

# From fossils to metals: the energy transition is circular!

René Kleijn

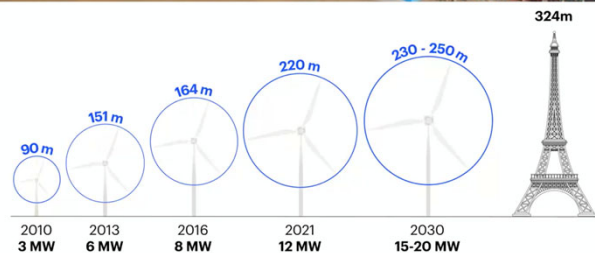
Chemistry for Energy Transition, August 21<sup>st</sup> 2023



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The Netherlands

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## The energy transition is a materials transition: from fossil fuels to metals



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## A transition from securing inflows to fostering stocks



Current energy system: inflow of 17 Gtons of fossil fuels per year (every year)



Renewable energy system: huge increase in metal stocks in society: solar cells, wind turbines, batteries, electrolyzers, grid etc.



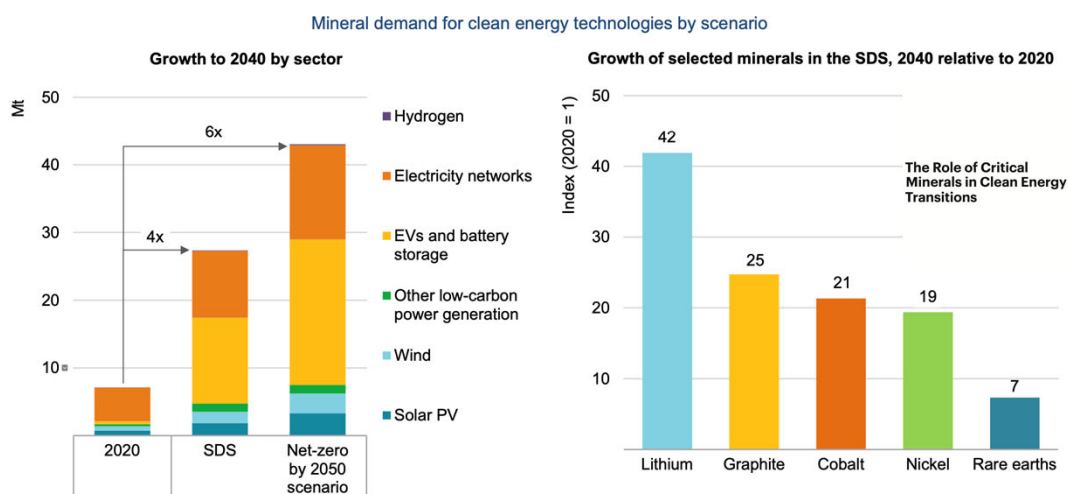
So a huge increase of inflows of metals is required until the transition is complete



But once the transition is complete it is all about fostering a stock of metals in society

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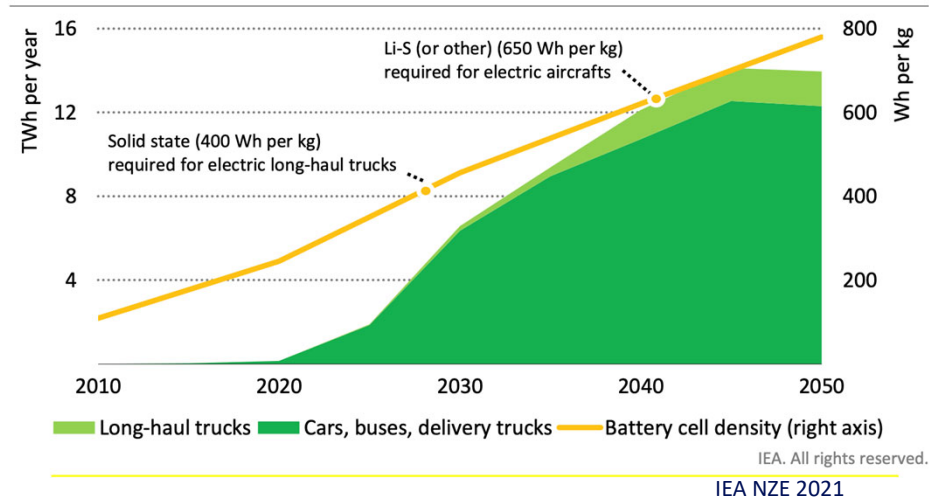
## EV batteries are dominant in the additional demand



Notes: Mt = million tonnes. Includes all minerals in the scope of this report, but does not include steel and aluminium. See Annex for a full list of minerals.

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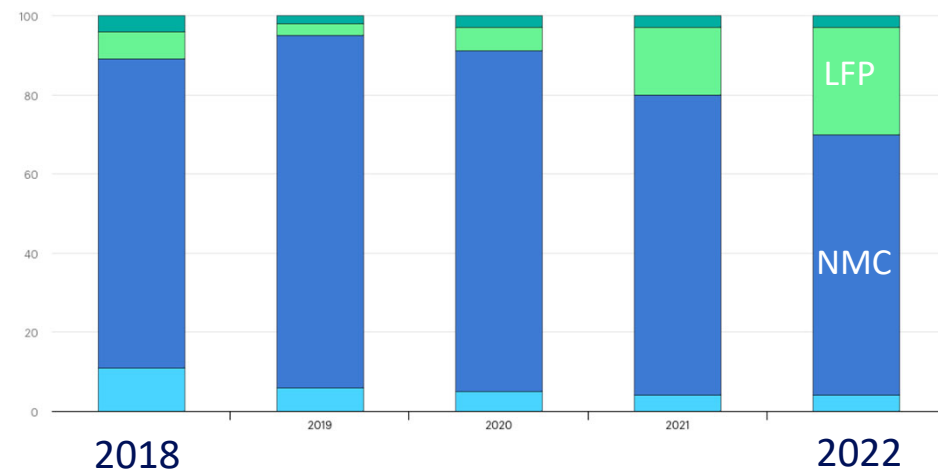
**Figure 2.17** ▶ Battery demand growth in transport and battery energy density in the NZE



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## Competing technologies: NMC vs LFP

LFP in China: from 18 to 60% in the last three years  
 Battery market grows 10-fold in the next few years



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## LFP vs NMC batteries

-  No Cobalt or Nickel
-  30-40% cheaper to produce
-  Much smaller fire hazard
-  Longer lifetime (50-70%)
-  Much more suitable for second life
-  lower energy density & slower charging (?????)
-  LFP production dominated by China

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**CATL** Together for

Global Locations Market Performance R&D and Product Test Strength

**NEWS FEED**

**CATL launches the world's first 4C superfast charging LFP battery**

by TechNode Feed Aug 17, 2023

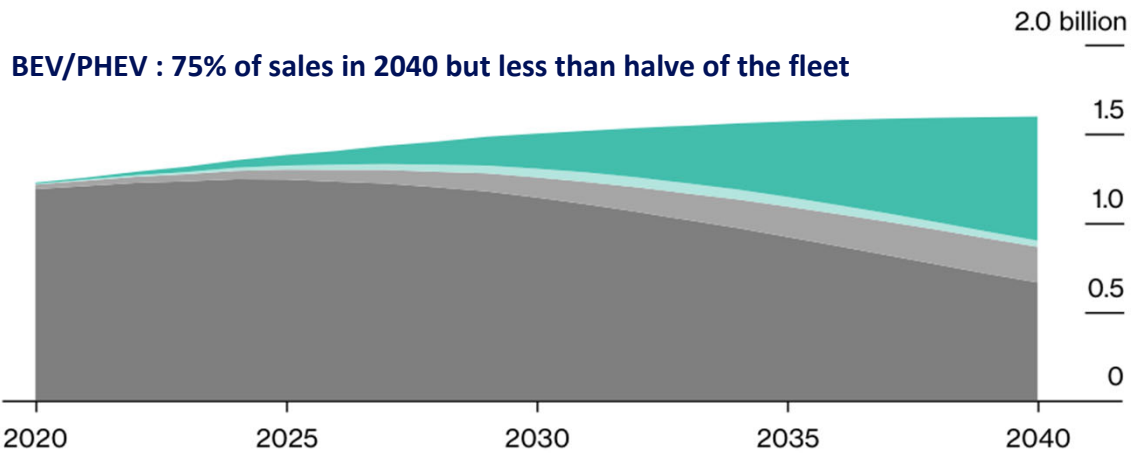
400 km/10 minutes, 700km range  
Available Q1 2024

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## Vehicle Sales Take Time to Turn into a Meaningful Fleet Share

Global passenger vehicle fleet outlook by drivetrain

■ Internal combustion ■ Hybrid ■ Plug-in hybrid ■ Battery electric



Source: BloombergNEF's Economic Transition Scenario

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## Future battery technologies



Substitution of Lithium by Sodium (CATL 2023)



Solid State batteries (Quantumscape (US) Solid Power (US), others, in cars 2025 (VW) ?



Li-S, Li-air others ?

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## The need for resilient supply chains

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### From *just-in-time* to *just-in-case*

- Resilience comes at a cost:
  - Inventories / buffers / stocks require capital
  - Not only the cheapest supplier but diversity of supply at higher cost
  - Shift from less to more reliable trade partners (bilateral deals US, UK..)
  - Develop alternative (sub-optimal?) product designs / technologies, in case preferred option is not available
  - Substitute rare materials by more common materials (performance?)

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## What should Europe do to secure supply ?

- **Short-term: supply primary materials**

- Re-shore supply chains for critical technologies (energy, IT) including mining and refining ?
- Friendshoring (bilateral deals with Canada, Australia etc)
- Bilateral deals 'with benefits' with more complex partners ? (Untied Loan Guarantee / Raw Material Guarantee, combine investments in raw material sectors with aid and responsible sourcing)

- **Long-term but start now: foster stocks of metals in society (urban mine)**

- Design the renewable energy system for lifetime extension, second life, re-use and recycle
- Develop the infrastructure and facilitate the industry for this

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## This is no longer just economics...

- In a world in geopolitical turmoil, economic dependency becomes a **political issue**
- Economic optimization through **globalization has served us well in the past**
- **Secure and resilient supply comes at a cost**
- But the **costs of shortages, or worse, weaponized resource / tech supply, are much higher !**

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## Circularity in mobility design is key : act now – harvest later



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## Circularity Strategies for batteries

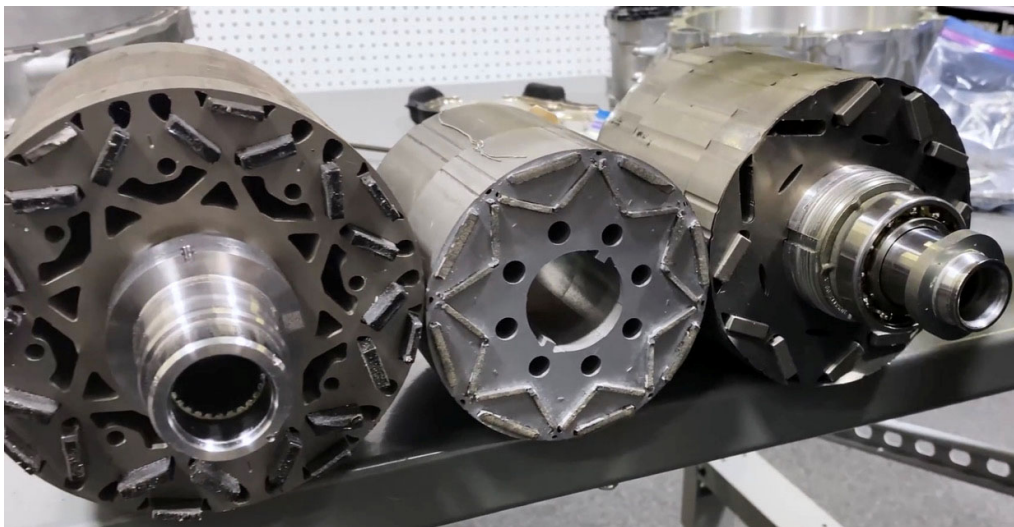
- Less is better
  - Modal shifts (less batteries) (keep an eye on e-bikes / mopeds !)
  - Smaller batteries (less materials)
  - Batteries with less critical raw materials
- Life-time extension & second Life
  - Improve battery management systems / user instructions
  - Improve reparability
  - Design for disassembly
  - Standardization of cells
  - Export policies
  - Pack level: Stationary storage
  - Cell level: collection testing and remanufacturing
- Recycling
  - Collection
  - Recycling goals (recycled content)
  - Recycling infrastructure (regional ? national ? EU ?)

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## Rare Earth magnets in EV motors




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FINANCIAL TIMES

Batteries + Add to myFT

## Metals industry opposes proposed EU toxic label on battery component lithium

European Chemicals Agency seeks to classify the metal as a reproductive toxin




Lithium is one of the key materials needed to make the batteries that power electric vehicles © Krisztian Bocsi/Bloomberg

Neil Hume, Natural Resources Editor JULY 7 2022 18

## Glencore plans Europe's biggest electric car battery recycling plant

Commodity trader and mining group aims to extend its business to take advantage of big demand for EVs



Glencore's plant in Sardinia, where it aims to repurpose its zinc and lead smelter to produce lithium, nickel and cobalt — key metals used to make batteries for electric cars

Harry Dempsey MAY 9 2023 55

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## Opportunities for Dutch industry

- Explore potential for co-production CRMs from existing flows / industries
- Utilize expertise in transport and distribution (ports, road and rail networks )
- Attract refining industry
- Product and system design to substitute / minimize the use of CRMs
- Utilize our knowledge innovation capacity to develop disruptive technologies that offer different solutions for the functionality that is required by society
- Design products that are suited for repair, re-use, and recycling
- Design and develop new business models focused on lease concepts
- Collection & separation of waste flows and develop second-life applications
- Develop or attract recycling systems / industries

## The future of energy is circular

- A fossil energysystem relies on securing a continuous inflow of materials : coal, oil, gas
- A renewable energysystem relies on fostering a standing stock : solar cells, wind turbines, supergrids, batteries etc.
- If climate goals are met, we will build this stock in the next 30 years
- IF we use circularity principles we only have to do this once and mining can be reduced by an order of magnitude after 2050
- Renewable energy technologies / systems should therefore be designed with circularity in mind