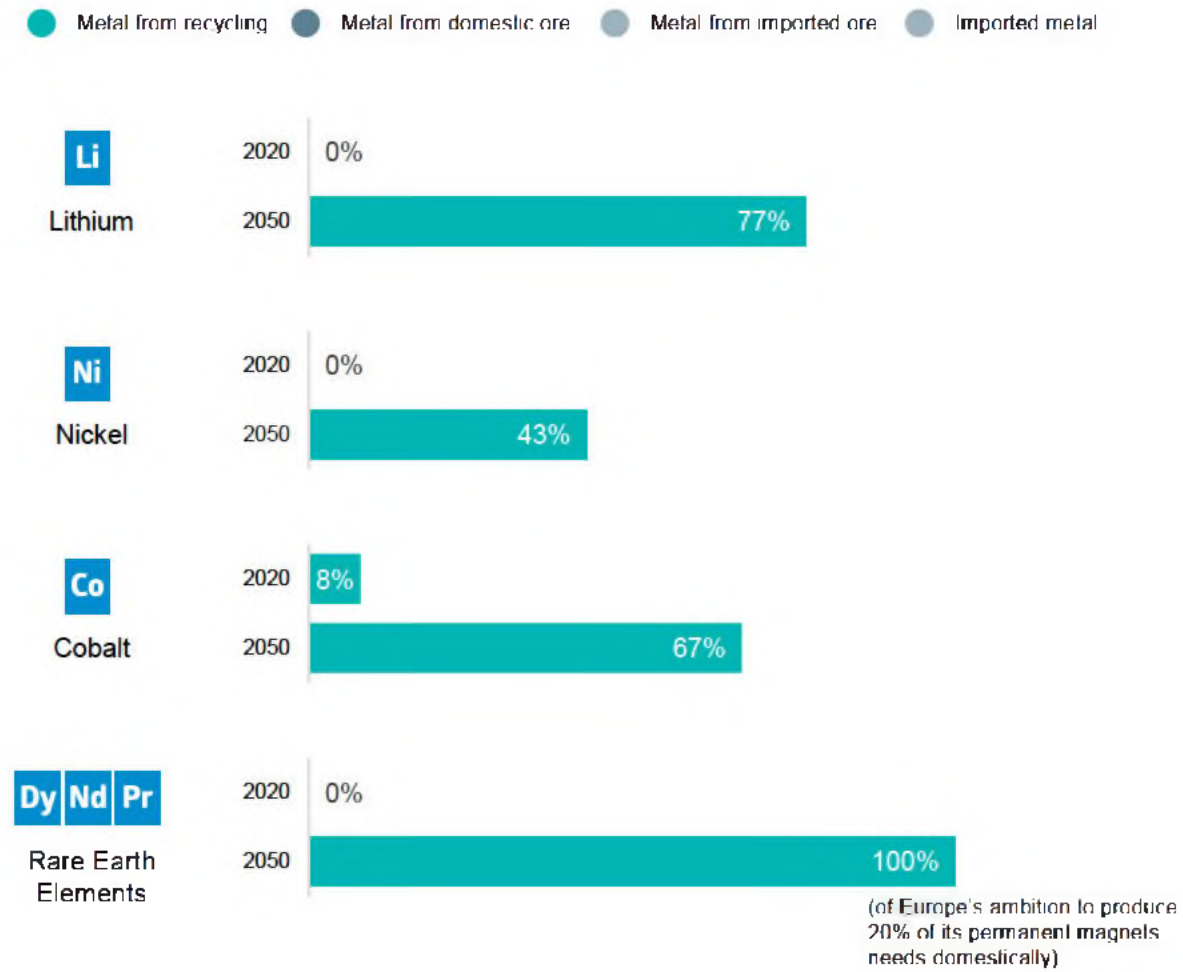
Recycling is Europe's key long-term driver in creating strategic autonomy

Massive potential after 2040 for new energy commodities

New energy commodities

Lithium, cobalt, nickel, rare earth elements

- Recycling volumes will rise after 2040, with potential for:
  - 65-75% of Europe's 2050 battery cathode needs*
  - 200% of Europe's 2050 rare earths needs*
- High supply from electric vehicles with 15 years expected lifetime
- Required:
  - New recycling capacity
  - Process improvements
  - Economic viability



*Based on today's EU technology production plans & assumptions

Pillar 4: Maximise recycling, including new streams

STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

PILLAR 4

Maximise recycling, including new streams

END POINT

2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability

Key takeaway:

Recycling is Europe's major long-term self sufficiency potential, requiring action now

Pillar 5: Drive technological and behavioural change

STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

PILLAR 5

Driving technological & behavioural change

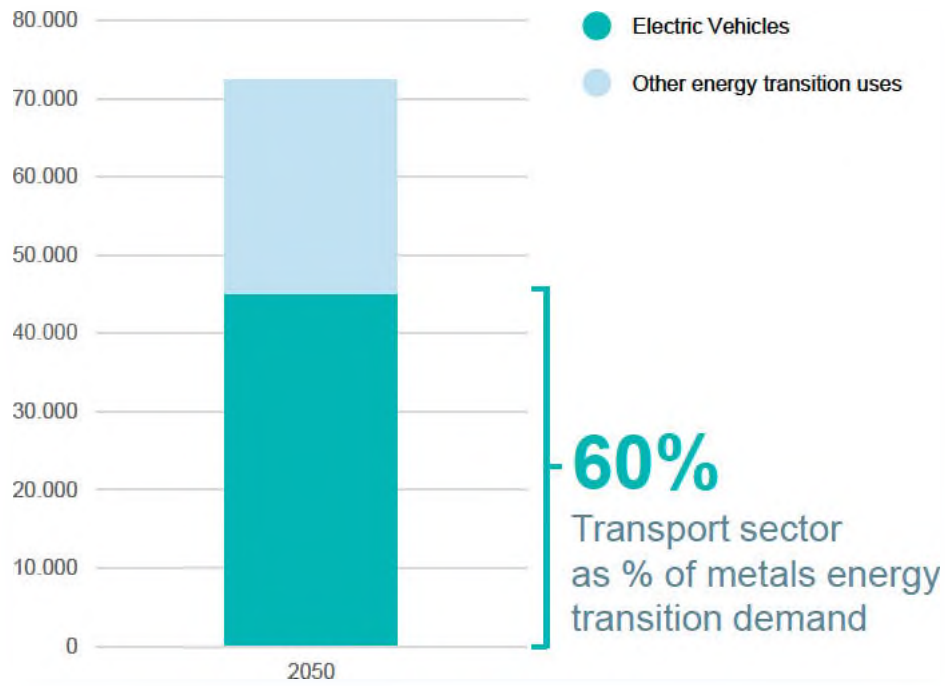
END POINT

2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability

Technological and behavioral change can reduce our demand

Time is needed to achieve measurable impact



Impacts will be longer term

Innovation and substitution

- Europe: frontrunner in R&D to reduce metals intensities in products
- Substitution in focus: cobalt in batteries, non-rare earth magnets

Behavioral change

- Transport sector represents 60% of metals demand + big supply risks
- Shared economy can here make a real difference (but not quantified)

Pillar 5: Drive technological and behavioural change

STARTING POINT

NOW

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

PILLAR 5

Driving technological & behavioural change

END POINT

2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability

Key takeaway:

Further efforts needed if longer-term change will be realised

Conclusion: 10 EU actions to bridge its looming metals supply gap

NOW → 2040

- Acceleration of clean energy transition
- Aim to improve strategic autonomy for energy

2035 ONWARDS

END POINT 2050

- Clean energy system with higher level of strategic autonomy & right level of sustainability

PILLAR 3

Secure sustainable imports from reliable partners

- Take forward viable mining projects
- Set high ESG standards
- Prevent further closures of existing capacity
- Support new refineries for battery metals & rare earths
- Diversify trade partners while driving ESG
- Source from certified, responsible suppliers

PILLAR 4

Maximise recycling, including new streams

- Remove current bottlenecks on collection, sorting and retention
- Invest into new recycling for batteries, PV, magnets

PILLAR 5

Drive technological & behavioural change

- Ensure continued R&D leadership on optimisation
- Investigate how to evolve consumption patterns in the transport sector

Four action areas for a new EU raw materials strategy

1. Stimulate new domestic investment

- **Finance:** Introduce new raw materials financing covering full value chain (e.g. dedicated risk-sharing fund, IPCEI)
- **Permits:** Improve and speed up permitting process, while upholding ESG standards
- **Dialogue:** Start multi-stakeholder dialogue around responsible European mining and appropriate benchmarks

2. Improve business conditions

- **Energy:** Address long-term high EU power prices faced by refineries (key focus: renewable power purchase agreements)
- **Fair trade:** Set up trade defence for sectors at risk from China dumping: present (aluminium, silicon), future (rare earths)
- **Chemicals:** Ensure long-term predictability from REACH review for future markets and safe metals management

3. Be bolder globally

- **Projects:** Expand finance to support EU companies with (joint) ownership of global mines (with ESG conditionality)
- **Partnerships:** Strengthen partnership network of like-minded regions (e.g. Canada, Latin America)
- **Support:** Develop an EU model for supporting Africa & other growth markets in sustainable raw materials growth

4. Set foundations for future Circular Economy

- **Capacity:** Support investment into advanced collection/ sorting & new recycling capacity for batteries, PV, magnets
- **Exports:** Prevent shipments of scrap, electronics, & batteries waste to destinations without equiv. ESG standards
- **Design:** Use sustainable products initiative to require that new products are designed ready for easy recycling

KU LEUVEN

Metals for Clean Energy:

Pathways to solving Europe's raw materials challenge

POLICYMAKER SUMMARY

Read more!

www.eurometaux.eu/metalscleanenergy