→ To fully reap the benefits of the energy transition, European and national green industrial supply chains must be created, developed and strengthened to support the growth and to reduce reliance on import, thus reducing the risk of technological dependence

1 The rising global competition on decarbonization-related industrial supply chains

↘
The **European share of global manufacturing capacity** of the 17 strategic components of the main clean technologies is equal to **14%** compared to **65% of China.**

↘
In **March 2023**, the EU proposed the "**Net Zero Industry Act**", setting the goal of achieving by 2030 **at least 40% domestic production of the annual green technology demand**. To reach this ambitious target, the European Union could redirect existing public funds to decarbonization purposes: if all of them were channeled to finance net zero technologies **EUR 695.1 billion between 2021 and 2027** would be available.

↘
The Study shows that public money is available, but that it needs to be managed in a more straightforward and effective way to ensure it unlocks industrial renaissance in the green domain within a reasonable time frame. In addition, better coordination of research activities currently scattered across the continent and an enhanced effort to develop an industry-wide circular approach based on higher recycling and substitution rates, would help exploiting and maximizing the sustainability advantage of the European supply chains in the international context.

Source → The European House – Ambrosetti and Enel Foundation on European Commission, IEA data and various sources, 2023.

* Excluding China. ** As reported in the "Net Zero Industry Act". These are existing funds that could be redirected to finance net zero technologies. EU, US and Chinese funding are not fully comparable since the underlying mechanisms are different. China and US amounts based on official Governments data discolure.

Figure 1 → Share of clean-energy technologies' manufacturing global capacity by Region, 2021 (% values)

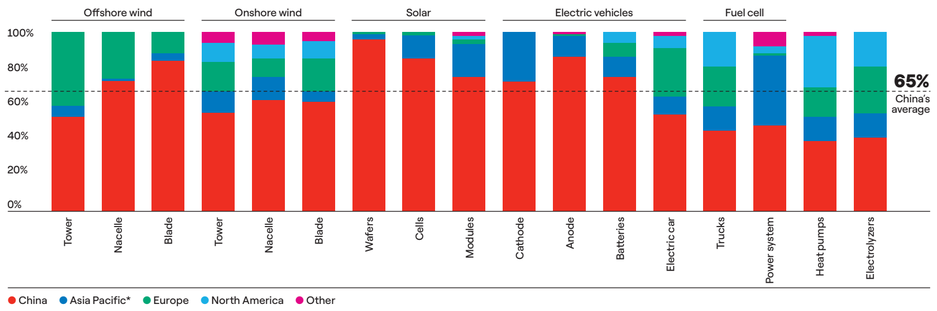
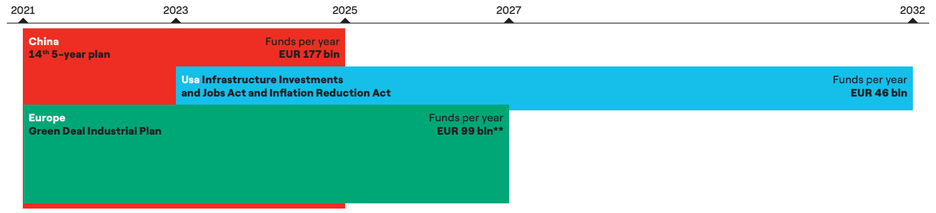


Figure 2 → Measures and financial commitments adopted in the major economies for green industrial development, 2023 (EUR billion per year)



enel

WITH THE SCIENTIFIC CONTRIBUTION OF
enel Foundation

SCAN THE QR CODE WITH YOUR SMARTPHONE TO DOWNLOAD AND READ THE DIGITAL VERSION OF THE STUDY.

enelfoundation.org
enel.com

2 The three key decarbonization-related industrial supply chains analyzed in the Study

Figure 3 → The key Facts&Figures of decarbonization-related industrial supply chains, 2030 vs. 2021 (illustrative)

↘
This Study focuses on **photovoltaic** (PV), **batteries** and **heat pumps** (HP), the decarbonization technologies that will have the **largest growth by 2030** in the sectors of energy production, distribution, and consumption, respectively, and which value chains are either not robustly present (PV, and batteries) or which market is at an ealry stage of development (HP) in the EU and Italy

Source → The European House – Ambrosetti and Enel Foundation on European Commission, EHPA and Agici data and various sources, 2023.

* 2030 trajectories reflect the "REPowerEU" for European Union and the Elettricità Futura scenario (inspired by the "REPowerEU" plan) for Italy.
** Announced, planned/partially financed, under construction/in operation.
***2030 expected demand according to EHPA and Enel and Agici report *"Electrification Of Domestic Heating And Hot Water Systems In Italy"*.

Photovoltaic

By 2030

+432 GW → in Europe

+58 GW → in Italy

according to the latest trajectories*

Cheapest power generation technology

Batteries

By 2030

+810 GWh → in Europe

+60/106 GWh → in Italy

according to current projects announcements**

Crucial role to facilitate the penetration of renewable energy sources and electric vehicles deployment

Heat Pumps

By 2030

+60 million → in Europe

+10 million → in Italy

according to the latest scenarios***

Best combination **of technology readiness, efficiency** and the **lowest cost of heat** vs. traditional heating solutions

3 The main European and Italian bottlenecks along the three supply chains

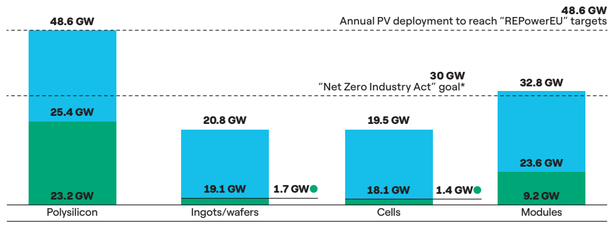
	Bottleneck	Bottleneck severity (Low – High)	Reasoning
Photovoltaic	Production facilities high investment cost and lead time		→ **CAPEX 2.2 to 5.6 times higher** in EU and Italy than in China → **Lead times** up to **1.7 times longer** in EU and Italy than in China
	High energy, CO_2 and labour costs		→ EU and Italian industry energy price **45% higher** vs. China → EU CO_2 emission cost **x10** vs. Chinese one → EU **average hourly wage up to x5** vs. China
	Absence of vertical integration		→ In Italy and in Europe **no single company vertically integrated along the PV value chain** making them more **subject to unexpected shocks**
	Lack of competence, skills and equipment manufacturers		→ Some PV **segments require advanced technologies, know-how, skilled labor** and access **to state-of-the-art production technology** → **Lack of equipment suppliers** in upstream segments in EU and Italy
Batteries	Limited access to raw materials: import dependency and strong regulation constraints for mining		→ **100%** lithium and **81%** cobalt imported in EU → **15-17 years** to get a permit for mining in EU vs. **3 months in China** → In Italy competence for mining titles is in the hands of the **Regions**, generating a **lack of homogeneity**
	Lack of recycling capacity		→ China holds **81%** of current global capacity for EV and stationary storage batteries → EU has **low recycling rates** for batteries' raw materials (e.g., **0%** for lithium, **32%** for cobalt and **43%** for nickel)
	Current limited production capacity to be scaled up		→ **Limited production capacity of EU and Italy** (**80%** of EU batteries production capacity in the hands of Asian manufacturers) → Gigafactories need about **5 years to build and fully ramp up** in EU
	High costs for batteries manufacturing		→ **The manufacturing cost of batteries** in EU is **33% higher** than in China, with the CAPEX for setting up a new gigafactory that is **47% higher**
Heat Pumps	Heterogeneous installation requirements		→ Several building **requirements** (space, distribution system, electricity and insulation), high cost of installation (**~EUR 6,000 for air-source** HP) and lack of installers (need to increase by **50%**) and **50% of existing ones need reskilling**
	Market immaturity and high uncertainties regarding future demand		→ **Immature market**, implying **uncertainties** about future demand evolution, disincentivizing the conversion of existing structured industries (e.g. gas boiler) and companies' investment plans
	Restricting refrigerant regulation		→ **EU HFC's phase-down plan** can obstacle the development of HP market while **increasing the cost of refrigerants** (+394% between April 2021-April 2022) without relevant environmental benefits
	Lack of EU specialization in strategic components		→ **63% of EU compressors' demand** is **imported** and their market is **concentrated**. Manufacturers might not be able to **scale up** their production due to **cost competition** and the massive scale of the few existing global manufacturers

4 The main European and Italian opportunities and risks for the development of the three value chains

	Risk/opportunity	Risk/opportunity severity (Risk ↔ Opportunity)	Reasoning
Photovoltaic	Effective use of available funds		→ In EU and Italy, **funds are already available, but need to be effectively channeled** to expand and scale-up PV manufacturing capacity, coordinating and integrating current capabilities across the EU
	Environmental and social sustainability		→ The **manufacturing of PV modules in Europe is more environmentally sustainable** vs. China, even if the latter might **quickly catch up**. China has been accused to adopt **forced labor** in its polysilicon facilities
	Research and Development		→ Different research centers in EU and Italy but **need of higher coordination**. China R&D in the sector is strong and can leverage on the huge production capacity
	Chinese export ban		→ 3 Chinese technologies to manufacture PV modules might be **prohibited for export**. This is a risk but EU could promote the development of a local industry, but this **takes time**
Batteries	Effective use of available funds		→ In EU and Italy, **funds are already available, but need to be effectively channeled** to expand and scale-up batteries manufacturing capacity, coordinating and integrating current capabilities across the EU
	Environmental and social sustainability		→ The **manufacturing of batteries in Europe is more environmentally and socially sustainable** vs. China, even if the latter might **quickly catch up**
	Development of recycling capacity		→ By 2030, recycling capacity is expected to increase by **x50** but it will cover only **6%** of lithium demand, **7%** of nickel and **10%** of cobalt: further development of recycling capacity requires **higher investments** and **targeted R&D**
	Research and Development		→ High opportunities related to **disruptive technologies** (e.g., Na-ion batteries) but **limited funds and coordination** across EU Institutions and Member States
Heat Pumps	Relevance of European industry		→ With respect to the current market size (still at an early stage of development), the EU accounts for **15% of global HP production** and covers **77%** of **domestic demand**, with great potential to **convert gas boilers' value chain**
	Economic and environmental convenience		→ Despite high initial investment costs (cost of the machine and installation), HP is the best technology in terms of **total cost of ownership and adaptability to a variety of climates**, minimizing the impact on the environment
	Recycling capacity		→ In the longer term, recycling can be an **effective strategy to solve the price volatility and scarcity problems**
	European policies		→ The growth of heat pumps market is boosted by **European policies** aimed at reducing gas dependence

5 Projections of manufacturing capacity in the three value chains in Europe at 2030

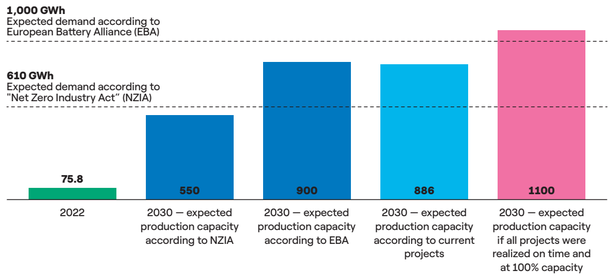
Figure 4 → State of the art of the PV industry in European Union, based on current and expected annual manufacturing capacity, policies for 2030 and requirements to reach the "REPower EU" targets, 2022 and 2030 (absolute values in GW)



*Based on the "Net Zero Industry Act", which lists 30 GW as the expectation by 2030.
Annual PV development at European level is estimated based on European Commission and IRENA data

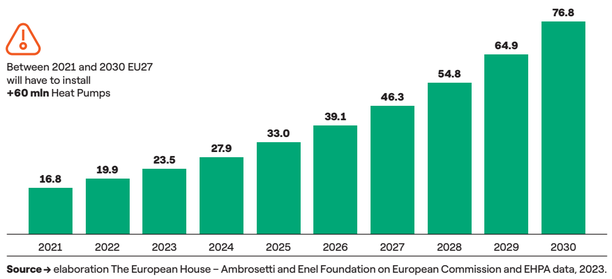
Source → elaboration The European House - Ambrosetti and Enel Foundation on SolarPower Europe and European Commission data, 2023.

Figure 5 → Current and expected production capacity of Li-on batteries in the European Union, 2022-2030E (GWh)



Source → The European House - Ambrosetti and Enel Foundation elaboration on European Commission data, 2023.

Figure 6 → Heat pumps in EU27, 2021-2030E (millions of units, cumulative)



Source → elaboration The European House – Ambrosetti and Enel Foundation on European Commission and EHPA data, 2023.

6 The systemic effects from achieving the "Net Zero Industry Act" domestic production capacity targets

There is a **significant benefit coming from the investments in local value chains**, which could **contribute to achieving production capacity set by NZIA while reducing imports and creating systemic effects**. Adding together the net benefit of **reduced imports** and the **direct, indirect and induced economic benefits** coming from investments needed to reach the NZIA targets for the creation of local supply chains in the three technologies under analysis, the **overall return on the investments would be equal up to EUR 642 billion**

Figure 7 → Summary view of investments to reach NZIA 2030 targets of domestic production and levers that can reduce cost of EU products and bring benefits to European-based companies and citizens by value chains (EUR billion)

	Photovoltaic	Batteries	Heat Pumps
Investments to reach the NZIA 2030 targets of domestic production	EUR 10-15 bln	EUR 80-130 bln	EUR 6 bln
↓ Levers that can reduce cost of EU products and bring benefits to European-based companies and citizens			
Import reduction	EUR 21 bln	EUR 178-281 bln	EUR 38 bln
Direct, indirect and induced economic benefits	EUR 16-25 bln	EUR 131-215 bln	EUR 62 bln
Total return on investments		EUR 446-642 bln	

Source → The European House - Ambrosetti and Enel Foundation on "Net Zero Industry Act" Staff Working Document of the European Commission, Eurostat and Istat, 2023.

7 Proposing a new strategic vision and policies

The EU and its Member States should adopt a **new strategic vision** aimed at developing a competitive European-wide decarbonization industry, implementing **integrated and coordinated European value chains** and promoting **greater diversification in the supply** of technology components and **critical raw materials**, also leveraging on the already existing partnerships and complementarities with countries outside the EU

Policy level	Policy actions	Photovoltaic	Batteries	Heat pumps	Implemented: No	Partially	Yes
Italian level	1 Applying **streamlined and predictable permitting procedures for factories' realization**	✓	✓			●	
	2 Favoring the **realization of gigafactories** through **financial support** in terms of **CAPEX and OPEX**	✓	✓		●		
	3 Promoting decarbonization through **efficient electric technologies** such as heat pumps			✓	●		
	4 Supporting measures to ease the gas **boiler value chain conversion**			✓	●		
	5 Implementing a **clear strategy** to ensure **critical raw materials supply**	✓	✓	✓			
	6 Creating dedicated **green finance** mechanisms to develop value chains	✓	✓	✓		●	
	7 Facilitating **upskilling/reskilling**	✓	✓	✓	●		
European level	1 Favoring the **distribution** to companies and citizens of the **strategic value** generated by the development of local supply chains	✓	✓	✓	●		
	2 Promoting EU Member States coordination on **R&D** and **industrial innovation**	✓	✓	✓	●		
	3 Providing **specific financial tools** to ensure that all the clean technology products installed and imported comply with **ESG criteria**	✓	✓	✓		●	
	4 Establishing a **common frame for the governance** to **guarantee coordination and integration** in policy actions implementation in EU and in its Member States	✓	✓	✓	●		