EU Clean Tech Industry

Webinar with Agora Energiewende

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A. Project approach

The project structure is focused on the overall project objective: Setting, quantifying and implementing an optimized level of manufacturing resilience in the EU

Overall project structure

1 Technology status quo assessment

- Technology briefings for PV, Wind, Electrolyzer, Heat Pumps and Battery
- Demand & supply development (REPower, Agora EU Gas Exit Pathway scenario)
- Overview on as-is Unit Manufacturing Costs (UMCs)
- EU-perspective on geographic allocation
- View on the required time to market to scale up
- Qualitative risk assessment

2 European value chain coverage & potential

- Identification and assessment of relevant raw materials
- View on world and key European raw material extraction and processing capacities
- View on key European opportunities for value chain coverage
- Selected view on EU trade balances

3 European supply scenarios

- Introduction to the scenario approach
- Key results across scenarios and technology deep dives
- Scenario methodology and overview on selected key inputs (risk scoring, country allocation keys and key assumptions)

4 Policies & competitive outlook

- Policy booklets with key policy levers including
  - Financial incentives & subsidies
  - Legislative levers
  - Infrastructure levers
  - R&D levers
  - International partnership levers
- Competitive outlook

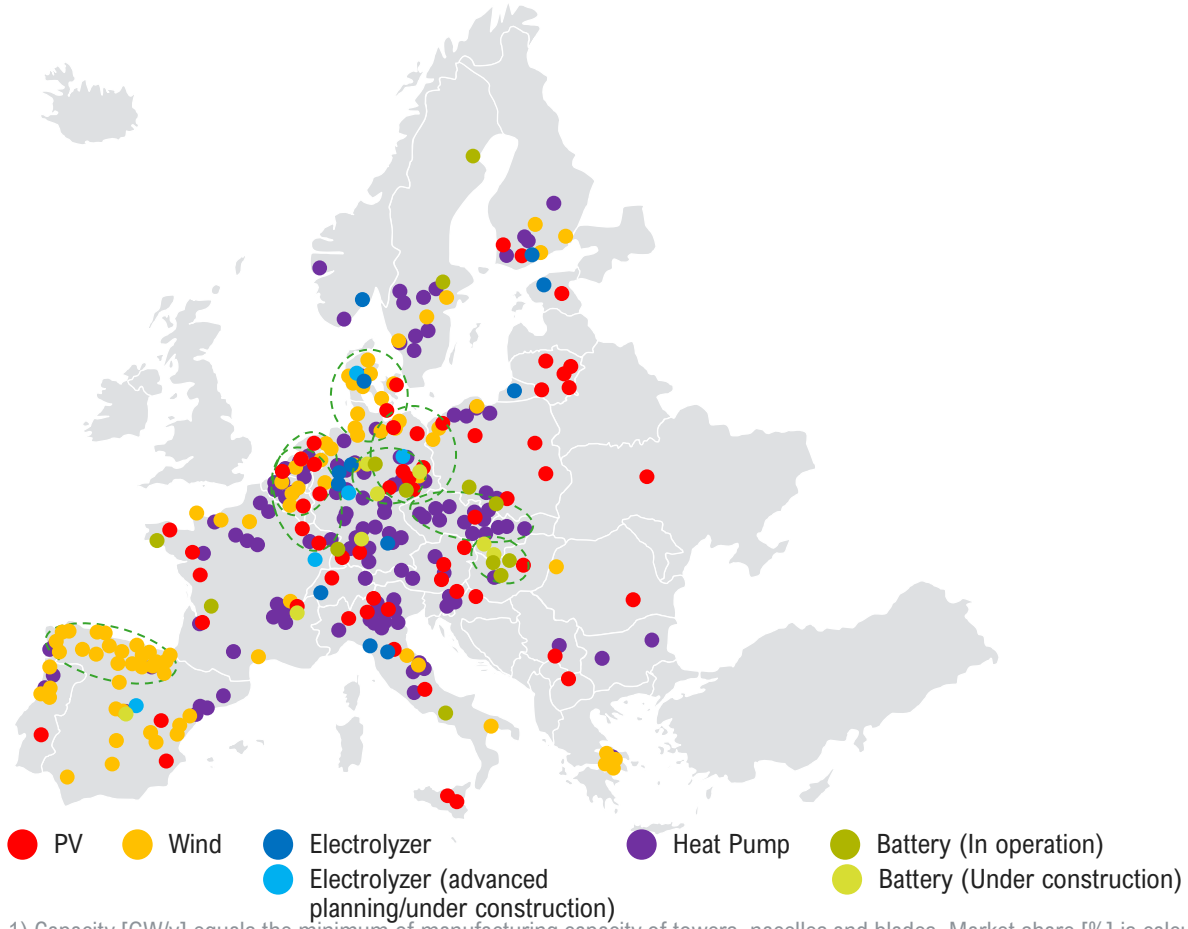
Focus today

Creating a resilient European-based green technology manufacturing footprint

B. Technology assessment

Manufacturing plants are concentrated in Middle Europe – Electrolyzer and Wind show highest global market shares, followed by Heat Pump manufacturer

Overview geographical concentration across all technologies – Component manufacturing



EU manufacturing capacities [2022]		Global market share ['22]	EU demand share[2] ['23]
PV module [GW/y]	9	2%	28%
Solar cell [GW/y]	1	<1%	4%
Wind, onshore[1] [GW/y]	13	16%	54%
Wind, offshore[1] [GW/y]	2	23%	44%
Electrolyzer [GW/y]	2	26%	>100%
Heat Pump [GW/y]	14	16%	79%
Battery [GWh/y]	75	8%	43%

Europe shows **high global manufacturing shares** for **Electrolyzer and Wind** with up to c. 26% – The **Heat Pump** production is distributed across the **highest number of plants**

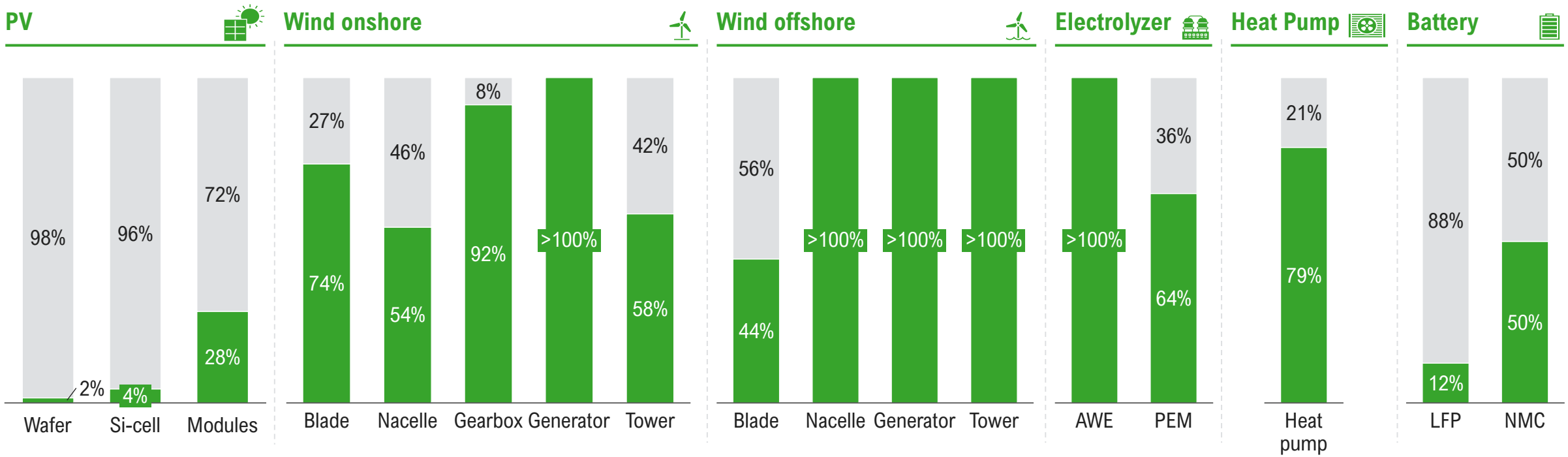
1) Capacity [GW/y] equals the minimum of manufacturing capacity of towers, nacelles and blades. Market share [%] is calculated as the weighted average share of the three categories based on their respective manufacturing capacity; 2) Demand share understood as share of EU manufacturing capacity of total EU demand for a technology – Based on demand forecast for 2023 according to Agora EU Gas Exit Pathway and EU manufacturing capacity from literature analysis

Source: IEA (2023), European Union (2023), European Commission (2022), Desk research

Indicative

For most Wind offshore components as well as AWE Electrolyzer EU manufacturing capacities surpass demand, while PV and LFP battery require significant imports

EU demand shares[1] [GW, 2023]



- **PV** with very limited production for wafers and cells – Modules at higher level
- **Wind onshore/offshore** with high market coverage and export potential to RoW
- **Electrolyzer** production captures total EU demand for AWE – PEM at lower level
- **Heat Pump production** at high level driven by smaller, fragmented set-ups
- **European battery production** is focused on NMC rather than LFP in line with the global market development (stronger focus on nickel-rich technologies)

EU manufacturing capacity Gap to yearly demand

1) Demand share understood as share of EU manufacturing capacity of total EU demand for a technology – Based on demand forecast for 2023 according to Agora EU Gas Exit Pathway and EU manufacturing capacity from literature analysis see sources without adjustment for planned annual additions or trends | Note: Rounding differences may appear

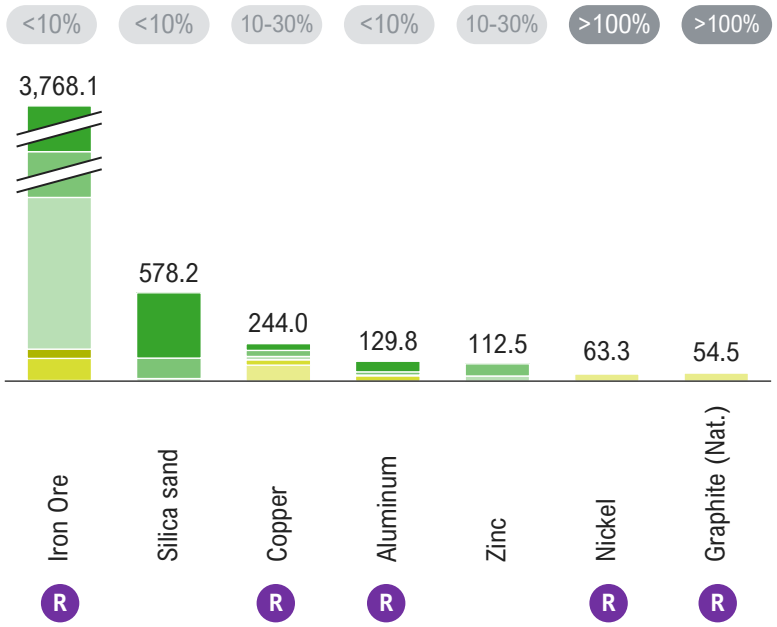
Source: European Commission (2022), European Union (2023), IEA (2022)

Indicative | Dependent on scope & product specifications as per manufacturer

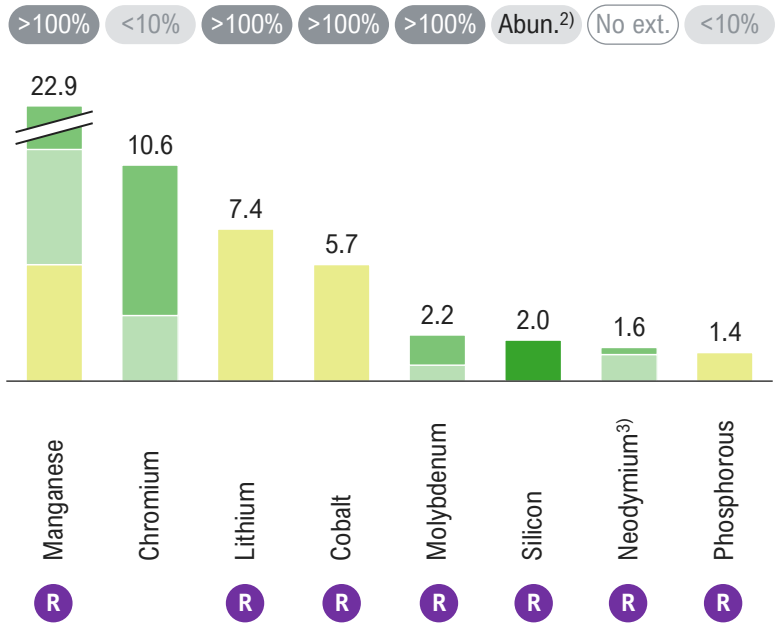
EU raw material extraction shows most insufficiencies to cover the requirements of the as-is manufacturing base especially for Battery, Wind and Electrolyzer

Raw material demand for as-is manufacturing base, 2022[1] [kt/y]

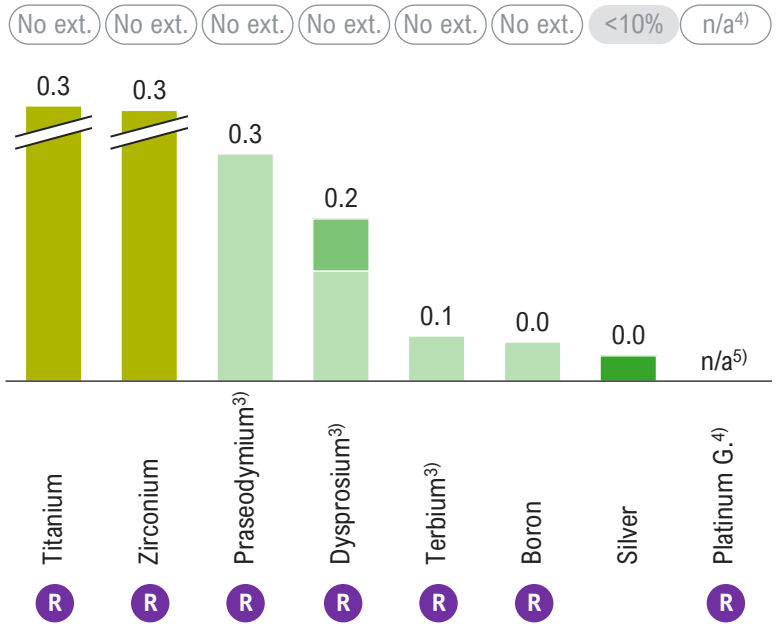
High-range material demand (>50 kt/y)



Medium-range material demand (1-50 kt/y)



Low-range material demand (<1 kt/y)



Most EU material insufficiencies for **Battery, Wind** and **Electrolyzer** – Thereof, extraction capacities are either not available or not enough given as-is demand

- **Manganese** and **Molybdenum** as well as **Rare Earth Elements** problematic for **Wind**, while for **Battery**, **Titanium** and **Zirconium** are affected
- For **Battery**, the EU extraction of **Nickel, Graphite, Manganese, Lithium and Cobalt** does not cover demand requirements

Solar PV | Wind onshore | Wind offshore | Electrolyzer | Heat pump | Battery | x% x% Share of EU extraction (last data set available, 2020) | No ext. No EU extraction | R Relevant material

1) Projection of raw material demand based on the discussed raw material intensities from the raw material assessment to cover the as-is manufacturing base 2022; 2) Abundant supply available, quantitative estimates are not available; 3) Raw materials of the group Rare Earth Elements; 4) Includes Iridium, Palladium, Platinum, Rhodium, Ruthenium; 5) Missing data for quantification, import reliance identifiable

Source: European Commission (2023), U.S. Geological Survey (2022), World Mining Data (2021)

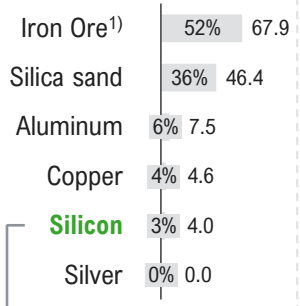
Indicative | Not exhaustive

Wind and Battery include most import reliant raw materials – For Wind, the permanent magnet is particularly affected by the import of Rare Earth Elements

Selected raw material intensities with focus on import reliance [kt/GW | kt/GWh]

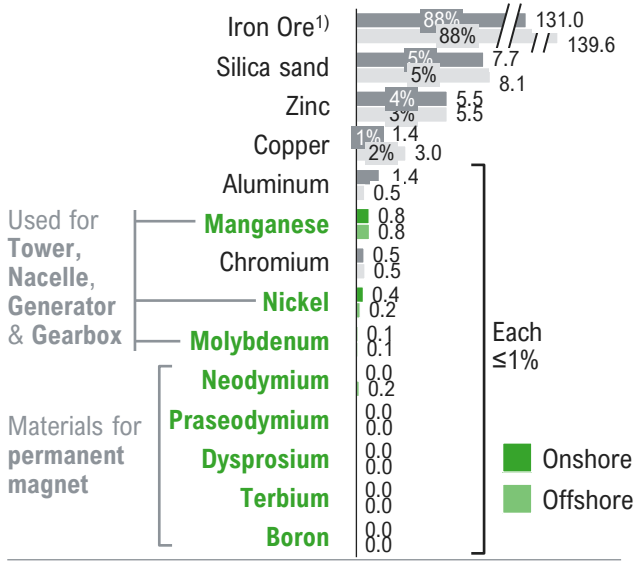
kt/GW

PV



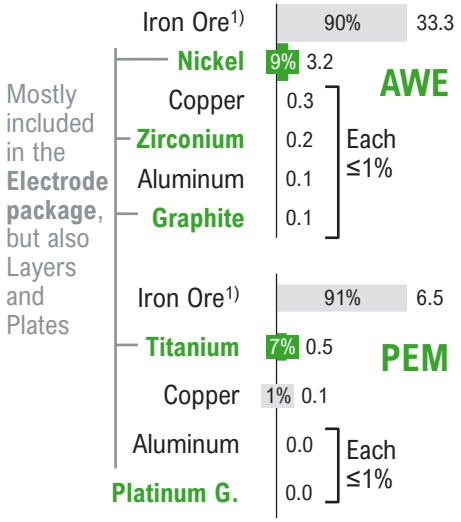
- EU extraction for most materials available
- Despite abundant Silicon reserves, pure form **Polysilicon** is highly import reliant

Wind



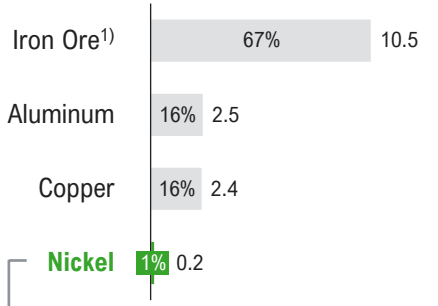
- **Permanent magnets** consist fully of import reliant materials (esp. REE[2)]) except for Iron Ore – High import dependence both on raw materials as well as on finished pre-components (magnets)
- Further 'at-risk' materials are used for all components except for blade production (balsa wood as pre-component)

Electrolyzer



- **Some of the main raw materials** of Electrolyzers besides Iron Ore are highly import reliant
- **Platinum Group Materials (PGMs)** and **Rare Earth Elements (REEs)** are important materials dependent on imports

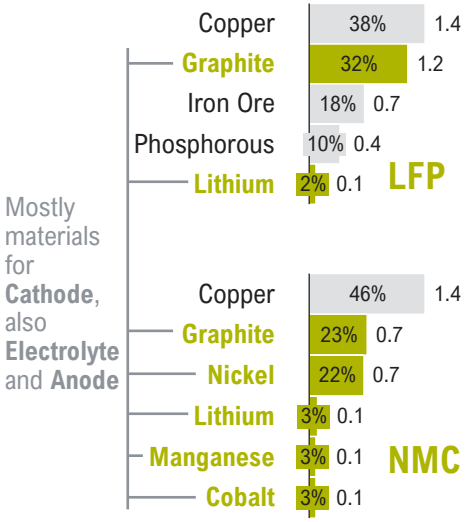
Heat Pump



- Heat Pumps show **low reliance** on highly imported raw materials
- **Nickel** with insufficient EU extraction is used across multiple parts of the Heat Pump, mainly for the control unit

kt/GWh

Battery



- Especially **NMC** is **significantly affected** by import reliant materials – Most used materials lack EU extraction
- For **LFP**, import reliance is also significant as key materials are concerned

EU extraction insufficient to cover demand of as-is manufacturing base or no extraction available

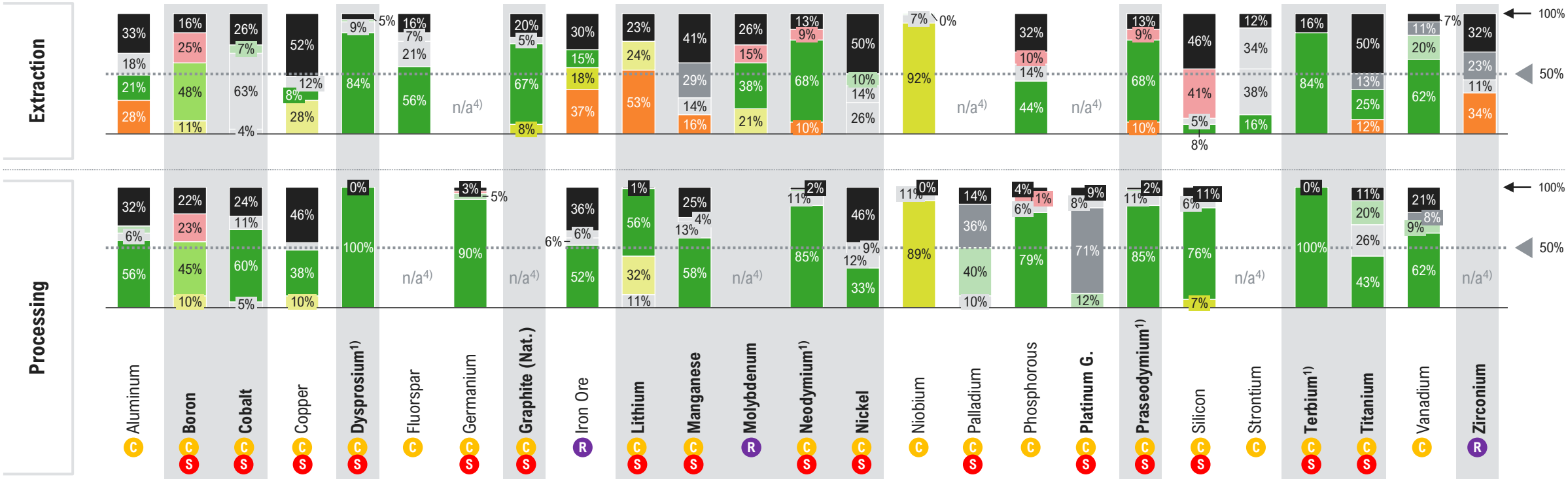
1) Including steel, iron cast and other iron; 2) Rare Earth Elements (REE)

Source: European Commission (2018, 2020, 2022), Energy Transitions Commission (2023), IEA (2023), Bareiß et al. (2019), Koj et al. (2017)

Not exhaustive

Out of 25 identified ‘relevant’ raw materials (RMs), China is dominant world extractor for 7 (28%) and dominant processor for 14 (56%) RMs

World extraction and processing capacities across relevant raw materials (%-share)



- Across all **25 relevant raw materials**, China is dominant for both raw material extraction (+ 50% of world capacities for 7 RM) and raw material processing (plus 50% for 14 RM)
- **Few other countries with significant market shares** including Brazil (91% Niobium), Australia (53% Lithium) and USA (41% Silicon) for extraction capacities

Strategic material | Critical material | Relevant material | xx Insufficient EU extraction

Australia | Brazil | Chile | China | Russia | South Africa | Turkey | United States | RoW | Other countries

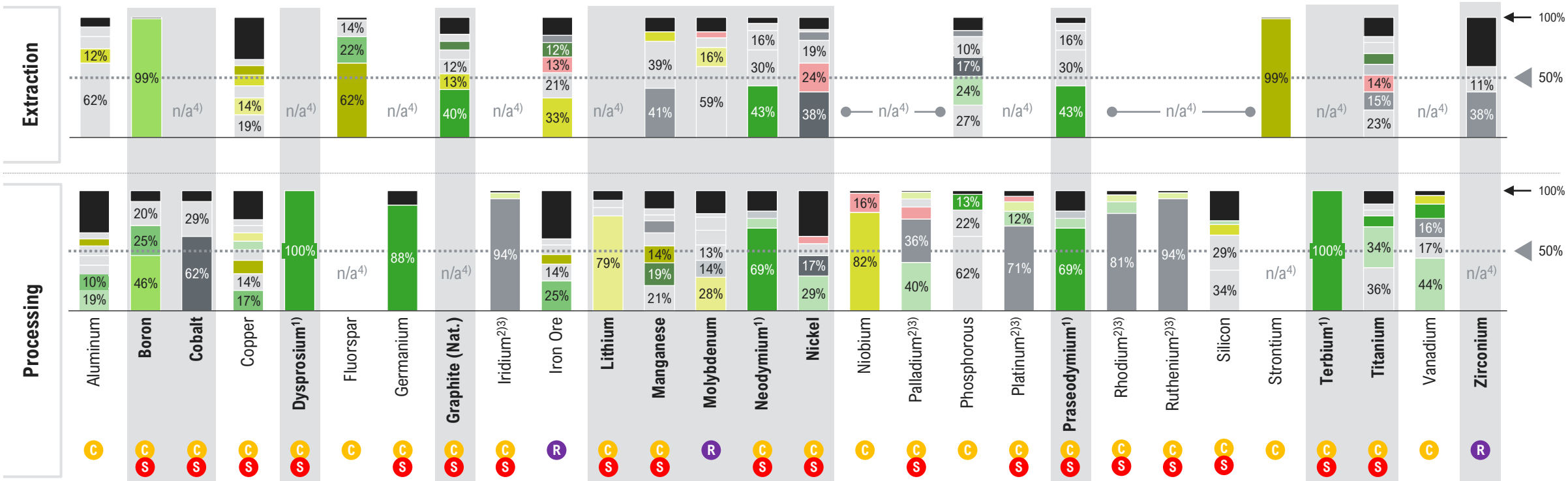
1) Raw materials of the group Rare Earth Elements (REEs)

Source: European Union (2023)

Not exhaustive

In contrast, Europe seems more diversified for suppliers in extraction & processing – However, due to the strong Chinese positioning a 'sub-dependency' seems likely

EU sourcing share across relevant raw materials (%-share)



- At extraction stage, the **EU key suppliers appear more diversified** than expected given the Chinese dominance at world
- Across all relevant 28 raw materials including the REEs and PGMs five are being dominated by China and four by South Africa in the processing stage

Strategic material | Critical material | Relevant material | xx Insufficient EU extraction

Brazil | Canada | Chile | China | Finland | Germany | Russia | South Africa | Spain | Turkey | Ukraine | United Kingdom | Zimbabwe | ROW | Other countries

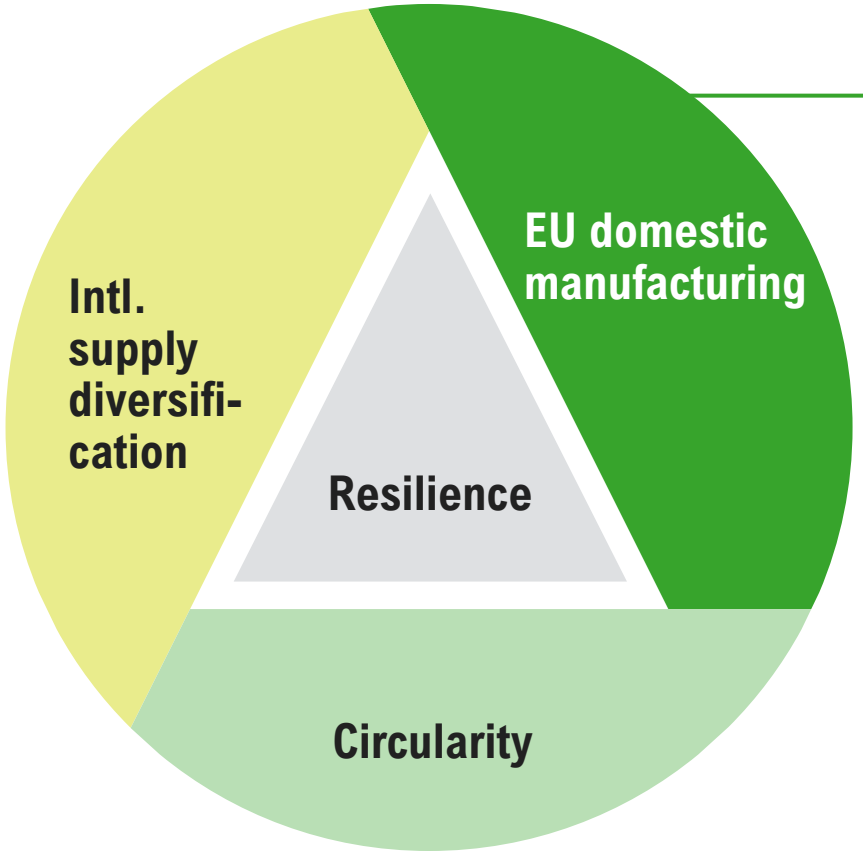
1) Raw materials of the group Rare Earth Elements (REEs) 2) Raw materials of the Platinum-group metals (PGMs)
3) Values for PGM are global market numbers; 4) No data available – Extraction/processing unknown

Source: European Union (2023)

C. Supply scenarios

Resilience is driven by EU domestic production, the international supply diversification and circularity – Project focus is set on EU domestic manufacturing

Introduction resilience



Focus

1. What is appropriate level of EU domestic manufacturing to balance resilience and cost optimization?
2. Which sectors and segments of the value chain should be prioritized for public support?
3. What is the resilience premium for increased levels of EU manufacturing?

From a scenario perspective, manufacturing resilience is ultimately understood as from risk derived share of EU-based manufacturing vs. total European demand

Definition of manufacturing resilience [Scenario view]

Manufacturing resilience

- Understood as **ability to mitigate risks to the overall European market** derived from the dependencies on imports into the EU
- **Influenced by the (resulting) level of EU-based manufacturing supply** vs. the total demanded annual deployments
- **Measured as**

%-RL [Resilience Level]	=	%- RAS [Risk Assess-ment Score]

Risk assessment score

Category		Risk	Weight	Score	Score total
Economical	1	Demand & supply gap	10%	0-1	0-1
	2	Supplier/partner dependence	10%	0-1	
	3	Material & labor shortage	10%	0-1	
Geopolitical	4	Regulation (e.g., ESG)	10%	0-1	
	5	Political risks (e.g., sanctions)	10%	0-1	
Technological	6	Incremental tech. innovations	10%	0-1	
	7	Disruptive technologies	10%	0-1	
Geographic	8	Blockade of transport/trade routes	10%	0-1	
	9	Force majeure (environmental)	10%	0-1	
Digital	10	Digital malfunctions	10%	0-1	

- The higher the assessed level of risk, the higher the resulting desired level of EU-based manufacturing should be
- Risk assessment & quantification is performed based on a set of key identified risks for each technology
- For the technology-specific scores, all risks are weighted equally

Major risks for the supply chain can be categorized in economical, geopolitical, technological, geographic and digital risks

Overview of identified key risks

Economical risks

1 **Demand & supply gap**
- Ambitious growth levels for installed capacities of technologies leading to bottlenecks along the manufacturing value chain (e.g., supply of materials, manufacturing capacities)

2 **Supplier/partner dependence**
- Concentration of single partner and/or homogenic group of suppliers/partners with high dependence on financial performance and reliability

3 **Material & labor shortage**
- Scarcity of material or labor implies price volatility as well as delays along the supply chain

Geopolitical risks

4 **Regulation (e.g., ESG)**
- National law and policies concerning sourcing quotas, child labor, environmental standards, etc., enforcing shift in production processes or of production locations

5 **Political risks (e.g., sanctions)**
- Trade restrictions due to international conflicts as constraint for import and export flows

Technological risks

6 **Incremental technological innovations**
- Danger to existing technologies due to incremental innovations

7 **Disruptive technologies**
- Danger to existing technology advantages due to new, disruptive alternative solutions
- Threat of built-up manufacturing capacities to become obsolete

Geographic risks

8 **Blockade of transport/trade routes**
- Delays in shipping due to blockades, strikes, etc. resulting in process delays

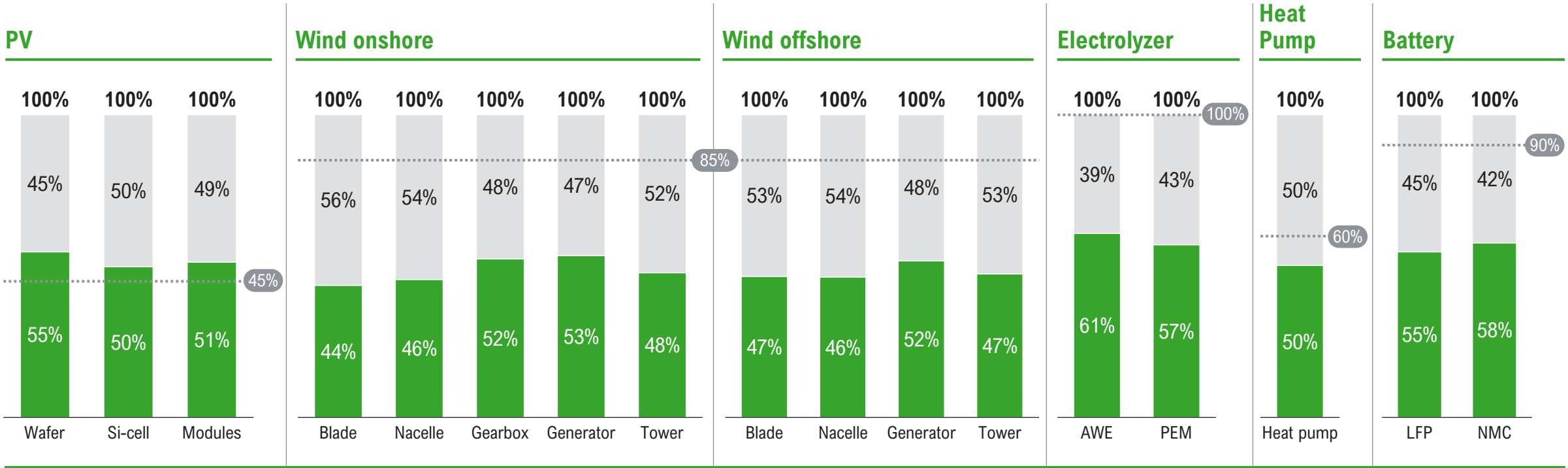
9 **Force majeure (environmental)**
- Drought, floods, storms, etc. damaging sites, transport and overall process

Digital risks

10 **Digital malfunctions**
- Data leakages, failure of control software or cyber attacks jeopardizing processes along the value chain

PV, Electrolyzer, Heat Pump and battery are evaluated with higher target market shares due to greater supplier concentration & import reliance – NZIA targets differ

Risk assessment score: Resulting market shares by technology and component [%]



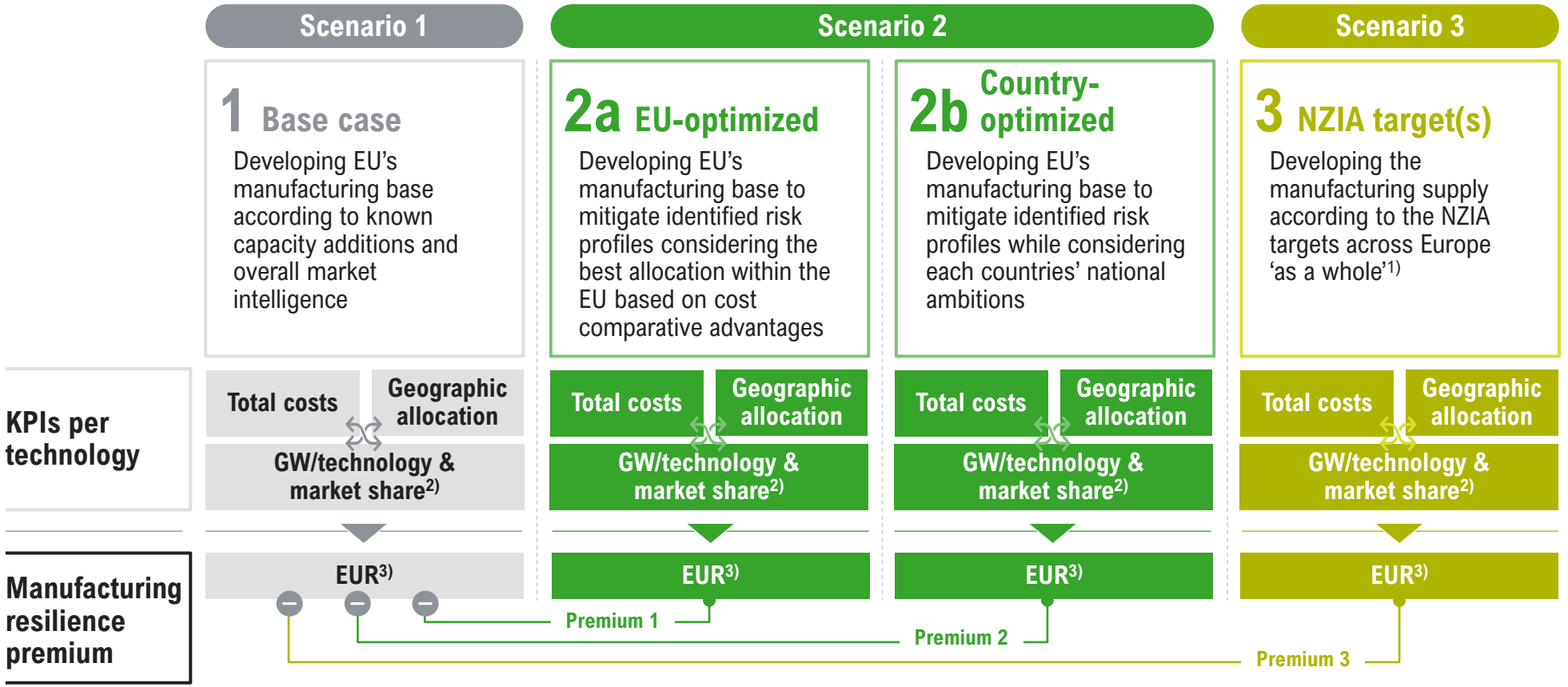
- Assessment based on selected risk parameters results in **differentiated targets for the value chain coverage** by technology and by component due to different risk exposures and value chain characteristics – compared to individual (unofficial) NZIA targets per technology
- Especially for PV, Electrolyzer and battery, **higher investments are required** to increase the resilience of the respective value chains

EU supply | Demand gap | xx Targeted market shares from NZIA

Source: European Commission (2023)

Three scenarios are differentiated: Base case, two-leveled resilience-led case and NZIA target case – Resilience premium derived by comparing base vs. scenarios

Introduction scenario logic & KPIs



- **Scenarios are quantified by three key KPIs:**
  - Total **costs** (UMC plus capital costs)
  - **Geographic allocation**
  - Total **GW and market share** of supply by technology
- **Resilience premium**…
  - Depicts the **level of risk mitigation for European-based manufacturing** vs. base case
  - Compares the resulting EUR per technology and scenario vs. the EUR per technology of the base case
  - Can **only be summed up and compared at scenario-level in total EUR** due to differences in volume denominations
- **World-based EU supply** is derived as residual value

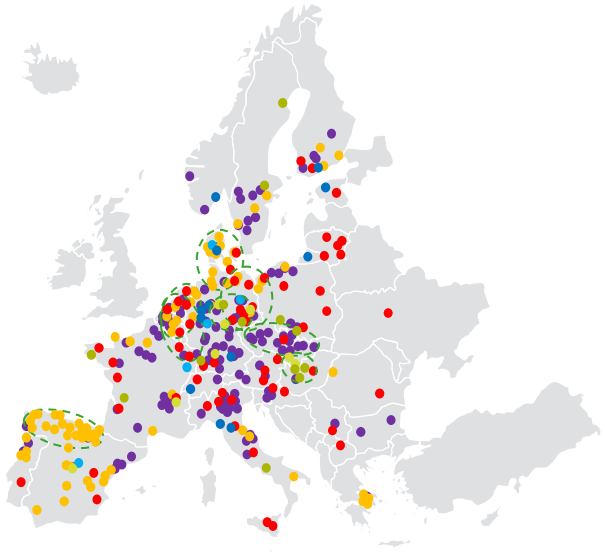
1) No official individual targets available – Shares of PV: 45%, Wind: 85%, Electrolyzer: 100%, Heat Pump: 60% and Battery: 90% of 2030 demand according to Commission Staff Working Document (European Commission, 2023); 2) Market share understood as share of EU manufactured supply of total EU demand for a technology; 3) EUR/kW available at component/technology sub-type level

Indicative

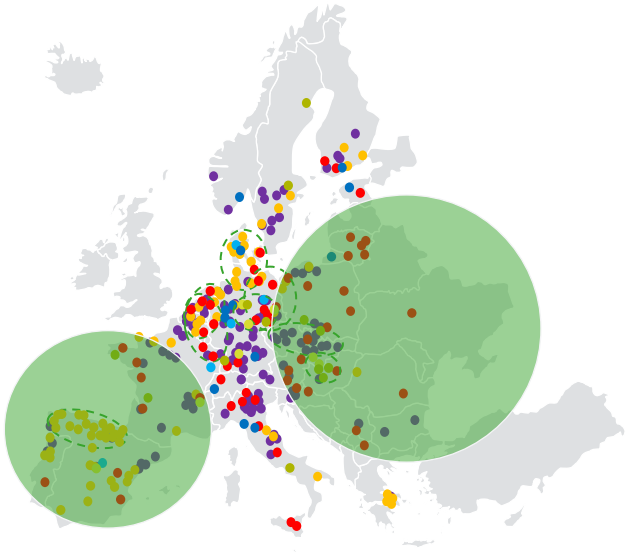
Scenario 2a focuses on building manufacturing capacity in Central/Eastern and Southern Europe – In contrast, scenario 2b favors Northern & Western Europe

Scenario additions at European-level [schematic]

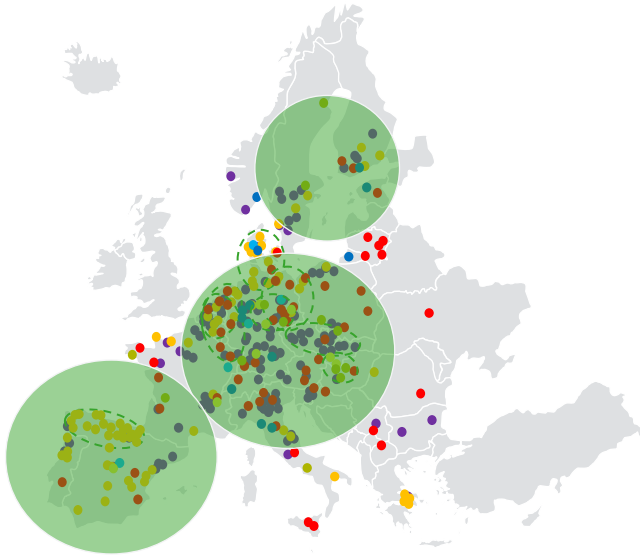
Base case



Scenario 2a: 'EU-optimized'



Scenario 2b: 'Country-optimized'



- **Scenario 2a – 'EU-optimized':** Focus on **Central & Eastern** (e.g.: Latvia, Bulgaria, Lithuania, Estonia, Hungary) and **Southern** (e.g.: Portugal, Spain) Europe due to higher cost competitiveness compared to Western European countries
- **Scenario 2b – 'Country-optimized':** Focus on **Northern** (e.g.: Sweden, Finland), **Western** (e.g.: Germany, France, Luxembourg) and **Southern** (e.g.: Spain) Europe to high country-specific drive as well as their financial and economic power

PV · Wind · Electrolyzer · Electrolyzer (advanced planning/under construction) · Heat Pump · Battery (In operation) · Battery (Under construction) · Focus of scenario-based additions


Roland
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