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The Economics of "Buy-European"

The Pull Effects of EU-Origin Criteria for Net-Zero Technologies

André Wolf

The proposal of the European Commission to introduce binding local content requirements in public procurement procedures and support schemes for strategic net-zero technologies marks a fundamental shift in its industry strategy. By stimulating demand, such requirements offer a scaling potential for domestic manufacturing in areas of high external dependencies. However, by raising procurement costs and reallocating resources away from successful export sectors, they also entail significant macroeconomic risks. Applying such criteria requires a highly responsible and risk-oriented approach, rooted in an assessment of technology-specific development potentials. This cepStudy investigates the economic potentials and risks of local content criteria for net-zero technologies by quantifying future income potentials and assessing their conditionalities.

- In defining legally binding "Made-in-Europe" criteria for the green transformation, the EU should follow a cautious and growth-centred approach. To avoid undermining structural change and reduce long-term risks to public budgets, it should initially focus on a limited set of hard-to-substitute net-zero technologies with high systemic importance and strong potential for future cost-reducing scale economies.
- A switch to 100% EU origin in central manufacturing stages of four key net-zero technologies (lithium-ion batteries, electrolysers, heat pumps, PV modules) is estimated to create a potential for additional EU value added of 43 to 50 billion EUR in 2030 alone. To realize these potentials, the EU must simultaneously tackle the severe supply-side constraints to a ramp-up of domestic production, in particular excessive red tape, growing skill bottlenecks and the lack of appropriately specialized manufacturing clusters.
- The estimations show that any positive income effect is likely to be very unevenly distributed among Member States, endangering political consensus. Any roll-out of "Buy-European" criteria should thus be accompanied with a fair and transparent EU-wide financing scheme for the direct cost burden of switching to domestic products.

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1 Background

The idea of the European Commission to introduce local content requirements for products considered critical for Europe's future prosperity has sparked a controversial debate across Europe. The first concrete step in this direction is the proposal for an Industrial Accelerator Act.[1] In this, the Commission proposes local content rules in public procurement and public support schemes for a first list of green technologies. Since such rules are clearly at odds with WTO agreements, their proposal represents a breach with the EU's self-image as a guardian of a rules-based trading system. Apart from the long-term risk of a loss of credibility in the international political sphere, local content requirements also represent a risky bet in economic perspective. While helping to secure European jobs in the affected sectors in the short run, they threaten to harm other sectors and consumers through higher purchase costs and the withdrawal of productive resources.

At the same time, one must acknowledge that the Commission's proposal is primarily a reaction to a drastically changing global trade policy landscape. Apart from the increased use of tariffs and export restrictions as economic weapons, this also involves an increasing prevalence of local content requirements, for instance in public procurement in China[2] and within the support schemes of the US Inflation Reduction Act[3]. From a geopolitical perspective, the EU's policy move could be justified as an act of self-assertion and an attempt to restore a balance of power. However, history teaches us that economic policies based on a tit-for-tat philosophy tend to result in a loss of prosperity for everyone. If there really is a case for local content rules, it must be derived from a positive economic growth vision, not on fear or the desire for self-assertion. In this respect, the literature on local content rules draws a nuanced picture, pointing to several conditionalities for success, but also long-term chances. In the context of the green transition, this primarily concerns the potential to realize productivity gains and develop new specialization patterns through scaling and learning.

This article contributes a sober view to the debate that reaches beyond ideological trenches. By focusing on the implications of local content rules for key green technologies, it analyses their interplay with the EU's long-term vision of climate-neutral growth. On the one hand, domestic demand support to manufacturing capacities in areas like PV modules and batteries could help to overcome existing external dependencies and secure technology competencies in Europe. On the other hand, higher prices for domestic procurement would raise short-term costs of the green transition and likely become a new source of distributive conflicts between Member States and economic sectors. In analysing these trade-offs, the article starts with an overview on current EU policies, main impact channels and lines of argumentation in the literature. Then, it provides a quantitative assessment of the direct and indirect value-added potential of a switch to 100% EU procurement for four key net-zero technologies: electrolysers, heat pumps, lithium-ion batteries and PV modules. Then, the conditionalities for realizing these potentials are discussed. The article concludes with a set of basic recommendations for a coherent policy framework.

1 European Commission (2026). Proposal for a Regulation of the European Parliament and of the Council on establishing a framework of measures for the acceleration of industrial capacity and decarbonisation in strategic sectors and amending Regulation (EU) 2018/1724, Regulation (EU) 2024/1735 and Regulation (EU) 2024/3110. COM(2026) 100.

2 ITA (2025). China commercial guide – Selling to the public sector. U.S. International Trade Administration.

3 Kauer, P. (2025). A new deal for the climate? Lessons from the Inflation Reduction Act (No. 248/2025). Working Paper.

2 EU Resilience Policies for Green Technologies

2.1 Public Procurement

The Net-Zero Industry Act (NZIA) regulates the application of resilience criteria in public procurement procedures where contracts involve technologies that belong to the list of net-zero technologies defined in its Article 4(1).[4]

Resilience criteria shall only be applied to those net-zero technologies where supply dependence on specific third countries exceeds at least one of two thresholds (Article 25(7)):

- The proportion of a specific net-zero technology or its main specific components originating in a third country accounts for more than **50%** of the supply of that specific net-zero technology or its main specific components within the Union;
- the proportion of supply within the Union of a specific net-zero technology or its main specific components originating in a third country has increased by at least **10 percentage points** on average for two consecutive years and reaches at least **40%** of the supply within the Union.

If these thresholds are exceeded, Member States are asked to include the obligation in public procurement contracts that not more than **50%** of the value of the net-zero technology and not more than **50%** of the value of its main specific components are supplied by providers from a single third country. A disregard of the obligations shall result in the payment of a charge of at least **10%** of the value of the relevant net-zero technologies.

Hence, even though the main goal of the NZIA is to foster the build-up of EU-internal production capacities of net-zero technologies, it avoids formulating resilience criteria in the form of explicit local content requirements. Instead, criteria refer to the goal of diversifying supply channels, i.e., reducing dependence on dominant supplier countries like China, not necessarily reducing import dependence in general.

At the same time, the NZIA provides room for some cost- and feasibility related exceptions (Article 25(8-11)). Contracting authorities may decide not to apply the resilience criteria if the net-zero technology can under fair procurement conditions only be provided by a single supplier if no suitable tenders have been submitted in similar procurement procedures in the past two years or if the application would result in disproportionate equipment costs (defined as an estimated cost difference above **20%**). Moreover, the criteria may not conflict with international trade agreements, i.e., supply from countries that have entered such agreements with the EU is excluded.

[4] European Union (2024a). Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724.

2.2 Renewable Energy Support Auctions

In its Article 26, the NZIA defines similar criteria for **auctions supporting the deployment of renewable energies**. First, this includes the application of specific types of pre-qualification criteria (Article 26(1)). When designing renewable energy support auctions, the list of pre-qualification criteria applied by Member State Projects shall include preconditions on responsible business conduct, the maintenance of cyber and data security as well as ability to deliver the project fully and on time. Moreover, criteria for the auction's sustainability and resilience contribution, which could take the form of pre-qualification criteria or of award criteria.

The NZIA itself is defining some basic preconditions (Article 26(2)). Accordingly, criteria shall be objective, transparent and non-discriminatory. In analogy to public procurement procedures (see Subsection 2.1), the provision of **more than 50%** of a net-zero technology or of its main specific components by a single third country shall be applied as a yardstick for the resilience criterion. Detailed criteria are spelled out in an Implementing Act.[5] If the dominance threshold is surpassed, bids must source both the finished product and a certain number of components from alternative supply countries. In addition, if the EU's reliance on any single main component from a third country exceeds 85%, the quantity of that component originating in that third country may not exceed 85%. Thus, resilience is supposed to be achieved through a diversification of existing supply channels, not through local content requirements.

In the case of applying sustainability and/or resilience contributions as award criteria, the NZIA sets requirements for the weighting of these criteria. In the awarding decision, Member States shall give to each of the two aspects a minimum weight of **5%** and a combined weight **between 15% and 30%** (Article 26(4)). Member States can totally refrain from applying the sustainability and resilience contributions as either pre-qualification or award criterion if this application is associated with disproportionate costs. In this case, disproportionate costs are defined as an estimated cost difference of **more than 15%** (Article 26(5)).

3 The Economics of Local Content Rules

3.1 Types of Effects and Repercussions

Local content quotas have played an important role in industrial policy history as a strategic growth tool. A focus has been on developing technologies with initially low domestic manufacturing capabilities, but with strong perceived growth potential.[6] Local content quotas are one of the most rigorous tools in the industrial policy arsenal. While tariffs and other import duties attempt to compensate for the cost or quality disadvantages of domestic products through domestic pricing, thereby indirectly strengthening demand, local content quotas directly enforce a demand switch. This switch is less dependent on the degree of substitution between domestic and foreign products than in the case of

[5] European Union (2025). Commission Implementing Regulation (EU) 2025/1176 of 23 May 2025 specifying the pre-qualification and award criteria for auctions for the deployment of energy from renewable sources.

[6] Di Maio, M. (2009). Industrial policies in developing countries: history and perspectives. Industrial policy and development: The political economy of capabilities accumulation, 107-143.

tariffs. In this regard, local content quotas appear to be more effective in terms of location policy objectives.

However, the effect on demand is subject to a negative income effect. This is particularly evident when local content quotas are applied to private demand. Cost or quality disadvantages of domestic inputs initially place a burden on the competitiveness of domestic downstream industries. This is reflected in lower sales and, consequently, lower absolute demand for local inputs. Therefore, the net effect on domestic value added is unclear.[7] Above all, the risk of a negative net effect exists when local content quotas alone are insufficient to incentivize investment in domestic capacities. For instance, incentives might be undermined by a high general level of demand uncertainty for the respective product. The result would be a scarcity-induced increase in the domestic price.

Limiting local content quotas to public procurement helps to avoid direct cost risks for downstream industries. In competitive public tenders, the additional costs of fulfilling quota requirements can be passed on to the public sector in the form of higher bid prices. However, this results in opportunity costs due to increased scarcity of public funding for other purposes. The state's creditworthiness and the correlation between local content requirements and potential state revenues play an important role in the net economic balance. If the positive demand stimulus leads to higher tax revenues, this could offset the direct burden on the state budget, but such an outcome is again dependent on general market trends. The market risk is outsourced to the community of taxpayers.

Compared to price-related interventions such as tariffs or subsidies, local content requirements carry greater cost risks. This is because the magnitude of additional costs imposed on domestic buyers is not politically controlled, but subject to technology and market developments. The cost spread is thus more vulnerable to local shocks, such as domestic shortages of raw materials or rising energy costs. From a macroeconomic perspective, local content rules may distort existing patterns of specialization. For instance, introducing local content requirements in sectors where the economy is a net importer could divert domestic resources away from successful export sectors. This could undermine an efficient international division of labor based on comparative advantages.[8]

However, from a dynamic perspective, such an effect could be reversed if the technologies affected by local content requirements have a high potential for economies of scale. If local content requirements facilitate experience-based learning, they can create new specialization advantages and forms of international division of labor. In particular, this could happen in the presence of strong knowledge spillovers between domestic firms, if the knowledge spread across borders can be effectively limited or at least delayed.[9] In these circumstances, local content requirements help to internalize learning externalities, reduce productivity gaps with foreign competitors and thus increase domestic competitiveness. An additional positive global welfare effect may be increased global competition. Safeguarding the growth of new domestic suppliers through local content requirements could reduce monopoly

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[7] Grossman, G. M. (1981). The theory of domestic content protection and content preference. The Quarterly Journal of Economics, 96(4), 583-603.

[8] Kalyuzhnova, Y., Nygaard, C. A., Omarov, Y., & Saparbayev, A. (2016). Local content policies in resource-rich countries (p. 235). London: Palgrave Macmillan UK.

[9] Stiglitz, J. E. (1987). Learning to learn, localized learning and technological progress. Economic policy and technological performance, 125-153.

rents of dominant foreign suppliers in international markets.[10] This suggests limiting local content requirements to technologies in early development stage with strong economies of scale, as frontrunners are particularly likely to develop market-dominating positions under these conditions.

At the political level, potential counter-reactions from trading partners could undermine the intended effect. For example, if partners respond with own local content requirements in the same sectors, this reduces the positive demand effect by curbing export opportunities. This also reduces the likelihood of establishing new forms of international division of labor. Furthermore, such mutual isolation hinders the development of common market rules and technical standards, which are essential for establishing global markets for emerging technologies.[11] In the worst case, local content criteria can have the opposite effect to that intended. Rather than being an instrument of technological development and modernization, they consolidate existing economic structures by dampening competition through isolation. Such a development is particularly harmful when the domestic demand potential is relatively low compared to export markets.

Much of the empirical literature focuses on local content rules as an industrialization tool in developing economies. The long-term impact of such rules in countries with a higher level of technological development has not been adequately researched yet. This is particularly true in the field of green technologies. Experience from strategies in countries like China are difficult to generalize, given their very specific institutional framework.[12] Among the existing studies, there appears to be a consensus that, from a risk perspective, a gradual approach is preferable when introducing local content criteria. Initial local content quotas should be set low and increased slowly over time.[13] Furthermore, the introduction should initially be limited to a few technologies and production steps, ideally those in which the domestic economy already has a certain degree of know-how and production capacities.[14]

The literature highlights the dangers of creating artificial scarcity of products, particularly when local content rules are implemented in isolation rather than as part of a coordinated package of measures. Evidence suggests that introducing financial support schemes alongside local content requirements is key to create sufficient investment incentives in domestic capacities.[15] For example, this would be the case with local content rules linked to public tenders and funding programs, as envisaged by the Commission. In principle, the literature makes it clear that local content rules can only be assessed on a case-by-case basis, given the critical role of technology-specific growth potentials.

10 Kuntze, J. C., & Moerenhout, T. (2012). Local Content Requirements and the Renewable Energy Industry-A Good Match?. Available at SSRN 2188607.

11 Erzurumlu, S. S., & Erzurumlu, Y. O. (2013). Development and deployment drivers of clean technology innovations. The Journal of High Technology Management Research, 24(2), 100-108.

12 Oh, S. Y. (2021). China's race to the top: regional and global implications of China's industrial policy. World trade review, 20(2), 169-185.

13 Lewis, J. I., & Wiser, R. H. (2007). Fostering a renewable energy technology industry: An international comparison of wind industry policy support mechanisms. Energy policy, 35(3), 1844-1857.

14 Scheifele, F., Bräuning, M., & Probst, B. (2022). The impact of local content requirements on the development of export competitiveness in solar and wind technologies. Renewable and Sustainable Energy Reviews, 168, 112831.

15 Veloso, F. (2001). Local content requirements and industrial development: economic analysis and cost modeling of the automotive supply chain (Doctoral dissertation, Massachusetts Institute of Technology).

3.2 Justification in the Context of the Green Transition

The green transition requires access to a variety of hard-to-substitute resources (raw materials, skills, technologies).[16] These are only partly available within the EU. External sourcing creates risks in the form of unilateral dependencies on dominant supplier countries and exposure to global supply chain shocks. Avoiding such supply chain risks is alone not a sufficient reason for introducing local content criteria. Managing supply chains risks is the prime responsibility of the companies involved and is part of the general entrepreneurial risk assessment. A justification requires that benefits of switching to domestic content extend beyond the actors in the supply chain. As discussed above, this can be the case when domestic production creates strong and spatially bounded learning effects. Under these conditions, demand-side promotion can lead to productivity gains in domestic production that would otherwise not be sufficiently reflected in the procurement decisions of individual companies.

Another form of externality can be seen in the reduced risk of economic coercion from foreign supplier countries. The partial re-Europeanisation of production capacities for critical goods reduces the economic leverage of third countries in relation to the EU. This increases the EU's technological sovereignty by reducing its dependence on foreign resources when choosing technology paths. In this sense, the initial cost of switching to more expensive domestic products can be viewed as a necessary 'sovereignty premium'. This reflects the fact that, in recent years, international economic policy has clearly not purely followed a market logic, but has increasingly become an instrument of geopolitical power interests, even at the expense of losses in global prosperity.[17] When politics takes precedence over economics, the EU might need instruments to create a balance of power. Ideally, raising the economic costs will increase internal political pressure within third countries, which forces them to revert to economically rational policies.

However, this view does not give carte blanche for market segmentation. In order to be a credible countermeasure against external dominance, "Buy-European" rules must be part of a balanced growth strategy. In the context of the green transition, this requires a smart focus on green technologies with a broad range of applications and high potential for specialized knowledge creation. Furthermore, the positive pull effects of increased demand for domestic production must not be undermined too severely by negative purchasing power effects resulting from higher domestic manufacturing costs. Against this backdrop, Section 4 examines the economy-wide effects of local content rules for four key green technologies (electrolysers, heat pumps, lithium-ion batteries and PV modules) on value added in the EU27.

[16] Wolf, A. (2023). Strategic resource partnerships. cepInput No.4/2023.

[17] Bosone, C., Dautović, E., Fidora, M., & Stamato, G. (2024). How geopolitics is changing trade. ECB Economic Bulletin, 2(2024), 49-54.

4 Analysis of Demand Potential

4.1 Methodology

From an economic perspective, introducing binding 'Union content' criteria could contribute to the improved utilization of existing domestic production capacities and provide incentives for capacity expansion. Sectors not directly affected by the criteria could indirectly benefit through increased demand for domestic intermediate goods. However, unlike a general increase in consumer spending, the macroeconomic impact of the demand shock is not straightforward. This is because it results from the forced substitution of imports with domestic goods, which causes additional costs that reduce purchasing power, at least in the short term. In principle, this holds regardless of whether the Union content criteria are enforced through requirements placed on the private (burden on downstream companies and final users) or public (burden on government budgets) sectors.

We examine these demand-side effects below using an adjusted form of Input-Output-Analysis (I-O-Analysis). Demand-side I-O-Analyses are a well-established and widely used tool for measuring the direct and indirect effects of changes in demand on overall economic value added and employment. Based on official Input-Output-Tables (I-O-Tables), they depict the economic structure of Member States in a relatively high resolution. To apply them to the analysis of demand effects in green technologies, however, the available tables must be adapted. This is because zero-emission technologies span several sectors of the official economic classification. The level of sectoral aggregation is also too high to identify individual transformation industries, such as battery production.

We use the latest (2023) version of the I-O-Tables published in the Eurostat Figaro database as a basis.[18] Here, sectors are differentiated according to the two-digit level of the NACE classification (economic divisions). The net-zero technologies defined by the EU as strategically important in the NZIA are primarily found in the 'Electric equipment' and 'Machinery and equipment' sectors. To delineate net-zero technologies within these sectors, we combine data from the EU-wide I-O-Table with microeconomic cost analysis results for selected technologies. Our focus is on four technologies that play a key role in the green transformation and are subject to intense global competition: electrolysers, heat pumps, lithium-ion batteries and PV modules (see the next subsection for a discussion of their specific economics).

Through a literature review, current analyses of cost structures, demand and capacity forecasts, and cost differences between European and external production are evaluated for each of the four technologies. These analyses then formed the basis for adapting the official I-O-Table. Each technology is defined as a subsector and is separated from the other parts of the super-sectors 'Electric equipment' and 'Machinery and equipment n.e.c.', creating a total of four additional columns and rows in the I-O-Table. The production values of the subsectors (column totals) are calculated by multiplying the EU-wide production volumes by the production value per unit. Production volumes are determined by multiplying the expected domestic demand by the domestic self-sufficiency quota. The production

18 Eurostat (2026). ESA supply, use and input-output tables. Database.

value per unit is calculated by adding the estimated unit costs of domestic production, a profit markup, and indirect taxes.

The results of external microeconomic cost analyses are used to calculate the input mix for green technology production, i.e. how production values are distributed among individual cells in the sector columns. Estimated cost shares for intermediates, production equipment and labor are updated based on current market prices, then aggregated at sector levels in the I-O-Table. Material-specific estimates of current import reliance are used to allocate material use to domestic and imported inputs, in line with the basic scenario assumptions (see below). Cost analyses in the literature typically do not provide profit markup estimates or only make very rough assumptions about markup rates. The average markup rate is highly dependent on competitive structures and is therefore subject to significant fluctuations, particularly in the case of new green technologies. We estimate profit markups based on the markups shown in the I-O table for the top-level sectors 'Electric equipment' and 'Machinery and equipment n.e.c.'.

Specific 'Union Origin' scenarios are then defined to calculate demand shocks. The target year is 2030. This year is important as it is used as a reference point for the EU's medium-term production and installation targets (RePowerEU[19], NZIA[20]). According to current project plans, the EU's internal manufacturing capacities for the technologies under consideration should also have increased significantly by then. The next step is to decide which stages of green technology production the 'Union Origin' requirements apply to. In line with the Commission's approach favored in its proposal for the IAA, we do not consider 'Union Origin' in its most radical form, i.e. complete EU sourcing of all inputs, including raw material extraction and processing. This is because the technologies under consideration depend on a large number of critical mineral raw materials (including lithium, cobalt and platinum), for which the EU currently possesses almost no mining and processing capacity. Given the lengthy approval processes involved, it is unrealistic to expect significant mining capacities to be established by 2030. Instead, we consider the effect of '100% EU' content in the final assembly stages and production of the essential direct intermediates of the technologies in all scenarios (see Table 2 in Subsection 4.3 for a technology-specific presentation).

We examine the policy implications based on the currently expected demand trends for the green technologies until 2030. We compare a situation in which technology manufacturing would feature 100% EU content with a situation in which import quotas would remain at today's level. The effects calculated thus correspond to the pure effect of a demand switch to domestic production for the year 2030. They may not be confused with the effects triggered by the general increase in demand for green technologies over the period up to 2030.

[19] European Commission (2022). REPowerEU Plan. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions COM(2022) 230 final.

[20] See European Union (2024a).

We consider the following three types of effects[21]:

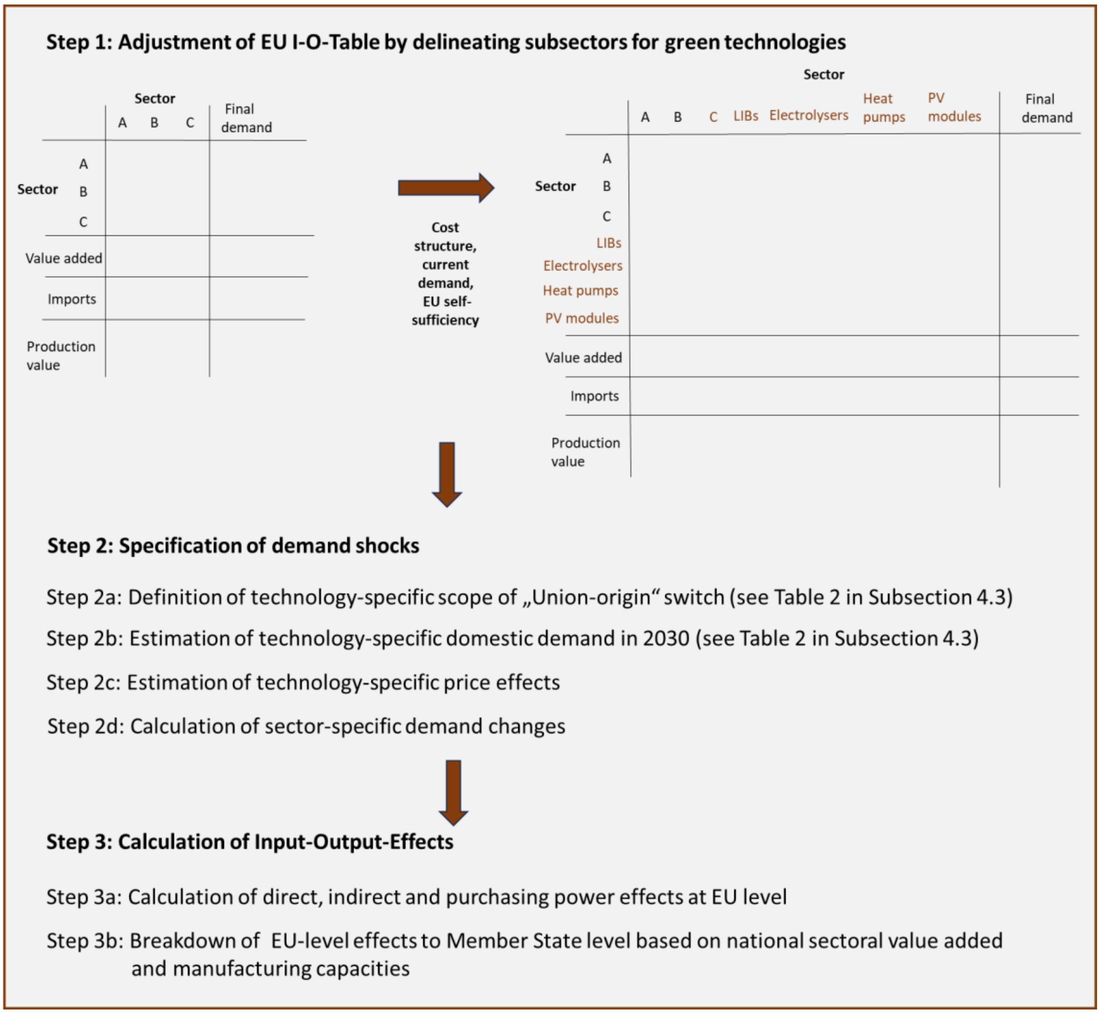
- **Direct demand-pull effect** (backward linkage I): Positive effect of green technology deployment on demand in the domestic sectors electrolyser, heat pump, lithium-ion battery, and PV module manufacturing.
- **Indirect demand-pull effect** (backward linkage II): Positive effect of increased input needs of electrolyser, heat pump, lithium-ion battery, and PV module manufacturing on demand in other EU sectors.
- **Purchasing power effect**: Negative effect of increased procurement costs for green technologies on final demand in other EU sectors.

The first two effects reflect the direct and indirect effects of traditional demand-side I-O-Analyses. Beyond the sectors concerned, they consider the positive multiplier effects on other sectors of the EU economy, depending on their degree of input-output interdependence with green technologies. We model the demand shock as a change in final demand for green technology capital goods, thus representing a change in the final demand vector.

One limitation of this approach is that it does not permit direct analysis of forward linkages, i.e. the influence of '100% EU' content on the cost performance downstream sectors that use green technologies. Nevertheless, in order to account for at least the negative effects of a cost increase on final demand, a correction factor for domestic final consumption is introduced. It reflects the loss of purchasing power resulting from higher prices for procuring green technologies. To this end, we first estimate the additional costs of 100% EU content compared to the current procurement mix for green technologies. Current cost comparisons between the EU and major importing countries (see Subsection 4.3) form the basis of this analysis. This procedure is based on the assumption that switching to EU origin would have no impact on the overall savings rate or the import ratio in other sectors.

[21] The formula for calculating the total net effect on sectoral output value is: $\Delta X \equiv (I - A)^{-1} \cdot \Delta Y$. I is the unity matrix, A is the matrix of coefficients of the adjusted I-O-Table and ΔY is the net change in the final demand vector caused by the demand switch (positive effect on entries in sectors "lithium-ion batteries", "electrolysers", "heat pumps" and "PV modules") and by the reduction in purchasing power (equi-proportional negative effect on entries in all remaining sectors). The effects on output values are translated into the value-added effect by assuming an unchanged sectoral value-added intensity.

Figure 1: Steps in I-O-Analysis of value-added potential



Source: own illustration

Such a setting is compatible with the instruments envisaged by the Commission in the Industrial Accelerator Act: local content rules for public procurement and public support programs.[22] This is because the additional costs directly burden national budgets, which should sooner or later result in lower public demand (cuts in other government spending) and/or private demand (higher tax burden). Beyond this, we do not make any specific assumptions about the policy impulse behind the switch to Union origin.

The calculated effects at EU level are then transferred to estimates at the country level. The distribution of direct effects is based on the existing or planned manufacturing capacity of green technologies in each Member State. The distribution of indirect and purchasing power effects in other sectors is based on the current value-added shares of member states in the respective sectors. Figure 1 summarizes the calculation steps.

[22] See European Commission (2026).

4.2 Technologies

4.2.1 Lithium-Ion Batteries

Among the existing energy storage technologies, Lithium-Ion Batteries (LIBs) have in recent years turned out to become the dominating option for a wide range of applications.[23] Besides their presence in personal electronic devices, global market growth was primarily driven by surging demand of the energy sector. Their use cases comprise both small-scale solutions for Electric Vehicles (EVs) and home storage (in combination with PV) and large-scale stationary storage. In this way, LIBs are a cornerstone of Europe's green transformation, ensuring an efficient matching of energy demand with volatile supply from renewables. Their key advantages compared to previous storage technologies are their high energy density, robustness and long lifetime. Moreover, persistent global market growth has created strong scale economies and continuous R&D efforts, leading to estimated manufacturing cost reductions by 90% over the period from 2010 to 2023.[24] For the medium-term future, promising recent innovations like sodium-ion batteries are still assessed to be several years away from commercialization.[25] increasing needs to balance out fluctuating energy supply in the course of the green transition thus promise a further steady increase in global demand, making access to LIBs of critical importance for Europe. The IEA expects global demand to rise by a factor of at least 4.7 over the period 2023 to 2030.[26]

For Europe, medium-term projections expect demand growth to reach a similar magnitude. Fraunhofer ISE (2023) projected annual European demand to grow from about 150 GWh battery capacity in 2022 to 550 GWh in 2028.[27] A more recent projection by RolandBerger (2025) expects European demand to increase to 900 GWh by 2030 and 1.5 TWh by 2035, mostly driven by the application in light vehicles.[28] In our estimations, we will use these values as future anchor values for a linear extrapolation of European demand.

The current global supply chain of LIBs is highly complex and characterized by strong geographical concentration of specific supply chain stages. In general, production steps can be differentiated into raw material mining, raw material refining, manufacture of chemical composites for anodes and cathodes (active material synthesis), manufacture of battery cell components (anodes, cathodes, electrolytes, separators), cell assembly and integration into battery packs. The biggest heterogeneity between different types of LIBs concerns the chemical composition of the cathode and thus the related raw material needs. Besides lithium, the currently dominating types Nickel-Manganese-Cobalt (NMC) and Lithium-Iron-Phosphate batteries depend on a set of additional critical minerals. In the case of NMC

[23] Ngoy, K. R., Lukong, V. T., Yoro, K. O., Makambo, J. B., Chukwuati, N. C., Ibegbulam, C., ... & Jen, T. C. (2025). Lithium-ion batteries and the future of sustainable energy: A comprehensive review. Renewable and Sustainable Energy Reviews, 223, 115971.

[24] Anderson, M.C. (2024). The 90% drop: How EV battery costs plummeted over 15 years. Battery Tech Online.

[25] Yadav, P., Shelke, V., Patrike, A., & Shelke, M. (2023). Sodium-based batteries: development, commercialization journey and new emerging chemistries. Oxford Open Materials Science, 3(1), itac019.

[26] IEA (2024). Batteries and secure energy transitions. World Energy Outlook Special Report. International Energy Agency.

[27] Fraunhofer ISI (2023). Lithium-Ion battery roadmap – Industrialization perspectives toward 2030. Report. Fraunhofer Institute for Systems and Innovation Research.

[28] Roland Berger (2025). Battery industry in Europe at a crossroads. Roland Berger Analysis.

batteries, both cobalt, manganese and nickel are considered critical raw materials by the EU.[29] Except for nickel, current supply routes of these materials are heavily controlled by China. In particular, this concerns the stage of mineral refining. Moreover, China has also gained a dominant position as a production location for anodes and cathodes as well as for the subsequent cell assembly.[30]

The EU's current external dependence also extends to cell component production and assembly, albeit to a shrinking degree. Jugé et al. (2025) estimate that current domestic battery manufacturing capacity reached a level of 251 GWh, while total battery deployment (stationary storage + vehicles) in 2024 is estimated at 410 GWh.[31] Link et al. (2025) consider a 90% EU self-sufficiency in batteries by 2030 feasible, but far from being certain.[32] A main hurdle towards European autarky is seen in structural cost disadvantages compared to incumbent producers in China. Roland Berger (2025) estimates average cost discrepancies of 21% for LPF cells and 13% for NMC cells between a full EU supply chain and imported battery cells from China.[33]

4.2.2 Heat Pumps

Due to their high efficiency and technical maturity, heat pumps are considered the key technology for the decarbonization of heating. By integrating electricity from renewable sources into the buildings sector, they can bring about an end to the dependence on fossil fuels through sector coupling. Moreover, their role is not limited to building heat. They also represent a suitable heat source for a wide range of industrial applications. For these reasons, the Commission makes specific reference to heat pumps in their RePowerEU-Plan, formulating the target that the amount of newly installed heat pumps doubles every four years, adding 60 million additional units to the existing stock of heat pumps.[34]

At the global level, the IEA predicts heat pumps to meet 20% of heat consumption in buildings by 2030, in particular due to strong market growth in China and Europe.[35] In the EU, the heat pump market is expected to recover after a strong short-term drop in sales in 2023 and 2024 caused by policy uncertainty. Growth will be stimulated by a combination of rising CO_2 prices and more flexibility of Member States in providing state aid to support investments. However, due to the recent slowdown, reaching the EU medium-term installation targets seems unlikely. The European Heat Pump Association predicts the total EU heat pump stock to reach only 45 million units in 2030.[36]

[29] European Union (2024b). Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020.

[30] Fraunhofer ISI (2025). Competitive market for battery materials: Market leaders, technologies and cost analysis. Battery Update.

[31] Jugé, M., U. Keliauskaitė, B. McWilliams and S. Tagliapietra (2025) 'Europe has a solid basis for battery and electric vehicle manufacturing growth', Analysis, 16 December, Bruegel.

[32] Link, S., Schneider, L., Stephan, A., Weymann, L., & Plötz, P. (2025). Feasibility of meeting future battery demand via domestic cell production in Europe. Nature Energy, 10(4), 526-534.

[33] See Roland Berger (2025).

[34] European Commission (2022). REPowerEU Plan. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. SWD(2022) 230 final.

[35] IEA (2025a). Renewables 2025 – Analysis and forecasts to 2030. International Energy Agency.

[36] EHPA (2024). EU could end up 15 million heat pumps short of 2030 ambition. European Heat Pump Association.

While being highly specific in detail, current commercial heat pump systems share the same basic components: a pump, a condenser, an evaporator, a refrigerant and an expansion valve. The pump itself is made of similar raw materials as conventional gas and oil boilers, mostly of reinforced steel. The condenser and the evaporator consist of many small tubes made of alloyed steel, copper or aluminium. Moreover, improving the energy efficiency of heat pumps requires the incorporation of electronically controlled motors. These involve the additional use of semiconductor material.[37] In all, the complexity of heat pump design entails a dependence on a wide range of partly critical raw materials (especially copper) as well as on highly specialized skills for production and installation.

Compared to other critical green technologies, external dependency of the EU is limited, thanks to a well-established domestic manufacturing base. The European Commission estimates the share of domestic producers in the European market at 73%. [38] However, significant import dependencies are reported for the manufacturing of several key components such as the compressor, the electronic control system and microchips.[39] At the global level, compressor production shows a high degree of geographical concentration, with China accounting for about 95% of compressors produced worldwide in 2023 according to IEA figures.[40] Moreover, cost advantages of producers in other parts of the world also put increasing pressure on the European heat pump pressure. The IEA estimates that on a per kilowatt basis, it is 40-60% cheaper to manufacture an air source heat pump in China than in the EU.[41]

4.2.3 Electrolysers

Hydrogen produced through water electrolysis by means of renewable sources creates the opportunity to decarbonize emission-intensive hard-to-abate sectors like steel and parts of the chemical industry. For this reason, it has become an indispensable building block of the EU decarbonization strategy. For the period until 2030, the EU has formulated the goal of producing 10 million tonnes of renewable hydrogen domestically. To achieve this quantity, the EU estimates the need to install 40 GW of electrolysis capacity by 2030. At the same time, it aims to strengthen the domestic manufacturing base for electrolysers through an electrolyser partnership with the industry founded in 2022. Estimates of the evolution of electrolyser deployment in the EU show a high degree of variation between different project datasets, mostly due to discrepancies in the expected starting datasets of large-scale projects. Estimates for installed capacities at the end of 2025 range between 514 MW and 800 MW. The gap widens for medium-term projections. For 2030, existing projections of deployed capacity range between about 30 GW to 108 GW.[42]

The basic manufacturing process of electrolysers is similar across technologies. It consists of four main steps. The first step is the manufacturing of the essential components of electrolysis cells: the anode, the cathode and (technology-dependent) either a liquid electrolyte or a solid electrolyte membrane. The second step is the cell assembly and the third step the connection of individual cells to electrolysis

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37 Scottish Enterprise (2023). Heat pumps and heating systems components analysis.
38 European Commission (2023). Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity. Commission Staff Working Document.
39 Schäfer, S. (2025). Solar debacle as a reminder for the heat pump industry. Table.Briefings.
40 IEA (2025b). Is a turnaround in sight for heat pump markets? Commentary. International Energy Agency.
41 See IEA (2025b).
42 CETO (2025). Water electrolysis and hydrogen in the European Union. Status report on technology development, trends value chains and markets. Clean Energy Technology Observatory at the European Commission.

stacks, involving the use of spacers, gaskets, frames and plates. Finally, stacks are integrated into a single electrolysis system, including additional "balance of plant" components like cooling devices, electricity connection and hydrogen processing equipment.[43]

Costs and input intensities differ by electrolyser technology. By now, three basic types of electrolysers have received the most attention commercially, distinguished by the nature of the electrolysis cells: Alkaline Electrolysis Cells (AEC), Proton Exchange Membrane Electrolysis Cells (PEMEC) and Solid Oxide Electrolysis Cells (SOEC). The AEC technology is the oldest method of water electrolysis. It requires low investment per kW, since no expensive metals are used in its construction, and it is durable. However, the conversion efficiency (i.e. amount of electricity needed per kg of hydrogen produced) is relatively low and operations are not very flexible. Operating costs are thus relatively high. PEMEC technology achieves higher efficiencies and is more flexible in operation. However, the use of precious metals such as platinum and iridium in production raises purchasing prices. The SOEC-technology is currently the least mature technology, operating in high-temperature mode.[44]

Due to the absence of official trade data for water electrolysers, the market position of European manufacturers is difficult to assess. Regarding global production capacities, China is dominating the scene, accounting for more than half (34.7 GW) of the global capacities. The initial aim of the EU electrolyser partnership was to raise the annual EU electrolyser manufacturing capacity from 2.5 GW in 2022 to 17.5 GW in 2025. In May 2025, about 10 GW capacity was operational. Estimates of current EU supply chain dependencies by the JRC point to the strongest import dependencies (> 95%) in the initial stage of raw material access. This dependency is focused on two countries: South Africa as a supplier of iridium and platinum needed for PEM electrolysers and China as a supplier of rare earths used by the SOEC technology. EU external sourcing also dominates in the stage of processed materials, with the US and China as main suppliers. In the downstream parts of the supply chains, EU external dependence is significantly lower, but still substantial. It is estimated as 65% in the production of components (cells, stacks, auxiliary components) and 50% in final assembly, with the US, Japan and China as the most important external suppliers.[45]

IEA estimates of the cost gap in electrolyser deployment indicate a strong cost advantage of China. However, this is largely due to the lower planning and installation costs for electrolysers installed in China. When comparing electrolysers installed in Europe of Chinese and of European origin, the average deployment cost discrepancy across the IEA scenario range amounts to 19.5%. For the near-term future, the IEA sees a potential for manufacturing costs in Europe to drop significantly, mostly due to innovation in the production of stack components. In a reference scenario, they expect total deployment costs per kW of European electrolysers to drop by 30% from 2025 to 2030.[46]

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43 Cicenergigune (2022). Electrolyzers - A manufacturing industry that everyone wants to lead.
44 Hydrogen Newsletter (2023). A comprehensive analysis on PEM vs. AEC electrolyser.
45 European Commission (2023). Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study.
46 IEA (2025c). Global Hydrogen Review 2025. International Energy Agency.

4.2.4 PV Modules

In many regions of the world, photovoltaics (PV) is the technology with the biggest potential for exploiting renewable energy potentials. At the global level, cumulative installations of PV modules have exhibited exponential growth over the past ten years. Between 2022 and 2024, installed capacities have doubled. Almost half of the global installations in 2024 took place in China. The share of the EU amounted to 18%.[47] Most recently, capacity growth in Europe has suffered a sharp slump. Growth in annual installations fell from 53% in 2023 to 4% in 2024. In 2025, the market contracted for the first time in a decade (-0.7%), mostly due to a sharp decline of the rooftop segment.[48]

As part of its RePowerEU plan, the European Commission targeted over 320 GW of newly installed EU PV capacity by 2025 and nearly 600 GW by 2030. While the 2025 target has been reached (406 GW), the 2030 target is endangered by the recent slowdown. In its current medium-term projections, the industry association Solar Power Europe expects the EU to reach only 718 GW capacity until 2030, due to the hampering effect of a combination of revenue-reducing bottlenecks like grid congestion, insufficient investments in flexibility technologies and slow permitting.[49]

The basis of electricity generation from PV technologies represents the individual PV cell. It contains semiconductor material. As chosen semiconductor material, silicon dominates the global market, with an estimated market share of 95%.[50] Before entering cell production, the crystals are cut into very thin wafers. These are further processed to form diodes and equipped with metal contacts on back and front surface, to collect the current and transfer it out of the cell.[51]

Variants of these cells are typically distinguished in two categories: monocrystalline (mono c-Si) and polycrystalline (poly c-Si) cells. Mono c-Si cells exhibit a single-crystal structure. In recent years, they have become the dominant cell technology (market share in 2023 of more than 90%)[52], mostly due to their superior conversion efficiency and thus their ability to generate a high electricity yield under increasingly though area restrictions.[53] The market share of the cheaper, but less efficient poly c-Si cells, composed of a number of small crystals, have shrunk to slightly below 5%. The remaining 5% of the global PV cells market is currently covered by the more recent thin film technologies. The currently most common types of thin film cells on the global market are cells based on Cadmium Telluride (CdTe), Copper Indium Gallium Selenide (CIGS) or amorphous silicon as semiconductor materials.[54] To achieve a sufficient generation capacity, the single solar cells are strung together, placed on a back sheet and covered with glass to form modules (or panels). Together with the inverter and mounting structure, which optimize the orientation of panels towards the sun, they form the PV system.[55]

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47 IEA (2025d). Trends in photovoltaic applications 202$. International Energy Agency – Photovoltaic Power Systems Program (PVPS).

48 Solar Power Europe (2025). EU Solar Market Outlook 2025-2030.

49 See Solar Power Europe (2025).

50 VDMA (2023). International Technology Roadmap for Photovoltaic (ITRPV) 2022 Results.

51 Energy.gov (2024). Solar Photovoltaic Technology Basics. US Office of Energy Efficiency & Renewable Energy.

52 Fraunhofer ISE (2024). Recent Facts about Photovoltaic in Germany. Version of 3.4.2024. Fraunhofer Institute of Solar Energy Systems.

53 See Energy.gov (2024).

54 Fraunhofer ISE (2024). Recent Facts about Photovoltaic in Germany. Version of 3.4.2024. Fraunhofer Institute of Solar Energy Systems.

55 See Energy.gov (2024).

The current international supply chains are characterized by a strong dominance of producers from East Asia, mostly from China. This starts with the primary stages of natural resource extraction and processing (e.g. crystallization of silicon). While future resource needs will be subject to the uncertain technological development, it is clear that silicon and gallium will remain essential for the time to come.[56] According to the US Geological Survey (USGS), China is a dominant producer of both materials, accounting in 2023 for global production shares of 79% and 98%, respectively.[57] In the subsequent steps of wafer production, cell production and module assembly, China has continuously expanded its leading position over the past decades. According to IEA estimates, China reached in 2024 global production shares of 97% in wafer production, 90% in cell production and 86.5% in module production. The accumulated shares of European countries were in all three segments below 1%. The European share in module production further declined in the past years.[58] Almost all of the remaining module manufacturers possess only a small production capacity (< 1 GW). Moreover, there is no active firm capacity in the segment of wafer production.[59]

According to UN Comtrade data, this resulted in 2024 in an EU trade deficit for PV modules and components of about 11.3 billion Euros compared to the rest of the world. About one billion Euros exports stood against 12 billion Euros imports from third countries. 98% of imports came from China, which mostly consisted of the final product, i.e. assembled PV modules.[60] This further highlights China's tight grip on the whole supply chain. Against this background, the European Solar PV Industry Alliance (ESIA) has formulated the goal to reach 30 GW of committed European manufacturing capacity by 2025 across all PV value chain segments (polysilicon, ingots, wafers, cells, modules, recycling).[61]

As part of a feasibility study for PV supply chains in Europe, the Libertas project produced detailed bottom-up estimates of comparative production costs and its components.[62] Accordingly, current total module production costs in the EU are estimated to be between 26% and 97% higher than total module production costs in China. Regarding the single production steps, the largest percentage cost discrepancies are estimated for the early production stages, i.e. silicon processing and wafer production. As explanation of Europe's significant cost disadvantage, the researchers refer to a variety of cost components. Both different components of OPEX (labour, electricity, material) and CAPEX (equipment, building) are estimated to be significantly higher than in the case of production in China.[63] For the future, learning effects could result in a reduction of the cost gap. According to estimates by Fraunhofer ISE, experience of the past 40 years indicates a learning rate of 25.7%, due to scale economies and technological improvements.[64]

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56 See Energy.gov (2024).
57 USGS (2024). Mineral Commodity Summaries. US Geological Survey.
58 See IEA (2025d).
59 Fraunhofer ISE (2025). Photovoltaics report. Fraunhofer Institute of Solar Energy Systems.
60 UN Comtrade (2026). UN Comtrade Database. Relevant HS Codes: 854142, 854143.
61 ESIA (2022). High level launch conference of the European Solar PV Industry Alliance - Joint statement. European Solar PV Industry Alliance.
62 Libertas (2024). Project Libertas.
63 ETIP (2024). PV Manufacturing in Europe: Ensuring resilience through industrial policy. White Paper. The European Technology and Innovation Platform for Photovoltaics.
64 See Fraunhofer ISE (2024).

4.3 Data

Our mixed methodological approach (see Subsection 4.1) requires data from a variety of sources. We rely exclusively on public sources, i.e., official statistics, public industry reports, and the results of published research papers. The basic framework is provided by the latest version of the I-O-Table for the EU27 published by Eurostat in the Figaro Database (year 2023).[65] In order to harmonize this data with the latest production and cost data for green technologies, the table values are scaled up to the year 2025, using EU27 real GDP growth in 2024 and 2025 as scaling factors. Technology-specific data on the input mix, unit costs, domestic installation rates, import reliance, and the EU import cost discrepancy are required to modify the I-O-Table and calculate demand shocks. Cost data for raw and processed materials are updated where necessary by referring to current market prices. The unit costs taken from the literature are estimated for specific plant capacities which are considered characteristic at the time of the study. Given the presence of economies of scale, these capacity assumptions are potentially critical (see discussion in Subsection 4.5).

The microeconomic cost analyses used to determine the input mix define inputs partly at a higher and partly at a lower level of aggregation than the I-O-Table. In the former case, the cost estimates are aggregated to the level of the I-O-Table. In the latter case, the cost estimates are divided among the relevant cells of the I-O-Table based on the cost shares of the cells in the corresponding upper sectors “Electric equipment” and “Machinery and equipment n.e.c.”. Table 1 provides an overview of the data sources and Figure 2 the vertical delineation of the “Union-origin” switch for the technologies considered.

The sub-sector “Electrolyser manufacturing” comprises the industrial production of electrolyser stacks (production of electrolysis cell components, cell assembly, connection of cells to stacks). The cost situation of PEM technology is used as a reference technology due to its high medium-term potential for widespread use.[66] The manufacture of the other BoP components of an electrolysis system is not included here due to a lack of available cost data. The sub-sector “Heat pump manufacturing” comprises the manufacturing of the basic components (pump, condenser, evaporator, refrigerant, expansion valve) and their assembly. The reference technology is air-source heat pumps. The sub-sector “lithium-ion battery manufacturing” comprises the production steps of active material synthesis, manufacture of cell components (anodes, cathodes, electrolytes, separators) and cell assembly. The input mix is calculated as the average of estimates for NMC (nickel manganese cobalt) and LFP (lithium iron phosphate) technology. The sub-sector “PV module manufacturing” comprises the production steps of wafer manufacturing, cell conversion, and module assembly. The reference technology is monocrystalline modules.

[65] See Eurostat (2026).
[66] RWTH Aachen (2023). Hydrogen economy: PEM highlights potential of electrolyzer systems.

Table 1: Overview on data sources

Technology	Indicator(s)	Source	Technology	Indicator(s)	Source
Electrolysers	Input mix	Krishna et al. (2023)[67]: PEM electrolyser	**Lithium-ion batteries**	Input mix	Orangi et al. (2024)[68]: Average of 8 LIB technologies analyzed
	Import reliance: Inputs	JRC (2023)[69], Eurostat (2026)		Import reliance: Inputs	JRC (2023), Eurostat (2026)
	Raw material prices	Trading Economics (2026)[70], Investing.com (2026)[71]		Raw material prices	Trading Economics (2026), Investing.com (2026)
	Import reliance: Final product	JRC (2023)		Import reliance: Final product	Jugé et al. (2025)
	Unit costs EU	IEA (2025c)		Unit costs EU	Roland Berger (2025)
	Price discrepancy Domestic vs. Imports	IEA (2025c)		Price discrepancy Domestic vs. Imports	Roland Berger (2025)
Heat pumps	Input mix	Shamoushaki & Koh (2024)[72]: Air-source heat pump	**PV modules**	Input mix	Woodhouse et al. (2019)[73]: Monocrystalline technology (values for Germany)
	Import reliance: Inputs	JRC (2023), Eurostat (2026), Eurosteel (2025)		Import reliance: Inputs	JRC (2023), Eurostat (2026)
	Raw material prices	Trading Economics (2026), Investing.com (2026)		Raw material prices	Trading Economics (2026), Investing.com (2026)
	Import reliance: Final product	European Commission (2023)		Import reliance: Final product	JRC (2023)
	Unit costs EU	IEA (2025b)		Unit costs EU	Libertas (2024)
	Price discrepancy Domestic vs. Imports	IEA (2025b)		Price discrepancy Domestic vs. Imports	Libertas (2024)

Source: own depiction

67 Krishnan, S., Koning, V., de Groot, M. T., de Groot, A., Mendoza, P. G., Junginger, M., & Kramer, G. J. (2023). Present and future cost of alkaline and PEM electrolyser stacks. International journal of hydrogen energy, 48(83), 32313-32330.
68 Orangi, S., Manjong, N., Clos, D. P., Usai, L., Burheim, O. S., & Strømman, A. H. (2024). Historical and prospective lithium-ion battery cost trajectories from a bottom-up production modeling perspective. Journal of Energy Storage, 76, 109800.
69 JRC (2023). Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study. JRC Science for Technology Report. Joint Research Centre at the European Commission.
70 Trading Economics (2026). Commodities.
71 Investing.com (2026). Commodity prices.
72 Shamoushaki, M., & Koh, S. L. (2024). Net-zero life cycle supply chain assessment of heat pump technologies. Energy, 309, 133124.
73 Woodhouse, M., Smith, B., Ramdas, A., Margolis, R. (2019). Crystalline Silicon Photovoltaic Module Manufacturing Costs and Sustainable Pricing: 1H 2018 Benchmark and Cost Reduction Roadmap. US National Renewable Energy Laboratory.

Figure 2: Vertical delineation of “EU Origin” switch by technology

Supply chain stage	Lithium-ion batteries	Electrolysers	Heat pumps	PV modules
Raw material extraction	Not included	Not included	Not included	Not included
Raw material refining	Active material synthesis			
Component manufacturing	Anodes, cathodes, electrolytes, separators	Electrolysis cell components	Pump, condenser, evaporator, refrigerant, expansion valve	Wafer, cell conversion
Final assembly	Cell assembly	Cell assembly, connection of cells to stacks	Heat pump assembly	Module assembly

Source: own illustration

The magnitude of the demand shocks included in the calculation depends on the expected medium-term installation rates and is therefore inherently uncertain. We reflect this uncertainty by comparing two scenarios: a benchmark scenario based on current literature forecasts for expected installation rates in 2030, and an optimistic scenario that assumes stronger increases in demand and is largely based on the EU's 2030 targets. Table 2 compares the scenarios considered.

Table 2: Description of projection scenarios

Technology		Installed capacities in 2024/25	Installed capacities in 2030: Benchmark Scenario	Installed capacities in 2030: Optimistic Scenario
Electrolysers	Value	450 MW (2025)	2.10 GW	7.91 GW
	Source	EHO	Hydrogen Europe	EU goal
	Remark	-	*Linear interpolation of total capacity forecast 2030 (15 GW)*	*Linear interpolation of total capacity goal 2030 (40 GW)*
Heat pumps	Value	2.3 million units (2024)	3.25 million units	5.75 million units
	Source	EHPA	EHPA	EU goal
	Remark	-	*Linear interpolation of total capacity forecast 2030 (45 mill. units)*	*Linear interpolation of total capacity goal 2030 (60 mill. units)*
Lithium-ion batteries	Value	410 GWh (2024)	1100 GWh	1300 GWh
	Source	Jogé et al. (2025)	Link et al. (2025)	Link et al. (2025)
	Remark	-	-	-
PV modules	Value	65.1 GW (2025)	62.4 GW	68.8 GW
	Source	Solar Power Europe	Solar Power Europe	EU goal
	Remark	-	*Linear interpolation of total capacity forecast 2030 (718 GW)*	*Linear interpolation of total capacity goal 2030 (750 GW)*

Source: own representation

4.4 Results

4.4.1 Effects at EU Level

Table 3 first shows the magnitude of the initial demand shocks for the individual technologies, broken down by benchmark and optimistic scenario. Lithium-ion batteries are estimated to have by far the strongest positive impact on demand. The switch to 100% EU origin for the manufacturing stages covered increases demand for domestic battery production in 2030 by an estimated EUR 88 billion in the benchmark scenario and EUR 104 billion in the optimistic scenario. These high figures result from the broad range of applications for the technology and the current high dependence on imports. Demand effects in the double-digit billion range are also estimated for PV modules. Due to the smaller application area and the restriction of the supply chain segment covered to stack production, the demand effects for electrolysers are lower, but still lie in the billion-euro range.

Table 3: Size of positive demand shocks in 2030 by technology and scenario (in billion EUR)

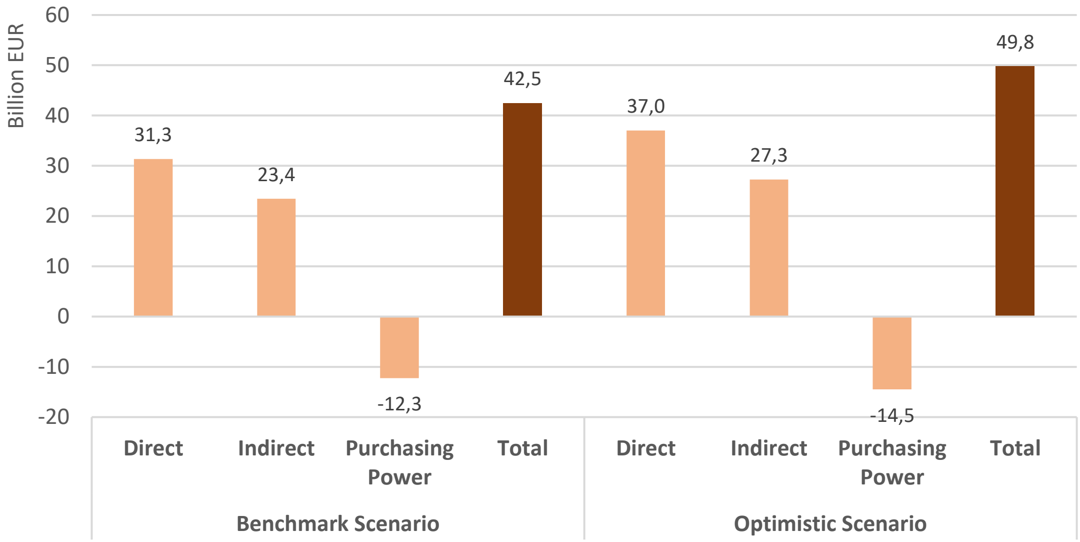
Technology	Benchmark Scenario	Optimistic Scenario
Lithium-ion batteries	58.83	69.53
Electrolysers	1.22	1.46
Heat pumps	4.14	7.32
PV modules	36.75	40.52

Source: own calculations

The introduction of the above-described demand shocks into the input-output model, followed by the subsequent calculations (see Subsection 4.1), determines the direct, indirect and purchasing power effects on the level of gross value added in the EU in 2030. Figure 3 illustrates the EU-wide effects of the benchmark and optimistic scenarios. Switching to 100% EU content would create an additional gross value added of EUR 31–37 billion in the immediately affected sectors in 2030 alone (direct effect). Due to its relatively large market size and strong growth outlook, around 50% of the direct effect in both scenarios is attributed to the battery sector. Relatively speaking, the PV module sector is expected to see by far the largest gains due to its high initial reliance on imports. Additional value added by domestic PV module producers would amount to EUR 11.4 billion in the benchmark scenario and EUR 12.5 billion in the optimistic scenario. By contrast, gains for heat pump manufacturers would amount to just EUR 1.4–2.5 billion, and for electrolyser manufacturers, EUR 380–450 million. This is partly a consequence of their significantly lower current import reliance.

The indirect value-added effects on other sectors of the EU economy caused by the increased demand for intermediates by green technology producers sum up to a magnitude of EUR 23-27 billion. Finally, the loss of purchasing power caused by the switch to high-priced domestic products results in negative economy-wide value-added effects of EUR 12-15 billion. Hence, while being substantial, the loss is clearly outweighed by the size of the positive direct and indirect effects. The resulting positive net effect reaches a level of EUR 43-50 billion (about 0.3% of the total EU27 GDP in 2024).

Figure 3: EU27 Value-added effects of a “100% EU procurement” switch in 2030



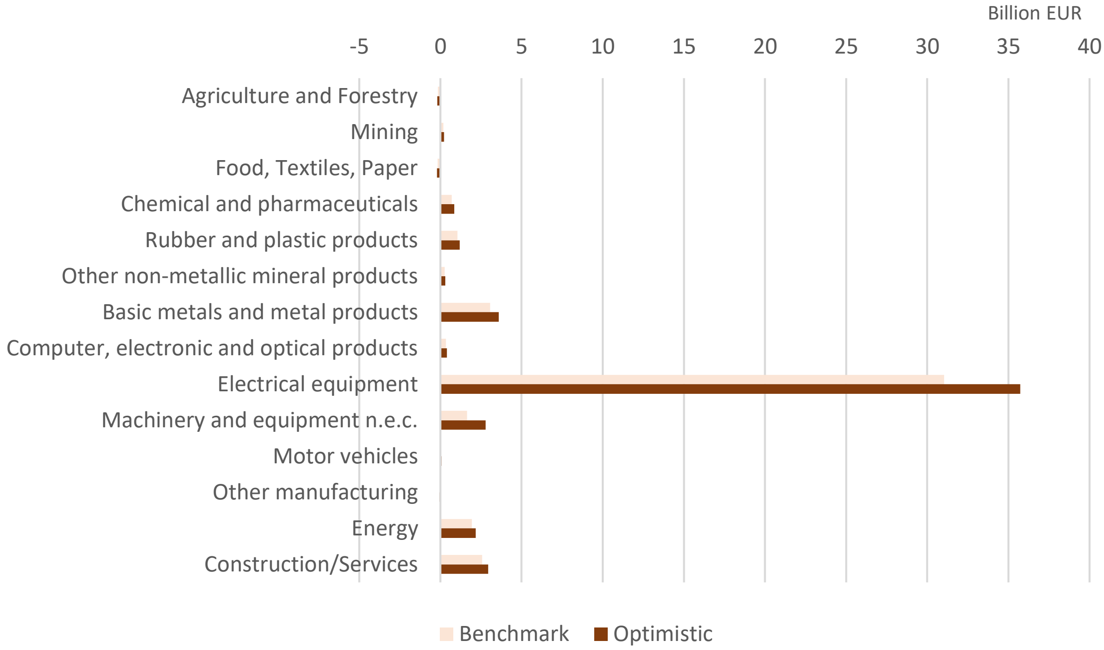
Source: own calculations

Figure 4 depicts the distribution of macroeconomic effects across economic sectors. A detailed list of the results for each sector is provided in Table A1 in the Appendix. As expected, the majority of net gains in value added are concentrated in the electric equipment sector due to the significant direct effects on battery and PV module manufacturing. Domestic basic metal producers, particularly steel and copper manufacturers (and their associated products), benefit from the resulting increase in demand for metals (e.g. copper for battery cathodes and stainless steel for heat pumps). The total effects on the services sector are also positive, albeit highly heterogeneous. The largest value-added gains are seen in wholesale trade services (between EUR 1.4 and 1.6 billion), legal and management services (between EUR 648 and 762 million), and land transport services (between EUR 472 and 552 million). Losses are estimated for the agricultural sector and parts of the low-tech industry, particularly food production.

Hence, the EU-wide macroeconomic income gains are distributed very unevenly between economic activities, with some sectors experiencing income declines. Realizing these gains will therefore require a significant internal shift of resources within the EU. This highlights the importance of identifying and overcoming potential supply bottlenecks, particularly those related to the availability of skilled workers (see the discussion below). At the same time, however, the sectoral results suggest that concerns about a 'despecialization effect' (see Subsection 3.1) appear to be unfounded, at least at a more aggregate level. The shift in demand primarily strengthens economic areas such as high-tech investment goods, in which the EU already achieves the highest net export values globally.[74]

[74] Eurostat (2025). International trade in goods.

Figure 4: EU27 Value-added effects of a "100% EU procurement" switch in 2030 by NACE sector



Source: own calculations

4.4.2 Effects at Member State Level

To estimate value added effects for specific Member States, the aggregate results for the EU27 are divided according to the economic structure at country level (see Subsection 4.1). Table 4 documents the resulting net changes in national value added (i.e. the sum of all effects) for both scenarios. Apart from Luxembourg, the estimated net effects are positive for all Member States. However, the magnitude of these effects differs considerably. In absolute terms, Germany is the biggest beneficiary, realising almost half of the EU-wide gains in value added. This is due to both its broad industrial capacity and the relative size of its high-tech segment. When viewed relative to country size, Austria, Slovenia, and the Czech Republic achieve similar value-added gains per capita. In relation to current GDP, Hungary is also among the major beneficiaries, primarily due to its substantial battery manufacturing capacities. The least benefiting countries are those with a small high-tech industrial base. France is also only expecting modest gains relative to its economic size. Overall, the positive economic effects of the demand-pull are highly concentrated in Central Europe.

Table 4: Value-added effects of a "100% EU procurement" switch in 2030 by Member State

	Absolute (Mill. EUR)		Per capita (EUR)		% GDP	
Member State	**Benchmark**	**Optimistic**	**Benchmark**	**Optimistic**	**Benchmark**	**Optimistic**
Austria	+1,841.95	+2,155.54	+201.11	+235.35	+0.37%	+0.44%
Belgium	+792.69	+925.46	+67.08	+78.32	+0.13%	+0.15%
Bulgaria	+243.59	+283.93	+37.79	+44.05	+0.23%	+0.27%
Croatia	+213.33	+247.85	+55.24	+64.18	+0.25%	+0.29%
Cyprus	+18.25	+21.06	+18.88	+21.80	+0.05%	+0.06%
Czechia	+1,684.82	+1,957.41	+154.56	+179.57	+0.53%	+0.61%
Denmark	+712.82	+833.84	+119.58	+139.88	+0.18%	+0.21%
Estonia	+92.39	+107.08	+67.21	+77.89	+0.23%	+0.27%
Finland	+825.01	+971.20	+147.22	+173.31	+0.30%	+0.35%
France	+4,048.15	+4,693.61	+58.95	+68.35	+0.14%	+0.16%
Germany	+16,155.32	+18,969.36	+193.58	+227.30	+0.37%	+0.44%
Greece	+337.56	+392.09	+32.53	+37.79	+0.14%	+0.17%
Hungary	+1,013.22	+1,180.60	+105.71	+123.18	+0.49%	+0.57%
Ireland	+283.61	+333.03	+53.00	+62.23	+0.05%	+0.06%
Italy	+4,918.67	+5,809.75	+83.41	+98.52	+0.22%	+0.26%
Latvia	+71.11	+82.33	+37.99	+43.98	+0.18%	+0.20%
Lithuania	+94.31	+109.58	+32.68	+37.97	+0.12%	+0.14%
Luxembourg	-8.73	-10.73	-12.99	-15.96	-0.01%	-0.01%
Malta	+17.06	+19.72	+30.27	+35.00	+0.07%	+0.09%
Netherlands	+1,656.68	+1,974.44	+92.33	+110.04	+0.15%	+0.18%
Poland	+2,367.67	+2,747.31	+64.65	+75.02	+0.28%	+0.32%
Portugal	+436.79	+508.50	+41.05	+47.79	+0.15%	+0.18%
Romania	+943.67	+1,092.58	+49.49	+57.30	+0.27%	+0.31%
Slovakia	+378.45	+442.25	+69.76	+81.53	+0.29%	+0.34%
Slovenia	+359.47	+416.77	+169.24	+196.22	+0.53%	+0.62%
Spain	+2,335.96	+2,720.54	+48.05	+55.96	+0.15%	+0.17%
Sweden	+623.08	+755.70	+59.05	+71.62	+0.11%	+0.14%

Source: own calculations

4.5 Discussion

The simulation results illustrate the considerable EU-wide value-added potential associated with a "Buy-European" strategy for green technologies. This potential significantly exceeds the sectors directly affected. Negative purchasing power effects associated with the switch to high-priced domestic goods reduce this demand-pull effect, but only to a minor extent. The bottom line is that, in addition to equipment producers, large parts of the rest of the EU economy can be expected to benefit as well.

One limiting factor that cannot be captured in such demand-side potential analyses is the role of supply-side constraints. Increased demand for specialized inputs for green technologies can lead to higher prices for domestic inputs, thereby increasing the opportunity costs of resource use in other sectors. This results in scarce resources being shifted away from other sectors, thereby slowing down their growth potential. The strength of this effect depends on the expected utilization rate of resources. The availability of capital depends on the extent to which planned investments in domestic production capacities are able to cover a future increase in demand resulting from “Buy-European” requirements. In this respect, there are significant differences between technologies. While current expansion plans in battery production suggest that domestic demand will be almost entirely covered by European manufacturing capacities in 2030[75], areas such as PV module production will still be far from achieving domestic self-sufficiency, due to the low initial capacities.

Another limiting constraint is the availability of skilled workers from the fields of Science, Technology, Engineering, and Mathematics (STEM). A demand-driven expansion of green technologies would not only intensify competition for engineers between different manufacturing sectors, but also between manufacturing, installation and consulting services in areas such as heat pumps. Since a medium-term shortage of STEM competencies is already predicted under current conditions[76], “Buy-European” criteria would in any case have to be accompanied by measures to promote supply.

One factor that could alleviate medium-term resource scarcity is the role of technological progress in the manufacture of green technologies. In recent years, significant cost reductions have been achieved in the production of these technologies through increased productivity, for example with a learning rate of 25% in PV module manufacturing.[77] In the medium term, expanding manufacturing activities promises further significant cost reductions in the form of static scale economies (a trend towards gigafactories with low fixed unit costs) and dynamic scale economies (new production methods, such as automation, and a switch to less scarce raw materials). Policies that promote domestic demand as a basis for rapid scaling can help to exploit experience-related efficiency potential and reduce future resource constraints on green growth. This helps to internalize the positive externalities from knowledge spillovers in green technologies, both within and beyond the affected sectors. Furthermore, if knowledge spillovers can be kept local for a period of time, this will contribute to reducing the cost gap between European and third-country producers.

However, it is very difficult to forecast future technical progress in green technologies. Current technology studies emphasize that productivity gains are far from factor-neutral. Instead, reductions in overall unit costs are accompanied by changes to the input mix. For example, this may be caused by automation (lower labor costs) or a focus on specific production steps in technology improvements (e.g. stack production in electrolyser manufacturing). When defining the scope of “Buy-European” criteria, policymakers should base their decisions on careful expert analysis of technology-specific learning potential, particularly the ability of new technologies to generate cross-sectoral knowledge gains. This selective approach could alleviate medium-term resource constraints and reduce pressure for structural change, as well as the resulting political opposition within and between Member States.

Finally, the risk of retaliatory action by third countries requires a separate investigation. “Buy-European” rules targeting high-potential green technologies would primarily affect third countries with a similar macroeconomic growth strategy to the EU. These include political rivals such as China, but also developed economies whose visions of green growth are very similar to those of the European Green Deal. While these countries are competitors, they are also indispensable partners for Europe’s diversification strategy. This concerns their capacity to supply Europe with essential raw materials and

75 See Jugé et al. (2025).
76 Business Europe (2023). Analysis of labor and skill shortages: Overcoming bottlenecks to productivity and growth.
77 See Fraunhofer ISE (2024).

expertise in green technologies, but also their role in establishing and disseminating shared technical standards and market regulations necessary to expand international sales markets for green technologies.

Therefore, any “Buy-European” requirement should involve exceptions for third countries that engage in trade agreements or more specific forms of green partnerships with the EU. This would also enable “Buy-European” policies to be used strategically in future trade talks. From the perspective of third countries, trade agreements with the EU would offer superior access to the rapidly expanding European market for green technologies compared to incumbent exporters from China and the US.

5 Policy Recommendations

Our simulations have highlighted the significant domestic income potential of introducing “Buy-European” criteria for rapidly growing green technologies. Besides creating jobs and strengthening supply resilience, the demand-based support of a domestic green manufacturing base can help to realize productivity gains and achieve technological leadership in the long-run. If designed carefully, they can become an instrument to accelerate structural change in high-tech industries, while securing demand for domestic intermediates (metals, chemicals). In this way, “Buy-European” criteria can become an essential tool to manage transitionary risks for EU supply chains on their path towards a climate-neutral post-2050 EU economy. At the same time, their use is inevitably associated with (direct and indirect) costs, while economy-wide gains depend on uncertain technology parameters and only materialize gradually. EU policymakers should thus follow a risk-oriented approach, reducing uncertainty through improvements of the information base and limiting the extent of downside cost risks for both private stakeholders and public budgets. As practical guidelines, we make the following basic recommendations:

1. Follow a growth-centered foresight approach in defining “Buy-European” rules:

“Buy-European” criteria should never be implemented in a lump-sum manner (e.g. for all net-zero technologies), but only for carefully selected technologies and parts of their supply chains. The selection of technologies should be based on a transparent, multi-criteria evaluation system including the following aspects: current market structure, existing domestic capacities and resource constraints, cost gaps to major competitors, potential for knowledge-based scale economies and potential for cross-sector knowledge spillovers. Selected technologies should be characterized by a minimum level of existing domestic technology competence, a sufficient likelihood to reach cost parity with competitors through experience-based knowledge accumulation and a high potential to spur cross-sector growth by transferring new knowledge to related economic activities. In selecting the supply chain stages to be covered, taking a realistic view on the lead time to operation for new domestic capacities is essential. For instance, given the regulatory complexities and social acceptance issues associated with critical raw material mining in Europe, the initial stage of raw material extraction should remain excluded from “Buy-European” requirements in the short-term future. Implementing an evaluation system requires the gathering of heterogeneous data sources from market reports, scientific forecast studies as well as analyses of patent data. At the same time, methodological innovation will be required to aggregate the information to meaningful indicators, e.g. measures to compare the future scaling potential of different technologies. Given its past experience in analyzing green supply chains, the JRC is best equipped to handle this challenge.

2. Limit applications to award and bonus criteria in public procurement and public support schemes:

Even when the policies are based on a scientifically sound evaluation system, uncertainty on the medium-term costs of "Buy-European"-criteria will remain. To reduce downside risks, application forms should be carefully restricted. Firstly, to prevent an unduly large cost burden on specific downstream companies, no direct obligations should be imposed on private demand. Instead, "Buy-European" criteria should be restricted to areas where costs are borne by public budgets. This is an appropriate reflection of the idea that technology sovereignty creates economy-wide benefits (productivity growth, reduced coercion potential), justifying the payment of a "sovereignty premium" by the entirety of citizens. Two application areas are essential: public procurement tenders and public support schemes for green technologies. In both cases, private actors should be able to pass on the extra costs of relying on domestic products through higher procurement prices or support premiums. Secondly, to limit cost risks for public budgets, "Buy-European" criteria should better not be defined as strict prequalification criteria, but as one of several award criteria. To achieve consistent application, a corridor of minimum and maximum weights for the relevance of such criteria should be prescribed at EU level, following the approach of the NZIA (see Section 2). Alternatively, in public support schemes, the use of local content could qualify for a pre-defined level of bonus payments, following the example of the US Inflation Reduction Act.[78] At the same time, public administrations should create transparency on the additional costs imposed by such criteria compared to conventional tender schemes.

3. Complement the demand-pull with policies to overcome supply-side bottlenecks:

Domestic resource constraints on the supply side risk to become a critical bottleneck for any demand-pull policy in the field of green technologies. Limiting this risk requires an integration of "Buy-European" requirements into an overarching growth framework tackling supply-side bottlenecks. Firstly, the lead time to operation of investments in green manufacturing capacities should be reduced through more efficient permit granting procedures. Beyond the implementation of a fast-track procedure for strategic projects defined in the NZIA, this requires binding time limits for administrative approval steps, including the application of the tacit approval principle. Secondly, the EU should address the increasing issue of skilled labor shortage through enhanced cooperation, e.g. through the development of common Master programs, the operation of specialized training centers and campaigns for the attraction of global talent. To exploit existing specialization potentials in net-zero technologies for regions with fitting industrial environment but weak investment dynamics, the EU should provide these regions with targeted support in modernizing their (tangible and non-tangible) public infrastructure. In particular, the emergence of efficient large-scale factories should be supported. To this end, the strategic policy goals set for the allocation of funds from the European Regional Development Fund (ERDF) and the EU Cohesion Fund should be supplemented by specific targets for infrastructure funding in dedicated Net-Zero Acceleration Valleys.[79]

[78] See ITA (2025).
[79] Wolf. A. (2024). Net-Zero Industry Valleys in Europe. cepStudy No. 5/2024.

4. Put forward measures to prevent technology leakage:

The long-term EU welfare impact of “Buy-European” policies will also depend on the ability to shield any resulting EU-internal knowledge gains from external competitors. Limiting outflows of critical technology knowledge facilitates the expansion of sales to global markets and thus promotes a rapid realization of further scale economies. The Economic Security Strategy is thus another essential pillar of a green technology growth framework.[80] In particular, the EU should put technology leakage risks at the heart of its monitoring policies for both inward and outward Foreign Direct Investments (FDI). Moreover, to manage the risks related to international R&D cooperation, the Commission should put forward its announced proposal for a European Research Area Act, striking a reasonable balance between fruitful research cooperation and the need to monitor technology risks in sensitive areas.[81]

5. Create fair and transparent financing schemes:

Our simulations have indicated that any positive EU-wide income effects of “Buy-European” criteria will be very unevenly distributed among Member States and economic sectors. At the same time, potential supply-side constraints and the transitory costs of reallocating workers and capital across sectors will affect the internal market as a whole. Consequently, introducing domestic content requirements as a conditionality for the EU approval of national state aid would force Member States to indirectly subsidize the EU’s industrial centers. This asymmetry is already reflected in the opposition by some Member States to the announced “Buy-European” rules. To meet this opposition and avoid a further source of economic divide in Europe, the development of a fair and transparent financing scheme for the direct costs associated with switching to domestic products must be an integral part of the policy strategy. To redistribute the cost increase between Member States, some degree of EU-level financing will be necessary. In particular, Member States with a weak domestic high-tech industry base, but clear commitment to support green technology deployment, should be able to apply for some cost compensation through EU funding. A prerequisite for this is sufficient transparency on the actual costs associated with introducing “Buy-European” criteria compared to current public tender schemes.

6. Intensify external policy dialogue and cooperation:

At the global level, an introduction of “Buy-European” rules by the EU is likely to be perceived as a breach with the EU’s long-standing commitment to free trade and undistorted international competition. The EU must be prepared for this in its economic diplomacy strategy. Since recent experience suggests that hostile counterreactions by the major powers US and China will be difficult to avoid, the EU should be all the more focused on limiting concerns of other trade partners through intense dialogue. In particular, this concerns partners which are essential for the EU’s trade diversification strategy. Providing exceptions for products stemming from third countries which engage in trade agreements or other forms of economic partnerships with the EU is one essential element of this. Moreover, in communicating the measures, the EU should be careful to stress their transitory nature, and the fact that they are a response to similar measures in China (public procurement) and the US

[80] European Commission/ High Representative of the Union for Foreign Affairs and Security Policy (2023). Strengthening EU economic security. Joint Communication to the European Parliament and the Council. JOIN(2025) 977 Final.

[81] European Commission (2025). Commission announces new measures to strengthen research security. News article, October 28 2025.

(local content rules in the Inflation Reduction Act). At the same time, the EU should step up its diplomatic efforts to achieve consensus on the need to restore multinational trade rules and trade dispute settlement mechanisms.

6 Conclusion

The Commission's announcement to support domestic manufacturing of a set of net-zero technologies through "Buy-European" rules has caused a major stir in Europe's economic policy circles. When considering such a significant policy shift, it is tempting to revert to fundamental positions on the use (and misuse) of industrial policies and to avoid the complexities of a world subject to drastic political, economic and technological change. However, a straightforward response in one direction or the other is neither supported by economic theory nor by experience of local content practices worldwide. Well-designed local content rules may support productivity-enhancing domestic structural change by helping to exploit economies of scale and strengthen the domestic knowledge base. However, rising domestic purchase costs can reduce domestic spending power and aggravate domestic resource constraints, thus curbing the growth potential of other domestic sectors. At the global level, there is a high risk of further fueling trade fragmentation and bloc building by provoking counter-reactions. Any evaluation of the net effects must consider the specifics of the products covered, particularly the market situation and the potential for future technological development.

To limit downside risks, a gradual and initially limited implementation of local content criteria is advisable. For several reasons, it makes sense to initially focus on a few hard-to-substitute technologies that are essential for Europe's green transformation. As these technologies have not yet reached their most mature stage, there is still sufficient scope for cost reductions. Current cost balances therefore often provide an inaccurate picture of their potential contribution to macroeconomic growth. The low substitutability and the high level of European import dependency in many stages of the production process for these technologies justifies the payment of a sovereignty premium in the form of initially high domestic purchase costs, reflecting the general benefits of reduced susceptibility to economic coercion. Furthermore, creating qualified domestic jobs in the green manufacturing sector could increase social acceptance of the EU Green Deal and reduce the risk of future climate policy legislation being blocked politically.

The potential value added created by the demand-pull effect is considerable. In 2030 alone, local content prescriptions for the major production stages of just four net-zero technologies (electrolysers, heat pumps, lithium-ion batteries and PV modules) could generate additional annual EU value added between 43 and 50 billion EUR. However, our findings also suggest that any aggregate gains will be associated with significant distributional effects. In order to manage these issues and limit overall downside risks, the implementation of local content rules must adhere to a set of clear principles. Specifically, decisions on product inclusion should be based on detailed technology and market data, using a sound methodology. To reduce the risk of excessive costs, applications should ideally take the form of award criteria (public procurement or public support tenders) or bonus payments (public support premiums) rather than strict pre-qualification criteria. To overcome resource bottlenecks, any demand-side support policy should be accompanied by measures to strengthen the supply base, particularly the availability of skilled technical workers. Moreover, EU-wide local content rules require a fair and transparent financing scheme to reach political consensus, avoiding an excessive financial burden on Member States with a small national high-tech industry base. Finally, to reduce the risk of fueling geoeconomic fragmentation trends, the EU must continue to demonstrate its commitment to new forms of global cooperation.

7 Appendix

Table A1: Value-added effects of a "100% EU procurement" switch in 2030 by economic sector

		Results (Million EUR)	
Sector name	**NACE level**	**Benchmark scenario**	**Optimistic scenario**
Products of agriculture, hunting and related services	A1	-140.51	-166.55
Products of forestry, logging and related services	A2	-10.08	-12.54
Fish and other fishing products	A3	-3.57	-4.22
Mining and quarrying	B	+191.62	+223.97
Food, beverages and tobacco products	C10-C12	-152.64	-180.39
Textiles, wearing apparel, leather and related products	C13-C15	-22.50	-27.35
Wood and of products of wood and cork	C16	-5.26	-7.19
Paper and paper products	C17	+7.63	+7.82
Printing and recording services	C18	+1.42	+1.30
Coke and refined petroleum products	C19	+52.04	+70.79
Chemicals and chemical products	C20	+718.73	+857.64
Basic pharmaceutical products and pharmaceutical preparations	C21	-65.13	-77.18
Rubber and plastic products	C22	+1,059.50	+1,183.23
Other non-metallic mineral products	C23	+265.40	+292.57
Basic metals	C24	+2,832.49	+3,341.06
Fabricated metal products, except machinery and equipment	C25	+223.54	+257.01
Computer, electronic and optical products	C26	+350.78	+395.57
Electrical equipment (excl. Lithium-ion batteries, Electrolysers, PV modules)	C27 (residual)	+1,116.87	+1,267.47
Lithium-ion batteries	-	+18,183.63	+21,489.75
Electrolysers	-	+376.42	+452.21
PV modules	-	+11,359.15	+12,524.19
Machinery and equipment n.e.c. (excl. Heat pumps)	C28 (residual)	+224.11	+255.43
Heat pumps	-	+1,426.39	+2,523.61
Motor vehicles, trailers and semi-trailers	C29	+54.72	+57.43
Other transport equipment	C30	-13.89	-17.13
Furniture and other manufactured goods	C31-C32	-22.14	-27.12
Repair and installation services of machinery and equipment	C33	+219.35	+259.50
Electricity, gas, steam and air conditioning	D	+1,926.64	+2,158.27
Natural water; water treatment and supply services	E36	+9.02	+10.32
Sewerage services; sewage sludge; waste collection	E37	+489.75	+570.13
Constructions and construction works	F	-228.32	-274.92
Wholesale and retail trade and repair services of motor vehicles	G45	+59.98	+71.06
Wholesale trade services, except of motor vehicles and motorcycles	G46	+1,092.60	+1,280.80
Retail trade services, except of motor vehicles and motorcycles	G47	+92.53	+103.28
Land transport services and transport services via pipelines	H49	+370.65	+431.76
Water transport services	H50	+13.85	+15.99
Air transport services	H51	+12.62	+14.91
Warehousing and support services for transportation	H52	+222.81	+261.62
Postal and courier services	H53	+60.85	+71.26

Accommodation and food services	I	-97.67	-115.72
Publishing services	J58	-10.86	-13.57
Motion picture, video and television programme production services	J59	-14.17	-17.13
Telecommunications services	J60	+13.69	+15.34
Computer programming, consultancy and related services; Information services	J61	+118.02	+136.12
Financial services, except insurance and pension funding	J62	+76.94	+88.37
Insurance, reinsurance and pension funding services, except compulsory social security	J63	-12.27	-15.08
Services auxiliary to financial services and insurance services	K	-11.72	-14.39
Real estate services excluding imputed rents	L	-318.34	-379.99
Legal and accounting services; services of head offices	M69-M70	+506.55	+594.69
Architectural and engineering services; technical testing services	M71	+256.40	+297.41
Scientific research and development services	M72	-79.36	-92.98
Advertising and market research services	M73	+57.25	+65.86
Other professional, scientific and technical services	M74-M75	+64.59	+74.90
Rental and leasing services	N77	+192.89	+224.24
Employment services	N78	+304.57	+357.86
Travel agency, tour operator and other reservation services and related services	N79	-4.91	-6.03
Security and investigation services; services to buildings and landscape	N80-N82	+232.23	+270.16
Public administration and defence services; compulsory social security services	O	-238.04	-284.94
Education services	P	-243.07	-287.81
Human health services	Q86	-336.55	-397.55
Residential care services; social work services without accommodation	Q87-Q88	-159.87	-188.72
Creative, arts, entertainment, library, archive, museum, other cultural services	R90-R92	-47.03	-55.68
Sporting services and amusement and recreation services	R93	-29.29	-34.74
Services furnished by membership organisations	S94	-11.21	-13.58
Repair services of computers and personal and household goods	S95	+8.29	+9.53
Other personal services	S96	-39.12	-46.37
Household production	T	-21.21	-25.04

Source: own calculations

Author:

Dr. André Wolf
Head of Division Technology, Infrastructure and Industrial Development
wolf@cep.eu

Centrum für Europäische Politik FREIBURG | BERLIN
Kaiser-Joseph-Straße 266 | D-79098 Freiburg
Schiffbauerdamm 40 Raum 4205 | D-10117 Berlin
Tel. + 49 761 38693-0

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