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EUROPEAN SOLAR MANUFACTURING COUNCIL

Draft Concept

A Tradable Certificate Framework for Achieving 40% "Made in Europe" Content in PV and BESS Manufacturing

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1 Executive Summary

This concept proposes a binding framework requiring that **40% of the value-added content** of every photovoltaic (PV) module sold in the European Union should be produced within the EU. The framework builds on existing provisions in the Net Zero Industry Act, the Clean Industrial Deal, the Customs Code, and the Renewable Energy Directives, and incorporates:

- **A value-based content calculation** with strategic component super credits.
- **Dual compliance pathways**: physical content or tradeable certificates.
- **A European PV industry** financing scheme free of subsidies or tariffs.
- **Cross-sector best practices** from automotive CO_2 super credits, food control, fuel.
- **A registry and enforcement** scheme leveraging the EU Digital Product Passport (DPP).
- **Implementation phases**, risk mitigation, and dynamic adjustment mechanisms.

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2 Background, Objective and Legal Context

Rapid decarbonization of energy systems requires a resilient EU PV manufacturing ecosystem. Dependence on third-country supply chains (notably China) poses strategic risks. This paper proposes a **mandatory 40% EU value addition** requirement for all PV modules and inverters sold within the union, aiming at aligning procurement, industrial policy, and trade law.

- **Current NZIA benchmark**: non-binding 40% target for domestic market share of PV along the supply chain by 2030.
- **Clean Industrial Deal** setting a KPI to ensure 40% domestically produced key components of clean tech products on the EU market domestic content of [1]
- Gaps:
  - Neither market nor other financing mechanisms provide sufficient OPEX for domestic PV manufacturing along the supply chain.
  - No other enforceable mechanism ensuring EU content.
- **Goal**: translate benchmark into law, supporting domestic industry while remaining WTO-compliant.

This proposal develops a binding system: every PV module and PV inverter sold in the EU must have at least 40% "Made in Europe" content — either physically or on a balance-sheet (certificate) basis. The system explicitly incentivizes strategic components (e.g., polysilicon, wafers, PV cells, etc.) to address value chain vulnerabilities.

3 Legal and Trade Framework

3.1 EU Law

- **Net Zero Industry Act (NZIA):**
  The NZIA sets the 40% benchmark and introduces resilience criteria in public procurement and auctions. The current delegated regulation of the NZIA[2] specifies the final products and key components regarded as primarily used in the production of net-zero technologies. For solar PV systems, these components are: (1) PV grade polysilicon, (2) PV grade silicon ingots or equivalent[3], (3) PV wafers or equivalent[2], (4) PV cells or equivalent[2], (5) Solar glass, (6) PV encapsulants, (7) PV ribbons, (8) PV backsheets, (9) PV connectors, (10) PV junction boxes (11), PV modules (12), PV inverters, and (13) PV trackers and their mounting structures. To ensure compatibility with the NZIA, this framework adopts the same set of components.
- **Energy Performance of Buildings Directive (EPBD) – EU Solar Standard (2024):**
  The revised EPBD, adopted in April 2024, introduces a binding EU Solar Standard requiring the installation of solar energy systems on buildings according to a phased timeline. Solar installations must be integrated on new commercial and public buildings by 2026, on commercial and public buildings undergoing major renovation by 2027, on new residential buildings by 2029, and on existing public buildings by 2030. These obligations will significantly increase PV deployment within the European building stock, strengthening the strategic importance of domestic PV manufacturing capacity. The measure reinforces the rationale for a European value-added certification scheme by creating sustained, policy-driven demand for PV components manufactured in Europe.

[1] https://commission.europa.eu/document/download/9db1c5c8-9e82-467b-ab6a-905feeb4b6b0_en?filename=Communication%20-%20Clean%20Industrial%20Deal_en.pdf&prefLang=de
[2] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=PI_COM:C(2025)2901
[3] The term 'equivalent' refers to similar steps or key enabling technologies needed for thin-film, organic, tandem or other PV technologies.

- **European Solar Charter (2024):**
  The European Solar Charter, signed in April 2024 by the European Commission and a broad coalition of Member States and industry actors, outlines a set of voluntary but coordinated actions to support the resilience, competitiveness, and expansion of the EU photovoltaic manufacturing sector. It includes commitments to improve the investment environment, facilitate permitting, encourage procurement of EU-made PV products, and enhance European value chains for key components. As a political and industrial policy instrument directly aimed at strengthening Europe's PV ecosystem, the Charter provides complementary backing for a "Made-in-Europe" certificate scheme that recognises and rewards European value-added in PV manufacturing.
- **Commission Implementing Regulation (EU) No 1357/2013:**
  Defines the origin of PV modules and cells for customs purposes, stating that the origin of both modules and cells is determined by the country where the cells are manufactured.
- **Community Customs Code (Regulation (EEC) No 2913/92, Article 24):**
  Goods whose production involves more than one country are deemed to originate in the country where they underwent their last substantial, economically justified processing. Under current EU Customs Code rules of origin, the decisive factor for PV modules is the place of cell production, meaning that modules assembled in Europe with imported cells are still considered non-EU in origin. However, for the purposes of industrial resilience and NZIA implementation, the European Commission (Delegated Act, Recital 10) explicitly states that:

  > *"it is appropriate to refer to the assembly of the solar photovoltaic system and of the PV module, rather than to their origin, as a reference for the contribution to resilience of those specific manufacturing steps."*

  This creates a gap between customs definitions and industrial policy objectives. The proposed 40% "Made in Europe" framework addresses this discrepancy by introducing a complementary metric based on value-added manufacturing in Europe. Instead of relying solely on legal rules of origin, the system tracks where value and strategic manufacturing steps occur, thereby aligning customs, industrial, and energy policy objectives under a transparent and auditable scheme.
- **Renewable Energy Directive (EU) 2018/2001:**
  Establishes guarantees of origin for renewable energy, providing a model for certificate-based tracking[4].

3.2 WTO Rules

Trade-Related Investment Measures (TRIMs):
The suggest "Made-in-Europe" certificate system is not a tariff, tax, or safeguard measure but a market-based traceability and certification system. Local content requirements (LCRs) are generally prohibited under WTO rules unless linked to government procurement or subsidies[5] [6] [7]

[4] https://www.aib-net.org/certification/certificates-supported/renewable-energy-guarantees-origin
[5] http://www.universitypublications.net/ijbms/0201/pdf/RHS405.pdf
[6] https://www.bundestag.de/resource/blob/1041550/2689022673fd766d0cc2a7738df04724/WD-2-066-24-pdf.pdf
[7] https://www.isi.fraunhofer.de/content/dam/isi/dokumente/ccx/2020/The_short_term_costs_of_local_content_requirements.pdf

and voluntary or certificate-based schemes, or those tied to public procurement, are less likely to be challenged[8] [9].

3.3 Benchmarking against International Practices

The methodology for *"Made in Europe"* content can draw inspiration from the US Buy American Act (BAA), which currently requires ≥60% domestic component value, rising to 65% in 2024 and 75% in 2029. A similar phased approach could be applied to PV modules, inverters and other system components in the EU:

- Initially, a defined percentage of the component value must originate from Europe.
- Over time, the threshold would increase (e.g., 10% then 20%, to reach 40%), providing a clear scaling path for local manufacturing.
- This ensures a significant portion of value creation occurs in Europe while allowing industry time to expand production capacity.

4 System Structure

4.1 Definition of Made in Europe

For the purposes of this framework, *"Made in Europe"* refers to value creation within the European Union (EU), the European Free Trade Association (EFTA) countries, and the United Kingdom (UK).

4.2 Ownership Criterion

Unlike the NZIA regulation, which does not impose specific requirements on company ownership structure when determining where products are considered manufactured, the *Made in Europe* certificate system is suggested to include an ownership criterion to align strategic incentives with European industrial policy. Eligibility requires that manufacturing entities are majority-controlled by European ultimate owners. While foreign participation is permitted, European entities must hold majority control of the facilities. Verified through corporate registry or shareholder documentation, this requirement ensures that *value creation* (see Section 4.7) and *supercredit* (see Section 5.1) benefits primarily accrue to European interests.

4.3 Unit Definition

4.3.1 European Solar Content Credits

The certificates are denominated in *European Solar Content Credits (ESCC)*, where 1 *ESCC* equals 1 euro of verified European value created. The *value creation* is determined *at the point of production*, which must be within the definition of Europe of Section 4.1, for each key manufacturing step of the four *final products* defined in section 4.4, based on verified cost and process data of the European producer (see section 4.7).

The calculation reflects the ex-works value — i.e., the net of material inputs — and includes labor, energy use, capital expenditure (CAPEX) amortization, research and development (R&D), overhead, and administration that are attributable to production within Europe.

[8] https://unctad.org/system/files/non-official-document/DITC_TED_13062013_Study_ICTSD.pdf
[9] https://solaralliance.eu/wp-content/uploads/2024/11/ESIA-PV-Passport-II.pdf

To ensure comparability and prevent overestimation, standardized CAPEX amortization rules apply — typically using linear depreciation over a 7–10-year period depending on the asset class and production technology. This ensures that long-term investments are fairly reflected in the value creation while maintaining methodological consistency across manufacturers. Together, these harmonized rules provide a **transparent and auditable framework** for quantifying verified European value creation, enabling **fair attribution of Made-in-Europe status** across diverse manufacturing steps, technologies and supply chains.

To maintain fairness and comparability, the system should avoid rewarding inefficient producers simply because their costs are higher. Therefore, *tabulated reference values* — based on independent market analysis of average European manufacturing costs relative to global benchmarks — are to be used to calculate verified European value creation in a consistent way. As outlined in Section 4.7, manufacturers should be able to choose between using these *tabulated reference values* or providing *audited company-specific data* to reflect their actual ex-works conversion costs. Applicants for *Supercredits* (see Section 5.1) status must, however, substantiate their claims through independent verification of both their cost-based value creation and its additionality.

4.3.2 European Content Units per watt-peak

In addition, an auxiliary unit — *European Content Units per watt-peak (ECU-Wp)* — can be used to express the verified European value added relative to the nominal power output of a PV module. This unit serves as a transparent communication metric, enabling manufacturers, policymakers, and customers to assess and compare the European content intensity of different PV products.

Unlike the primary *ESCC* unit, *ECU-Wp* is not a tradable or monetary instrument; it functions solely as an informational indicator, illustrating how much verified European value creation is embedded per installed watt of PV capacity of a *final PV module*, *final PV inverter*, *final PV mounting structure*, or *final BESS*, and in the end a PV system.

4.4 Definition of Final Product Categories and Category Integrity

To ensure that the *"Made in Europe"* framework reflects the full Photovoltaic (PV) and Battery Energy Storage Systems (BESS) value chains, the system defines four *final product* categories eligible for certification:

1. ***Final PV module*** — encompassing wafers, cells, solar glass or equivalent, encapsulants, ribbons, backsheets, and final module assembly.
2. ***Final PV inverter*** — including string, central, hybrid, and microinverters.
3. ***Final PV mounting structure*** — covering both fixed mounting systems and solar trackers, including their steel, aluminium, and drive components.
4. ***Final BESS*** — including cell, pack, and system-level manufacturing within Europe.

Defining these categories allows the framework to capture the full PV and storage system value chain, supporting European industrial policy by reinforcing adjacent clean-tech sectors and promoting localisation of assembly and integration activities.

To preserve the integrity of the certification mechanism, **cross-category trading of certificates is strictly prohibited**. For instance, an inverter manufacturer or importer cannot meet a "Made in Europe" requirement by purchasing *ESCC* certificates issued for the module production value chain. Each final product category therefore has its own non-fungible certificate class, ensuring that compliance directly corresponds to verified European *value creation* (see section 4.7) within

the same product category. Consequently, the base *ESCC* certificates are divided into final product category-specific certificate classes:

Category	Examples of components entitled to ESCC certificates (see section 4.5)	Certificate Type	Fungible with others?
Final PV module	Polysilicon, Ingots, Wafers, Cells, Module assembly	ESCC-M	✗ No
Final PV inverter	Printed Circuit Board Assembly (PCBA), Inverter assembly, Software Development	ESCC-I	✗ No
Final PV mounting structure	Structural materials, Rotational and drivetrain components, Actuators and motors	ESCC-S	✗ No
Final BESS	Active battery materials, Electrode manufacturing, Battery cell assembly	ESCC-B	✗ No

Each *ESCC* certificate type uses the same underlying *value creation* (see Section 4.7) logic, but is issued per category. The Central EU Registry (see Section 4.9.1) and the National Issuing Bodies (see Section 4.9.2) and would manage these categories separately (like different product codes), and cancellation for compliance (see Section □4) must use certificates of the same category as the final product in question.

4.5 Definition of Components within each of the Final Product Categories

The *Made-in-Europe* certificates (*ESCC*) are calculated based on the share of *value creation* (see Section 4.7) that occurs within Europe at each manufacturing step, ultimately contributing to one of the four final product categories: *final PV module*, *final PV inverter*, *final PV mounting Structure*, and *final BESS*.

4.5.1 The PV Module Value Chain Component List

To ensure alignment with the NZIA, this framework adopts the same component definitions as the NZIA-recognized key components of photovoltaic (PV) technology for the *final PV module* value chain. These key components are:

- PV grade polysilicon
- PV grade silicon ingots or equivalent
- PV wafers or equivalent
- PV cells or equivalent
- Solar glass
- PV encapsulants
- PV ribbons
- PV backsheets
- PV connectors
- PV junction boxes
- PV modules
- PV inverters
- PV trackers and their mounting structures'

However, for the purposes of the Made-in-Europe framework, the PV inverters (12) and the PV trackers with mounting structures (13) in this list are treated as separate *final product* categories

(see previous section) and are therefore withdrawn from the *final PV module* value chain component list.

In addition to the 11 first key components defined under the NZIA, several other elements are critical for strengthening Europe's strategic independence in PV manufacturing. It is therefore proposed that the framework also includes additional components such as:

- PV Manufacturing equipment (e.g., for ingot pulling, cell processing, and module assembly)

These additional components are essential for ensuring the technological sovereignty and resilience of the European PV value chain and should therefore be included within the scope of the Made-in-Europe framework.

Accordingly, the final PV *module component* list comprises the following key components and associated manufacturing steps:

1. ***PV Manufacturing equipment***
2. ***PV grade polysilicon***
3. ***PV grade silicon ingots or equivalent***
4. ***PV wafers or equivalent***
5. ***PV cells or equivalent***
6. ***Solar glass or equivalent***
7. ***PV encapsulants***
8. ***PV ribbons***
9. ***PV backsheets***
10. ***PV connectors***
11. ***PV junction boxes***
12. ***PV module assembly***

4.5.2 The PV Inverter Value Chain Component List

Building on existing national approaches — such as the Austrian Made in Europe Bonus — 11 key manufacturing and development stages are proposed as the *inverter component* list, decisive for determining the EU value-added content of a *final PV inverter*:

13. ***Inverter manufacturing equipment***
14. ***Housing components & heat sinks***
15. ***Power modules (specialized semiconductors)***
16. ***Protection technology component DC disconnect switch***
17. ***Protection technology components EMC cage***
18. ***Inductors/chokes***
19. ***Cables and cable harness***
20. ***Maximum power point tracking components or optimisers***
21. ***Printed circuit board assembly (PCBA)***
22. ***PV inverter assembly***
23. ***Software development***

Together, these *inverter component* criteria ensure that the *Made-in-Europe* framework reflects a comprehensive view of strategic value creation across hardware and software of *final PV inverter*, thereby strengthening Europe's technological sovereignty and resilience throughout the PV value chain.

4.5.3 The Mounting Structure Value Chain Component List

Nine key manufacturing and development stages are proposed as the *PV mounting structure* list, decisive for determining the EU value-added content of a *final PV mounting structure*:

24. ***Manufacturing equipment for mounting and tracking components***
25. ***Structural materials (steel profiles, aluminium extrusions, corrosion-resistant coatings)***
26. ***Fasteners and mechanical connectors (bolts, clamps, brackets, rail connectors)***
27. ***Fixed-tilt or tracker-specific mounting rails and support beams***
28. ***Rotational and drivetrain components***
29. ***Actuators and motors***
30. ***Tracking control hardware (controllers, sensors, PCBs)***
31. ***Final assembly, system integration, and quality testing***
32. ***Tracking software and control algorithms***

4.5.4 The Battery Energy Storage System (BESS) Value Chain Component List

Building on existing national approaches — such as the Austrian Made in Europe Bonus — 12 key manufacturing and development stages are proposed as the *BESS component* list, decisive for determining the EU value-added content of a *final BESS*:

33. ***BESS manufacturing equipment***
34. ***Active battery materials (cathode, anode, electrolyte, separator)***
35. ***Electrode manufacturing***
36. ***Battery cell assembly and testing***
37. ***Module housing and mechanical components***
38. ***BMS hardware***
39. ***BMS software development***
40. ***Module assembly***
41. ***Pack housing and thermal management components***
42. ***Pack-level power electronics and protection devices***
43. ***Pack assembly and testing***
44. ***System enclosure, safety systems, and final BESS assembly***

4.6 Generation of Made-in-Europe certificates (ESCC)

For the PV module value chain, the ***value creation*** of each component refers to the conversion cost incurred by a European manufacturer to transform inputs into the corresponding *module component*, *inverter component*, *mounting structure component* or *BESS component*. For example:

- ***PV grade polysilicon (2)***: the cost for a European producer to convert metallurgical-grade silicon using *Manufacturing equipment (1)* into *PV grade polysilicon (2)*, including the related expenses as described in section 3.2.
- ***PV-grade silicon ingots or equivalent (3)***: the cost for a European producer to convert *PV grade polysilicon (2)* using *Manufacturing equipment (1)* into *PV grade silicon ingots (3)*, covering all associated production costs.
- **A *final PV module***: the cost for a European module assembler to, with the use of *Manufacturing equipment (1)*, integrate *PV cells (5)*, *Solar glass or equivalent (6)*, *PV encapsulants (7)*, *Ribbons (8)*, *PV backsheets (9)*, *PV connectors (10)*, and *junction boxes (11)* into a *final PV module* by the *PV module assembly (12)* manufacturing step.

Each of the twelve *module components* defined in section 4.5.1, generates *ESCC-M* certificates when production takes place within Europe, i.e., within the European Union (EU), the European Free Trade Association (EFTA) countries, and the United Kingdom (UK). The *ESCC-M* certificates are issued to the European manufacturer responsible for each component and represent the verified *value creation* (see section 4.7) generated in that specific step of the production chain. It should be stressed that only value that is **physically created within Europe** — such as labour, energy use, and capital expenditure (CAPEX) amortized in European facilities — is eligible for *ESCC* certification. Subcomponents or contract manufacturing performed outside the EU do **not** qualify, even if they are owned or commissioned by a European company.

The *"Made in EU share"* of either a *final PV module*, *final PV inverter*, *final PV mounting structure*, or *final BESS* is calculated as follows: the value of each *module component*, *inverter component*, *mounting structure component* or *BESS component*, respectively, that originates from Europe is measured against the total value of the *final PV module*, *final PV inverter*, *final PV mounting Structure*, or *final BESS*, yielding a percentage share. The sum of these percentage shares represents the overall *Made in EU share* of the respective final products. The *Made in EU share* of a module can then be converted into the European Content Units per watt-peak (*ECU-Wp*) unit based on the nameplate capacity of the *final PV module*, *final PV inverter*, *final PV mounting structure*, or *final BESS*.

For each final product — *final PV module*, *final PV inverter*, *final PV mounting structure*, or *final BESS* — the corresponding *ESCC* certificates (*ESCC-M*, *ESCC-I*, *ESCC-S*, or *ESCC-B*, respectively) must be linked to the specific manufacturing steps that produced any of the components listed in Section 4.5 and that were used in its production. However, there is no requirement to include any particular component from these lists.

This means that for example:

- A European module assembling manufacturer using imported components would still generate *Made-in-Europe* certificates for the *PV module assembly (12)* manufacturing step, reflecting the value added within Europe. However, the *final PV module* would only receive *ESCC-M* certificates for that single step in this example.
- A European module assembling manufacturer using, e.g., European made *PV Manufacturing equipment (1)*, *PV cells (5)* and *solar glass or equivalent (6)* produced with corresponding *ESCC-M* certificates, and imported components for the rest, would generate *ESCC-M* certificates for the *PV module assembly (12)* manufacturing step, while the *final PV module* would be associated with *ESCC-M* certificates for *PV Manufacturing equipment (1), PV cells (5)*, *solar glass or equivalent (6)* and *PV module assembly (12)* in this example.
- Conversely, a *final PV module* assembled outside Europe may still generate *ESCC-M* certificates for any European-made *components* it incorporates. For instance, if the *PV grade polysilicon (2)* and the *PV connectors (10*) used in the *final PV module* were produced within Europe, the corresponding *ESCC-M* certificates would be issued to the corresponding European polysilicon and connector producers, reflecting the verified European *value added* from those two manufacturing steps, even if the *final PV module* was not assembled in Europe.

4.7 Determining the *value creation*

To determine the *value created* in each manufacturing step — where **1 *ESCC* corresponds to 1 euro of verified EU *value creation*** — European manufacturers should be able to choose between the following approaches:

1. **Tabulated Reference Values**
   A central European registry body (see Section 4.9.1) should publish standardized reference values for the *value creation* associated with the manufacturing step of each of the *module components*, *inverter components*, *mounting structure components* and *BESS components*. To protect commercially sensitive cost information, manufacturers could apply these predefined reference values instead of disclosing their own cost data. Table 1 below show how such a list *tabulated reference values* for the *PV module value chain component list* could look like. These tabulated reference values should be set at the lower end of the European manufacturing cost spectrum — establishing a minimum threshold — to ensure the certificate system incentivizes cost-efficient manufacturing without over-rewarding high-cost processes.

2. **Restricted Disclosure of Detailed Cost Data**
   Manufacturers applying for *ESCC* certificates could also base them on their actual, company-specific value creation when this results from higher efficiency or greater European integration. To do so, they may submit detailed cost data covering their entire manufacturing process directly to the relevant National Issuing Body (see Section 4.9.2). The submitted information will be reviewed by an accredited auditor (see Section 4.9.3) and treated as strictly confidential. However, aggregated and anonymized data may be used to periodically update and refine the standardized reference values.

   To ensure fairness and consistency, the assessment of value creation based on restricted cost data disclosure should not reward inefficient producers simply because their costs are higher. Additionally, to prevent over-dilution of the certificate system, a maximum threshold should be established for high-cost specialized products. While these products may generate more *ESCCs* per W_p than standard components due to their higher proven costs, they should not be permitted to exceed this cap, ensuring system integrity and preventing excessive *ESCCs* generation.

3. **Hybrid Approach**
   Manufacturers may combine the two methods — applying *tabulated reference values* for most cost components in their process, while submitting *restricted disclosure of detailed cost* data — which are audited for specific cost elements where they wish to demonstrate a higher or more accurate *value creation* within Europe.

Table 1 presents an example of how *tabulated reference values* for the *PV module value chain component list* could be structured. The table follows the same methodology as the report[10] SolarPower Europe (2025): *Reshoring Solar Module Manufacturing to Europe: A Cost Gap Analysis and Policy Impact Simulation* — associating each component or manufacturing step with a representative delivered minimum sustainable price (MSP) for a PV module. The values are based on the same study. Similar *tabulated reference values* should also be developed for the *PV inverter value chain component list*, the *mounting structure value chain component list*, and the *BESS value*

[10] https://www.solarpowereurope.org/insights/thematic-reports/reshoring-solar-manufacturing-to-europe

chain component list. Importantly, Table 1 should be viewed as an illustrative example only. Thorough research and investigation should be carried out by a central European registry body (see Section 4.9.1) before final *tabulated reference values* are established.

Table 1. Illustrative example table of preliminary tabulated reference values for European value creation, based on typical 2025 cost structures for a 400 W module, where European ingot, wafer, cell, and module manufacturing equipment have been assumed being used.

No.	Component	Typical European Minimum Sustainable Cost (€ct/W_p), i.e., European *value creation*	Comment
1	PV manufacturing equipment	1.7	Including European equipment for Ingot & Wafer, Cell, and PV Module production (not including polysilicon equipment). Also not included here is the manufacturing facilities, as CAPEX amortized of European facilities are included in each manufacturing step (see Sections 4.6).
2	PV grade polysilicon	3.0	
3	PV grade silicon ingots or equivalent	3.1	Not including manufacturing equipment, as already included in No. 1
4	PV wafers or equivalent	1.5	Not including manufacturing equipment, as already included in No. 1
5	PV cells or equivalent	4.9	Not including manufacturing equipment, as already included in No. 1
6	Solar glass or equivalent	2.0	
7	PV encapsulants	1.2	
8	PV ribbons	0.6	
9	PV backsheets	0.9	
10	PV connectors	0.4	
11	PV junction boxes	0.6	
12	PV module assembly	5.6	Not including manufacturing equipment, as already included in No. 1
	Total Final PV module	**25.5**	

4.7.1 Treatment of Manufacturing Equipment

Awarding ESCCs for the use of European equipment based on the same *value creation* method as for the other *components* should be avoided because doing so would create several challenges:

- Auditing would require tracking machine costs, usage hours, operational efficiency, yields, and depreciation.
- Production lines are dynamic, making standardized attribution difficult.
- Over-rewarding equipment could generate perverse incentives, encouraging over-capitalization or adoption of suboptimal platforms solely to inflate credit scores.

Consequently, it is necessary to separate equipment from *final PV module*, *final PV inverter*, *final PV mounting Structure*, and *final BESS* content to acknowledge the strategic value of European-made PV manufacturing equipment without distorting real *value creation*.

However, factory audits (as they are already part of the IEC certification of modules) can confirm the use of European equipment with small additional effort, making verification practical and cost-effective.

Consequently, under the ESCC framework it is suggested that equipment is treated as a capital enabler rather than a direct contributor to module content. To operationalize this, a non-fungible, line-specific "Commissioning Voucher" system can be introduced: **when a European-made machine is installed and commissioned in a European factory, the production line receives a fixed allotment of tradeable ESCCs**. The allotment is machine-class dependent, with higher allowances for critical equipment and lower allowances for ancillary machines.

A preliminary illustrative list of manufacturing equipment entitled to certificates should focus on key manufacturing steps, including equipment for the following key processing steps for the following PV module components:

- *PV grade polysilicon*: Hydrochlorination, Siemens/FBR reactors
- *PV grade silicon ingots or equivalent* and *PV wafers or equivalent*: Crystallization, squaring, wafering
- *PV cells or equivalent*: p-n junction formation, metallization, passivation
- *PV module assembly*: Melting (encapsulant), interconnection, lamination, inspection

These credits expire after a defined sunset date and cannot be transferred across production lines.

4.8 Physical Compliance

A *final PV module*, *final PV inverter*, *final PV mounting structure* or *final BESS* considered **physically compliant** if it contains at least **40% EU value-added content**, as measured on the basis of the corresponding *ESCC* certificates (*ESCC-M*, *ESCC-I*, *ESCC-S*, or *ESCC-B*, respectively) associated to it. This ensures that a substantial portion of the final product's value is generated within Europe, directly supporting European manufacturing capacity and industrial resilience.

If a *final PV module*, *final PV inverter*, *final PV mounting structure*, or *final BESS* does not physically reach the **40% European value-added threshold** — based on respective ESCC certificates generated during the final manufacturing step and those transferred from upstream European *component* manufacturers of the same value chain — the manufacturer or importer placing a *final PV module*, *final PV inverter*, *final PV mounting structure*, or *final BESS* on the EU market may still achieve compliance through **certificate acquisition**.

In such cases, the manufacturer or importer must purchase additional *ESCC* certificates to compensate for the shortfall. As previously defined, each *ESCC-M*, *ESCC-I*, *ESCC-S*, or *ESCC-B* certificate represents one euro of verified European *value creation*. These certificates may originate either from:

- Final products that exceed the 40% content requirement (surplus generation), or
- European producers of *components* for the respective *final product* that have independently generated surplus *ESCC* certificates through their production activities.

This mechanism ensures that all *final PV module*, *final PV inverter*, *final PV mounting structure* or *final BESS* placed on the EU market contribute proportionally to European *value creation* within

each separate value chain, while maintaining flexibility for globally integrated supply chains. At the same time, it provides a financial incentive for manufacturers investing in EU-based production and value-adding activities.

4.9 Governance, Registry, Monitoring, and Enforcement

The effectiveness of the *Made-in-Europe* certification system depends on a robust governance and monitoring framework that ensures integrity, traceability, and enforceability throughout the value chain. The governance model should combine central coordination at the EU level with national implementation and independent verification.

4.9.1 Central EU Registry

A central European registry body, modelled on the Association of Issuing Bodies (AIB) system for Guarantees of Origin (GOs), serves as the central platform for managing all certificates and related data. The central European registry body should:

- Track *key component* and *additional component* module serial numbers verified *value creation* declarations, and all *ESCC* transactions across the EU.
- Maintains digital accounts (wallets) for all economic operators — manufacturers, importers, traders, and buyers.
- Ensure that every *ESCC* is uniquely identifiable, transferable only once, and cancelable upon delivery to end users.
- Interfaces directly with the Digital Product Passport (DPP) or equivalent tracking system (see Section 4.9.4) infrastructure, which acts as the technical backbone for secure, interoperable data exchange. This integration enables digital binding of serial numbers to be verified *ESCC* certificates and ensures traceability across the entire PV supply chain.

4.9.2 National Issuing Bodies (NIBs) and Verification

National Issuing Bodies, legally appointed in each Member State, are responsible for issuing *ESCC* based on verified *value creation* declarations, and confirm the chain of custody for both *key components*, *additional components* along with *final PV modules*, *final PV modules* and *final PV mounting structures*. Verification includes annual base certification for each plant and component/final product families and maintaining records of production plants, component categories, and production volumes. This decentralized structure ensures alignment with national regulatory systems while maintaining EU-wide interoperability and harmonized data standards.

4.9.3 Independent Verification and Audit

Independent third-party verification is fundamental to ensuring the credibility and integrity of the certification system. Accredited verification bodies/companies, operating in accordance with international standards such as ISO 17029 and ISO 17065, are responsible for assessing and confirming compliance throughout the value chain.

Each manufacturing site and each *key component*, *additional component*, or *final product* undergoes an **annual certification audit**, during which the verifier reviews *value creation*, i.e. the bill of materials, production processes, cost structures, and where the Digital Product Passport (DPP) information and the Ownership criterion (See section 4.2) are cross-checked. These assessments establish the baseline for verified European *value creation*.

To validate actual production volumes and authorize the issuance of new *ESCC* certificates, periodic audits are conducted. The standard frequency is quarterly, but alternative intervals may

be applied where appropriate to avoid unnecessary administrative burden, particularly for small and medium-sized enterprises (SMEs) or low-volume production sites. This flexibility aims to balance verification integrity with proportional compliance costs

The verification process also includes a thorough review of the chain of custody, ensuring that certificates remain linked to the corresponding physical *key component*, *additional component* or *final* products at every stage of production and distribution.

All verification results are submitted digitally to the relevant national issuing body and to the European central register. Sensitive business data are handled confidentially, while only aggregated compliance indicators are made publicly available to demonstrate transparency and maintain trust in the system.

4.9.4 Monitoring, Reporting, and Digital Transfers

Certificates are digitally bound to module serial numbers through a robust, simple and non-bureaucratic system. The Digital Product Passport (DPP) framework (see Appendix A) or third party based verification such as an extension of the IEC 61730 certification to include origin may be used, with QR codes or secure links enabling traceable tracking. Digital transfers comply with eIDAS regulations and are recorded alongside invoices and delivery notes, ensuring transparent reporting of certificate ownership and preventing double-counting or fraud. Upon delivery to end-customers or public buyers, certificates are cancelled, completing the monitoring, reporting, and verification (MRV) process. The development of this DPP-based system builds on insights from Horizon-funded research projects such as RETRIEVE and CIRCUSOL, which explore digital traceability and lifecycle tracking in the PV sector.

4.9.5 Enforcement and Compliance

The Commission, through the central European registry body, retains oversight powers to conduct cross-country consistency checks, request re-verification or suspend issuing rights in cases of irregularities and impose sanctions (e.g., *ESCC* certificate invalidation, fines, or import restrictions) for non-compliance.
This layered system of **central coordination, national execution, and independent auditing** ensures both operational efficiency and credibility, while minimizing administrative burden for compliant manufacturers.

4.10 Market Function and Certificate Trading

To ensure the *ESCC* system functions as a credible market instrument rather than a compliance formality, a robust framework for certificate trading and settlement is essential. *ESCCs* must be verifiably linked to the defined components in Section **Error! Reference source not found.** through the Digital Product Passport (DPP) or equivalent tracking mechanisms (see Section 4.9.4).

Trading of *ESCCs* can be facilitated via a registry-based platform, supporting both spot and bilateral transactions. The system should define clear cancellation rules:

1. *ESCC-M*, *ESCC-I*, *ESCC-S*, or *ESCC-B* certificates are retired once applied to a *final PV module*, *final PV inverter*, *final PV mounting structure,* respectively, ensuring that upstream credits are not reused and preventing double-counting or inflation of compliance claims.

Price discovery may be market-based or guided by indicative reference values, providing transparency while supporting fair valuation. *ESCCs* should have a defined lifespan, for example

three years, to prevent stockpiling and ensure certificates reflect current European value creation.

4.11 Market Entry Points and ESCC Cancellation Rules

To ensure clarity and consistency in the application of *ESCCs*, the framework should define precise *market entry points* for all *final PV modules*, *final PV inverters*, *final PV mounting structures* or *final BESSs*, with cancellation of *ESCC-M*, *ESCC-I*, *ESCC-S*, or *ESCC-B* certificates, respectively, tied to these events. Market entry points are the stages at which a *final PV module*, *final PV inverter*, *final PV mounting structurs* or *final BESS* is deemed to have entered the relevant market for compliance purposes:

1. **Domestic Market Entry – EU Installation:**

The primary market entry point within the EU is the grid connection of a *final PV module*, *final PV inverter*, *final PV mounting structure,* or *final BESS*. Certificates are retired when the system is commissioned and connected to the electricity grid, ensuring that *ESCCs* are only applied to products genuinely contributing to European energy infrastructure.

However, the corresponding auxiliary unit — *European Content Units per watt-peak (ECU-Wp)* — remain assigned to the final PV system, enabling system owners or installers to express and communicate the verified European value creation embedded per installed watt of PV capacity.

2. **Export Market Entry – Leaving EU Borders:**

For *final PV modules*, *final PV inverters*, *final PV mounting structures* or *final BESS* or individual *module, inverter, mounting structure or BESS components* exported outside the EU, the market entry point is defined as the physical exit of the final products or components from Europe (see Section 4.1), verified through customs records. *ESCCs* may be detached at this stage and traded separately, reflecting European value creation while preventing double-counting in the domestic compliance system, but the link could be maintained if the component is intended to be imported again as part of a later stage in the value chain.

3. **Intermediate Transfers – Intra-Supply Chain Movements:**

ESCCs remain associated with the product as it moves through the supply chain (e.g., from manufacturer to distributor to installer). Certificates should not be canceled or detached until the product reaches a defined market entry point. This preserves traceability, avoids premature retirement, and ensures that upstream credits are properly accounted for.

4. **Cancellation Rules and Exceptions:**

ESCCs are non-transferable once retired at a *Domestic Market Entry* point. Any product returned or redirected after retirement requires specific adjustment procedures to prevent inadvertent reactivation or double-counting. Certificates have a finite lifespan (e.g., three years) to prevent long-term stockpiling and ensure timely application to end-use installations.

4.11.1 Rational and Risk Considerations:

Linking retiring of *ESCC* to well-defined *Domestic Market Entry* points provides transparency and reduces the risk of "compliance fiction." However, weaknesses remain, including reliance on accurate customs and grid connection records, potential delays in reporting, and the need to reconcile exported vs. domestically consumed certificates. Clear audit procedures, automated DPP integration, and mandatory verification at each entry point are essential to maintain the integrity of the system.

5 Strategic Component Incentives

5.1 Supercredits:

To accelerate the development of critical manufacturing capacity in Europe, *strategic components* — such as European-made polysilicon, wafers, cells, and other segments where Europe currently is structurally weak — may receive *supercredit multipliers* in the value-added calculation. For example, one ESCC generated from wafer production may count as 1.5 ESCCs for compliance purposes. This amplifies the contribution of these components toward the 40% manufacturing capacity threshold, thereby directly incentivizing investment and production in high-priority segments of the PV and BESS value chains to meet the NZIA goal of achieving 40% of the EU's annual deployment needs through domestic manufacturing.

Supercredit multipliers are conditional and time-limited and to qualify, production must pass an **additionality test**. The multipliers are intended phased down as sufficient EU capacity is established (dynamic tapering) and are subject to maximum stacking limits, ensuring that multiplied credits cannot be re-traded or applied beyond their intended compliance value.

All strategic ESCCs must be traceable at batch or serial level through a robust, simple and non-bureaucratic system. The Digital Product Passport (DPP) (see Appendix A for details) or third party based verification such as an extension of the IEC 61730 certification to include origin may be used. This allows verification that a credited component — such as a wafer or cell — has actually been integrated into the final product claiming the certificate.

In later phases, once strategic manufacturing capacity has been substantially established, the system can transition from weighted multipliers to *minimum content requirements*. This means that a defined share of the 40% EU value threshold — such as 15 percentage points — must derive from designated *strategic components*. This ensures that compliance of the Made-in-Europe certificate system cannot be achieved solely through a limited number of *module, inverter, BESS* or *mounting structure components* / manufacturing steps where Europe is strong, and that the framework continues to reinforce critical parts of the European value chain.

5.2 Targeted Funding:

A portion of the revenue generated through certificate trading, particularly from the sale of *supercredits*, should be earmarked to strengthen strategic capabilities across the European PV industry. Funds could be directed toward research and development, the scaling of manufacturing capacity, equipment commissioning, and workforce training focused on strategic components.

To preserve integrity and transparency, these proceeds should flow into a dedicated reinvestment mechanism, audited and linked to the registry. This ensures that the certificate system not only tracks and monetizes compliance but also actively reinvests in the underlying industrial base it aims to strengthen — creating a self-reinforcing loop between compliance incentives and manufacturing growth.

5.3 Dynamic Adjustment:

The framework must remain adaptive to changing industrial conditions, technological advances, and market realities. The list of components qualifying as strategic and their associated supercredit weighting factors should therefore be reviewed annually by the European registry body (see section 4.9.1). This review would assess supply chain vulnerabilities, production volumes, and innovation trends to recalibrate incentives toward areas still requiring support. As domestic capacity in certain segments matures, corresponding multipliers can be gradually reduced or withdrawn, while new or emerging bottlenecks can be added.

Because the allocation of super-credits can easily become controversial — potentially attracting political pressure or industry-specific lobbying — clear, objective, and transparent guidelines must be established from the outset. For example, a rule could state that super-credits cannot be assigned to certain *key components* once total European manufacturing volumes of that *key component* exceed 30% of the European market. Such predefined criteria help ensure predictability, fairness, and resistance to undue influence.

This dynamic adjustment mechanism ensures that the incentive structure continues to target the most critical links in the European PV value chain — maintaining strategic focus, market relevance, and long-term policy credibility.

6 Cost Implications and Financing of ESCC Compliance

Implementing the ESCC framework—including certificate issuance, trading, auditing, and compliance monitoring—will incur additional costs for manufacturers, suppliers, and intermediaries. These costs arise from administrative reporting, participation in digital registries, independent audits, product tracing through the Digital Product Passport (DPP), and potential adjustments to production processes to increase verified European content.
While exact costs will depend on company size, product type, and production scale, a plausible assumption is that these expenses would be internalized within the product price. This implies a modest increase in the cost of PV modules, inverters, and related components sold to the final customer. Preliminary analyses or pilot studies (for example, on modules and inverters) could help estimate the incremental price impact, which would likely vary by technology, certification approach (reference values vs. company-specific auditing), and degree of strategic component usage.

Financing mechanisms could include:

- **Cost pass-through** to end-users, where a small premium on certified products reflects the administrative and compliance burden.
- **Certificate trading revenue**, which could offset auditing and registry costs, particularly in a market-based trading system.
- **Public support or Horizon-linked funding**, leveraging EU programs or innovation projects (such as RETRIEVE and CIRCUSOL) to defray early-stage implementation expenses and encourage adoption of DPP-compliant tracking.

Explicitly including cost considerations strengthens the credibility of the framework by demonstrating that compliance is financially feasible, encourages informed decision-making for policymakers and industry, and lays the groundwork for future economic modeling to quantify price impacts.

7 Cross-Sector Best Practices and Analogous Mandates

This section highlights established mandates both within and outside the EU that employ similar content- or credit-based mechanisms to drive local production, resilience, and traceability.

7.1 PV-Specific Precedents

A number of national initiatives already provide incentives for European-made PV modules. However, these schemes are currently limited to the **module assembly step** (*PV modules (11)*) of the value chain or inverters. The proposed European-wide 40% "Made in Europe" framework expands this principle to cover **multiple value chain steps** thereby ensuring that strategic vulnerabilities beyond assembly are addressed in a systematic and harmonized manner across the Union.

Below are some examples of Made in Europe as a criterion in public support systems for solar energy

7.1.1 France

Feed-in Tariffs & Rooftop Solar: France pioneered a "Made in Europe" bonus in its solar feed-in tariffs. Since 2012, PV installations using at least 60% EU-made modules earned a 10% higher tariff[11]. In 2025, France overhauled its *S21* rooftop solar tariff scheme to introduce **"industrial resilience" criteria**: from 2026, eligible PV modules/cells must meet the EU Net-Zero Industry Act (NZIA) resilience test (no more than 50% of output produced outside Europe)[12]. This effectively requires manufacturers to have at least half of their production in Europe, ensuring a preference for EU-made panels.
Renewable Energy Auctions: For utility-scale projects, France's Energy Regulator (CRE) mandates a low-carbon footprint certification for PV components. In practice this favors European modules (made with cleaner grids) and excludes most high-carbon imports. Only PV systems with certified low-carbon modules can bid in tenders. This rule – described even as a "back door local content requirement" benefiting domestic/EU suppliers — requires third-party verification of the module's manufacturing process (handled by bodies like Certisolis via detailed data audits and factory inspections). The carbon-footprint score can account for up to ~30% of the tender evaluation, giving an edge to EU-made panels produced with lower emissions.

7.1.2 Italy

Tax Credits (Transizione 5.0): Italy's *Transizione 5.0* industrial tax credit scheme explicitly rewards EU-made solar equipment. Projects that use solar modules manufactured in the EU can claim tax credits up to 35% of module costs. The 2025 update of this scheme boosted the incentive base for high-efficiency EU-made cells/modules, encouraging use of cutting-edge European products. (Previously, an extra 20–25% credit was granted for EU-module projects achieving energy savings, but this was streamlined into the new efficiency-based bonuses.) These credits can stack with other regional aids, signaling strong national support for locally produced PV technology.
Renewable Auctions (FER X): Italy is aligning its auction design with NZIA's resilience goals. In 2025 it became the first EU country to exclude Chinese-made solar components in a major tender. Italy's *FER X* solar auction (for projects >1 MW) banned modules, cells, and inverters from China, implementing the NZIA "resilience" criterion that guards against

[11] https://www.pv-tech.org/france_endorses_made_in_europe_fit_bonus/
[12] https://strategicenergy.eu/france-rooftop-solar/

overreliance on a single foreign supplier. This effectively forces bidders to source equipment from European or non-Chinese manufacturers. The auction – part of a transitional scheme – attracted strong interest, indicating developers are adapting to the EU-origin requirement. Italy's approach, supported by its energy agency GSE, is a direct response to EU policy urging supply-chain diversification. *(Italy's wind and battery tenders have not reported similar origin bans, as European suppliers already dominate those segments.)*

Italian authorities tie these incentives to European frameworks. The FER X auction explicitly cited the EU Net-Zero Industry Act's "resilience criteria" in its rules. To enforce origin rules, Italy likely requires documentation such as manufacturers' certificates of origin or supply-chain affidavits from bidders, with compliance monitored by GSE. The tax-credit tenders for EU modules are similarly restricted to verified EU-made products (developers must prove module provenance, for example via EU customs codes or factory certificates). These measures ensure Italy's generous support only flows to European-produced tech, in line with EU industrial strategy.

7.1.3 Austria

"Made in Europe" Funding Bonus: Austria has introduced a clear preference for European-made components in its national subsidies. In mid-2025 the government launched a 20% funding bonus for new solar PV and energy storage projects that use EU-manufactured components. In practical terms, any project that qualifies for Austria's renewable investment grants will receive 20% higher government funding if its panels, inverters, batteries, etc. are made in Europe. The policy explicitly aims to counter "unfair global competition" — a reference to underpriced imports (primarily from Asia) — and to bolster Europe's clean-tech industry. This demand-side bonus follows a 2024 Austrian initiative that gave a similar 20% boost to subsidies for firms building solar manufacturing capacity in Austria/EU.

Austria's bonus applies specifically to solar PV systems and co-located battery storage. It was incorporated into the national renewable energy funding ordinance (EAG) in 2025. Other renewables (wind, biomass, small hydro) currently do not enjoy an EU-content bonus under this scheme. To qualify, project developers must provide proof (e.g. EU certificate of origin or supplier declarations) that major components are EU-made. Austrian officials have framed this as a commitment to "Europe as an industrial location," tying clean energy expansion to regional job creation. The bonus, set to roll out in grant rounds from June 2025 onward, makes Austria one of the few countries directly paying more for EU-made solar hardware.

7.1.4 Germany

Attempted "Resilience" Incentives (Not Yet Adopted): Germany has debated domestic content incentives but so far has no explicit EU-origin requirement in its support schemes. In 2023–24 the Economy Ministry floated a proposal for a "Resilience Bonus" to support local manufacturing. The idea was to reward consumers who install European-made solar panels with higher feed-in tariffs or payments, thereby stimulating demand for EU modules. This plan, however, was shelved in March 2024 after the governing coalition failed to agree. The pro-business FDP party objected to it as an excessive market intervention, and some solar installers warned it could disrupt supply chains (given their heavy reliance on Chinese panels).

7.2 Examples from other sectors

Sector / Region	Instrument & Mechanics	Outcome / Impact
EU Automotive	CO_2 supercredits (Reg. 443/2009) doubled small-car credits, improving fleet averages for low-emission models [13]	OEMs produced micro-cars and PHEVs, accelerating the shift toward cleaner vehicles.
EU Batteries	IPCEI Batteries: ≥ 50 % EU-sourced component requirement + off-take guarantees for local gigafactories [14].	Established a pan-EU gigafab network, securing a stable market for EU cathode and separator producers.
EU Semiconductors	CHIPS Act (Reg. 2023/2352) links funding to use of EU-made fab tools, fostering local equipment supply chains[15].	New wafer-fab investments in Germany and France with minimum EU-supplier participation in tool kits.
USA Automotive	CAFE & ZEV Mandates (49 CFR Part 533; California ZEV) award tradable credits for over-compliant EVs; non-compliance incurs fines[16] [17]	Rapid expansion of EV portfolios and domestic battery/drivetrain production.
USA – Buy American Act	≥60% domestic component value for qualifying products, increasing to 75% over time	Encouraged domestic manufacturing, phased compliance allowed industry scaling
EU Biofuels	RED II Blending Obligation (Dir. 2018/2001, Art 25) mandates advanced biofuel shares, tracked via mass-balance or certificates[18].	Growth of EU bio-refineries and sustainable feedstock supply under rigorous audit schemes.
Global Food Traceability	German QS System for Meat (QS GmbH) labels and traces each batch via a centralized database, from farm to retail [19].	High consumer confidence in QS-certified products, broad adoption by producers and retailers.

8 Implementation Roadmap

8.1 Transition Mechanisms to Address Current Capacity Gap

Today, Europe does not yet have sufficient manufacturing capacity to supply 40% of the value-added content of PV modules sold on its internal market (approx. 80 GW per year).
To avoid market disruption while ensuring a predictable scaling pathway for modules, the system should include transitional measures. Two potential pathways could be explored.

[13] https://climate.ec.europa.eu/eu-action/transport/road-transport-reducing-co2-emissions-vehicles/co2-emission-performance-standards-cars-and-vans_en
[14] https://ec.europa.eu/growth/industry/policy/strategic-industries/batteries_en
[15] https://eur-lex.europa.eu/eli/reg/2023/2352/oj
[16] https://www.ecfr.gov/current/title-49/subtitle-B/chapter-V/part-533
[17] https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program
[18] https://eur-lex.europa.eu/eli/dir/2018/2001/oj#d1e2272-1-1
[19] https://www.q-s.de/en/our-standards/q-s-system

8.1.1 Stepwise thresholds

A phased European content requirement, modelled after the US Buy American Act, could provide a predictable trajectory for compliance. Initially, a lower binding requirement (e.g., 10% value-added European content in 2027) could be introduced, increasing progressively (20% by 2029, 30% by 2031, 40% by 2033). As a further stepwise implementation, certain technologies could first enter a pilot phase, with the requirement initially applied only to e.g. the *final PV module* and *final PV inverters*, before expanding to other final products such as *final PV mounting structure* and *final BESS*. This approach provides industry and policymakers with a credible glide path aligned with capacity expansion.

8.1.2 Temporary "Support ESCC" certificates

A central EU body (e.g., an "EU PV Industrial Platform") could issue a limited volume of Support ESCCs not directly backed by production. Revenues from these certificates would be earmarked for CAPEX to accelerate new factories, as well as OPEX support to both existing and new manufacturing sites of the key components regarded as primarily used in the production of net-zero technologies by the NZIA delegated act. The mechanism should be phased out once real European capacity is sufficient.

Either of these two measures would ensure the framework is both credible and enforceable from day one, while avoiding distortions that would arise if requirements were imposed at levels Europe cannot yet deliver. The *central European registry body* (see Section 4.9.1), assigned by the Commission, should review progress annually and adjust thresholds or temporary certificate volumes in line with actual capacity deployment.

Phase	Years	Key Actions
Pilot	2026-2027	Voluntary system in public tenders or voluntary procurement agreements; test registry and certificate trading; supercredit pilot.
Ramp-up	2028-2029	Gradual extension to all segments; mandatory for >50% of installations.
Full Rollout	2030+	Universal application; annual review of strategic component list and weighting.

In contrast, the European inverter industry has *sufficient manufacturing capacity* to meet current European demand (see Figure 1). However, last year's actual production volumes and the current market share of European-made inverters in Europe remain below 40%.

This implies that a **40% 'Made in Europe' threshold** could be applied to inverters immediately. Implementing such a framework would drive additional demand for European-manufactured PV inverters and support higher utilisation rates across European production facilities.

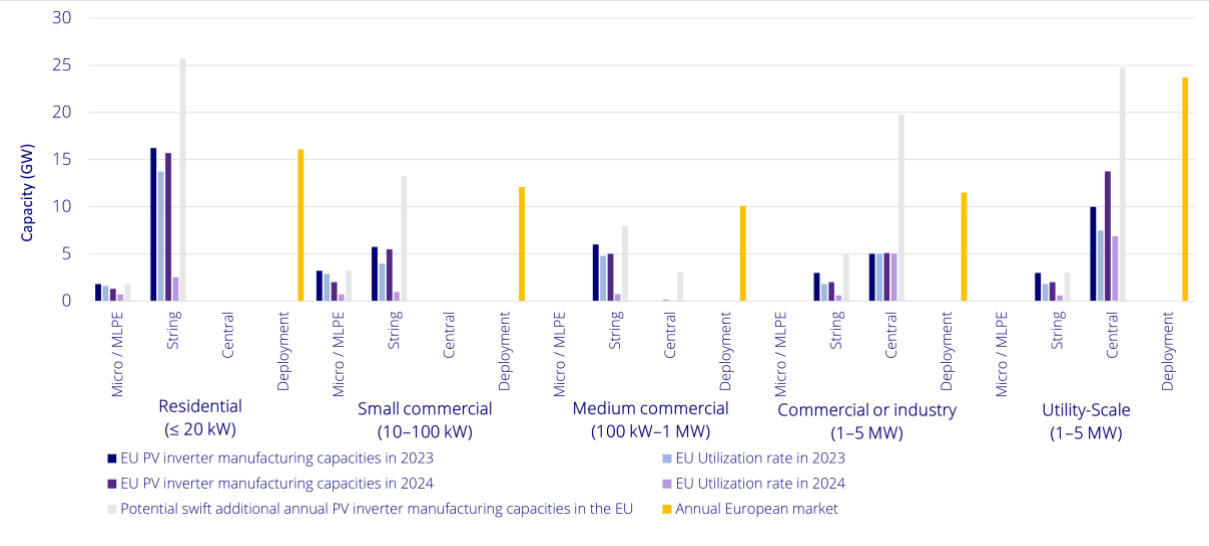


Figure 1. European PV inverter manufacturing capacities across major market segments, compared with annual PV deployment in the European.

9 Summary Table

Feature	Description
Minimum European Content	40% (value-added, with strategic weighting) per module and inverter, averaged across all modules and inverters sold
Strategic Component Incentive	Supercredits for polysilicon, wafers, cells, equipment, etc.—counting extra toward compliance
Compliance Options	Physical content or balance-sheet certificate system
Certificate Trading	Surplus European content and strategic component certificates can be traded
Verification	Digital registry (DPP), third-party audits, grid connection checks
Enforcement	Fines, import bans, loss of market access for non-compliance
Dynamic Adjustment	Annual review of strategic components and weighting factors

10 Advantages and Risks

- Incentivizes European-based PV system components including modules and inverters, increasing overall technological sovereignty and grid resilience.
- Addresses European value chain weaknesses (e.g., wafers, machinery).
- **Flexible, market-based compliance** with robust incentives for strategic re-shoring.
- Transparent, auditable, and adaptable to evolving industrial priorities.
- **Transparency**: Digital Product Passport[20] ensures end-to-end traceability.
- **Supports European industrial policy** and resilience while minimizing trade and supply risks.
- **WTO compliance risk** is mitigated by using a certificate system. It could also add on a tariff scheme on PV, exempting imported PV modules which do comply with the 40% „Made in Europe“ obligation.

[20] https://solaralliance.eu/wp-content/uploads/2024/11/ESIA-PV-Passport-II.pdf

11 Recommendations for development phase

1. **Concept Funding:** allocating EU grants for development and discussion of a more detailed concept
2. **Stakeholder Engagement**: convene a PV Supply-Chain Task Force to streamline concept
3. **Technical Standards**: publish methodology for value-content calculation.
4. **Registry Development**: mandate Digital Product Passport extension to module traceability.
5. **Pilot Funding**: allocate EU Innovation Fund grants for registry and audit infrastructure.
6. **Legislative Adoption**: integrate requirements into Clean Industrial Deal regulations and/or into NZIA-review 2027

Appendix A - The Digital Product Passport

a) What is the Digital Product Passport?

The Digital Product Passport (DPP) is a structured, interoperable digital technology that collects, stores, and shares key product, material, and lifecycle data of PV components across all stages of the value chain. It enables traceability, compliance, reuse, and circular business models by enhancing data exchange, systems interoperability, automatization, and standardization for all relevant stakeholders, from manufacturers to recyclers [21].

b) Purpose & vision

The DPP aims to facilitate a sustainable, data-driven circular economy for PV systems. It serves as a digital track of physical products, enhancing supply chain traceability and transparency, regulatory compliance (e.g., ESPR and Forced Labour regulation), and cross-sector collaboration throughout the PV value chain. Ultimately, it enables data-driven decisions for sustainable production, reuse, maintenance, recycling, and performance optimization.

c) The DPP infrastructure

Based on several research projects, major efforts could drive the implementation of the DPP for the European solar industry. Recent efforts in the Horizon Europe project Retrieve[22] led to the development of a DPP infrastructure, including the following components:

- **Modular, scalable platform architecture:** the platform supports dynamic integration of different stakeholders, data flows, and services. Its modular structure allows future scaling and adaptation to evolving business needs, technical standards, and EU policy frameworks (e.g., ESPR, CSRD).
- **DPP core:** The DPP serves as a centralized data hub for each PV module, enabling secure access to technical, material supply chain traceability, operational, and circularity-relevant data. It supports end-of-life decisions, compliance tracking, and sustainability metrics, based on real-world requirements from recyclers, manufacturers, and service providers.
- **Role-based access control & secure data exchange:** Stakeholders access the platform based on defined roles (e.g., recycler, installer, producer). This ensures data confidentiality, integrity, and trust while maintaining usability through intuitive dashboards and visualizations.
- **API-Enabled Interoperability:** Built on open API standards, the infrastructure ensures interoperability with existing systems (e.g., ERP tools, open-source platforms) and enables automated data integration. Integration with blockchain/DLT components can add tamper-proof traceability in the future.
- **Value-creating services:** To enable the economic viability of the platform, data-driven services will support certification schemes (e.g., ESCC), regulatory compliance, recycled material valorisation, and stakeholder networks.

The current version of the DPP platform is accessible via https://retrieve.winglabs.ch/

[21] Boukhatmi, Ä., Nyffenegger, R., Grösser, S.N., 2023. Designing a digital platform to foster data-enhanced circular practices in the European solar industry. J. Clean. Prod. 418, 137992 https://doi.org/10.1016/j.jclepro.2023.137992.
[22] https://www.retrieveproject.eu/the-retrieve-dpp-platform-prototype-digitizing-the-future-of-pv-circularity/