POLICY ARTICLE

GOVERNANCE

A Brussels Effect for battery sustainability

An EU battery regulation can help drive toward a widely shared evidentiary system for sustainability governance

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The global battery industry, central to clean-energy transitions, is entering a new phase, shaped not only by technology and finance but also by how sustainability is evidenced. The European Union's Batteries Regulation (EU 2023/1542) codifies this shift by mandating specific rules for product life-cycle data, calculation rules, and verification procedures for greenhouse gas emissions, material circularity, and responsible sourcing (*1*). It signals an emerging "Brussels Effect": The EU can globalize not only substantive rules, such as carbon footprint thresholds, but also the evidentiary system through which compliance is demonstrated. Batteries offer a test case because the Regulation is the first EU law to take a full life-cycle approach to product sustainability, reaching into supply chains where required evidence is generated outside Europe, and because these evidentiary rules may diffuse to other product domains. The challenge is whether such systems can remain credible when applied globally.

Traditionally, the Brussels Effect captures how firms outside the EU align with EU substantive rules—such as rules restricting which chemical substances may be used in products—to maintain access to the EU market, even without formal extraterritorial enforcement (*2*). The Batteries Regulation follows this logic but broadens the object of diffusion: Alongside substantive rules, evidentiary rules may also diffuse. The diffusion of evidentiary rules differs from the existing adoption of international standards, reporting protocols, and life-cycle inventory datasets, which usually do not determine market access. The Regulation goes further by integrating selected data standards, calculation rules, and verification procedures into a legally binding, EU-centered compliance system that determines what counts as compliance evidence. This regionally centered prescriptive approach is designed to improve comparability and verifiability but can become problematic when applied globally if more locally representative evidence is not recognized because it does not fit the compliance rules.

This emerging form of evidentiary diffusion raises a crucial question: Although regional regulations naturally draw on regionally anchored data, methodological approaches, and institutional conventions, can such evidentiary systems maintain credibility once applied globally? Batteries provide a revealing case because their supply chains are global and multistage, while the Regulation's current implementation phase makes the case timely. The legal framework is in place, but the evidentiary system that will determine market access is still being operationalized. Choices made now may become de facto expectations for batteries and, if the model extends to other product domains, for sustainability regulation more broadly, making this a critical window to assess how such systems can remain credible when globalized.

The draft Delegated Act establishing the calculation and verification of the carbon footprint (CF) for electric vehicle (EV) batteries (DA-CFB-EV) (*3*), the most technically developed DA supplementing the Regulation, shows how this evidentiary system operates for CF compliance. The DA specifies data, calculation, and verification requirements spanning raw material acquisition and preprocessing, battery production, distribution, and end-of-life recycling, normalized by the battery's lifetime energy output, while excluding electricity used to charge the battery during vehicle operation.

COMPLIANCE-DRIVEN SUPPLY-CHAIN DIFFUSION

To place any rechargeable EV battery above 2 kWh on the EU market, a manufacturer must prepare a CF declaration for each battery model and manufacturing plant, using life-cycle inventory data, calculation rules, and verification procedures specified by the EU (*3*). This evidentiary burden falls heavily on upstream supply-chain stages that largely occur outside Europe yet are central to determining battery CFs; these stages are also where evidence is more difficult to collect and verify. Across the EV battery supply chain serving EU demand, non-European production dominates mining, processing, and cathode manufacturing, supplying more than 80% of EU demand in most upstream stages, whereas Europe plays a larger role downstream in cell manufacturing and EV assembly (see the table).

As specified in the DA-CFB-EV (*3*), the data underlying a CF declaration must conform to the Environmental Footprint (EF) requirements, the EU's official methodology for measuring and communicating life-cycle environmental performance (*4*). Company-specific data must be reported using EF-compliant templates and nomenclatures. Secondary data must comply with EF requirements and are typically sourced from datasets on the Life Cycle Data Network (LCDN), hosted on the European Platform on Life Cycle Assessment (LCA). These datasets and their providers are largely European [see supplementary materials (SM) for details]. The DA also defaults electricity used in life-cycle stages to be modeled with national-average grid mixes—except in the narrow case of directly connected electricity—and mandates verification by EU-designated notified bodies operating under the EU's conformity-assessment framework. Together, these rules locate both data generation and verification within EU-centered structures.

Yet this EU-centered evidentiary system, when applied to globalized battery supply chains, can inadvertently constrain comparability and decarbonization efforts. Non-EU manufacturers often face the dilemma of either using less geographically representative EF-compliant data or generating new evidence under EU requirements.

Feedback from the European Commission's public consultation on the CF methodology highlights several barriers to generating such evidence, in particular limits on obtaining detailed supplier-level data across global value chains, as well as reporting differences and verification burdens (*5*). Such data are often commercially sensitive and outside the contractual control of downstream manufacturers.

Electricity modeling offers a concrete example of how this regionally centered evidentiary system, prescribed to enhance comparability, can compromise representativeness when applied to globally distributed production. Reliance on national-average grid mixes for electricity used in the life-cycle stages specified in the DA offers a standardized basis for comparison but becomes consequential in large, heterogeneous economies. For some major economies, more geographically specific grid-emission data are available and reveal within-country variation comparable in scale to differences among EU member states (see SM and fig. S1). The issue is therefore not simply whether more representative evidence can be generated, but whether the evidentiary system recognizes accurate, transparent, and verifiable data that better reflect actual production conditions. By restricting recognition of facility-level electricity sourcing to directly connected supply, the DA may miss opportunities to incentivize additional renewable procurement.

Europe's position in the EV battery supply chain: Global production shares and import reliance

The table reports Europe's share of global production at each supply-chain stage, alongside the estimated share of European demand supplied from outside Europe. Reference periods, geographic definitions, underlying values, data sources, calculation procedures, and further methodological details are provided in the accompanying SM text and tables S1 to S3.

EV battery supply chain stage	Europe's global production share	Import reliance
Lithium mining	~0%	>80%
Cobalt mining	<5%	>80%
Lithium processing	<1%	~100%
Cobalt processing	<5%	20–30%
Cathode manufacturing	<1%	>95%
Battery manufacturing	10–15%	50–60%
EV assembly	10–15%	30–40%

Together, these examples reveal the limits of a regionally centered evidentiary ruleset. It works within the EU but requires adaptation to function effectively in global contexts. The challenge is compounded by the battery industry's geography, which remains concentrated in non-European production networks, many in the Global South, whereas the EU plays only a limited role now and likely will for years to come (*6*). The DA-CFB-EV illustrates how the Regulation's evidentiary system reflects European evidentiary conventions more than on-the-ground industrial realities. The EF-compliance requirement for secondary datasets prioritizes methodological consistency over representativeness: When more accurate or locally specific data exist but fall outside the compliance hierarchy, CF estimates may systematically misrepresent climate impacts.

VOLUNTARY EPISTEMIC DIFFUSION

Diffusion also operates through voluntary reference to elements of the EU evidentiary system, including data infrastructures, methodological rules, and verification systems. International organizations, standard-setting bodies, and foreign regulators are beginning to reference or align with these elements, even in jurisdictions beyond the EU. Given the EU's market size and regulatory capacity, such diffusion is likely and can enhance the transparency and comparability of sustainability information across jurisdictions (*7*). Yet, the same mechanisms can also concentrate epistemic authority, raising questions about representativeness in globally distributed supply chains.

Growing alignment in the battery sector provides early evidence that elements of the EU evidentiary system are diffusing voluntarily. The battery passport—introduced by the EU Batteries Regulation as the first large-scale mandatory digital product passport (DPP)—has already influenced the Global Battery Alliance (GBA), whose voluntary passport aligns its disclosure principles with the EU framework (*8*). Several jurisdictions, including Japan, South Korea, and Canada, are exploring similar frameworks, and the United States has referenced elements of the EU traceability architecture in its Department of Energy programs on battery supply chains (*9*).

Such diffusion has precedents. Classic examples of the Brussels Effect—such as REACH (the Registration, Evaluation, Authorization and Restriction of Chemicals) and GDPR (General Data Protection Regulation)—demonstrated how EU regulations became global reference points as firms and regulators abroad aligned their rules to maintain market compatibility (*2*). These regulations primarily diffused substantive standards: rules that specify what a product may contain or how a process operates—for example, determining which chemical substances are restricted or how personal data may be processed. The Batteries Regulation will also introduce substantive rules (e.g., CF threshold for market entry) but stands out by diffusing standardized rules for how environmental performance is measured, reported, and verified. Because evidentiary rules are largely product-agnostic, the battery passport is presented as the first test case for a wider DPP system under the Ecodesign for Sustainable Products Regulation (ESPR), with planned extension to textiles, electronics, and other sectors (*10*).

Yet the same mechanisms that foster alignment can also centralize influence over what counts as credible evidence, raising questions about representativeness in globally distributed supply chains. EU-centered conventions increasingly shape emerging global norms, even though much of the production and primary data underpinning these assessments lie in the Global South. This gap reflects not deliberate exclusion but Europe's strategic engagement in standard setting and its influence over the evidentiary systems that organize sustainability information globally (*11*). At the same time, diffusion is not strictly one-directional: European regulatory models evolve through reciprocal learning, including uptake of foreign tools and industry feedback (*12*). These bidirectional dynamics underscore both the potential for a more inclusive evidentiary system and the risk that, without structural attention to representativeness, Europe's early and proactive role in standard setting may give its conventions outsized influence over how sustainability evidence is generated and validated worldwide.

CREDIBLE AND INCLUSIVE EVIDENTIARY GOVERNANCE

The EU Batteries Regulation marks a shift in sustainability governance, where standardized datasets, methods, and verification systems determine market access. Its long-term credibility will depend on whether evidentiary systems ensure trust, interoperability, and representation across diverse production contexts. Achieving this requires coordinated action across three interconnected areas.

Strengthen methodological foundations through reconciliation, not replacement

Industrial ecology and data science can help clarify where methodological choices materially affect results, including differences in system boundaries, allocation, and background datasets. Rather than developing parallel systems, efforts should focus on reconciling these differences and developing transparent conversion protocols between EF and other frameworks. This would enable sustainability evidence generated under different systems to remain comparable and policy-relevant across jurisdictions. Input-output data can help identify upstream hotspots and cross-check whether reported product-level estimates are reasonable, especially where supplier-level information is difficult to obtain (*13*).

Balance rigor with practical decarbonization

Excessive reporting and audit requirements risk redirecting resources from mitigation to compliance, particularly in regions with limited data and verification capacity. A phased and proportionate approach is needed, allowing alternative but demonstrably comparable data and modeling methods until full conformity becomes feasible. For electricity modeling, this means conditional flexibility: allowing region- or facility-specific grid data or verified renewable procurement to substitute for national averages when traceability and integrity can be ensured. Such flexibility helps ensure that evidentiary rules reinforce rather than hinder decarbonization.

Verification should focus on emission sources that materially affect battery CFs, while streamlining requirements for minor contributors. Regulators should assess verification models with varying data granularity and audit requirements to develop tiered pathways for small and medium enterprises and low-capacity regions. Investments in data infrastructure and partnerships with supplier countries can strengthen local verification systems and support mutual recognition of evidence.

Broaden international participation in evidentiary systems

Evidentiary systems remain concentrated in a small set of institutions and jurisdictions, limiting their ability to reflect evolving global production systems. Expanding participation—for example, through clearer roles in data curation and methodological review in the EU-managed LCDN, particularly for actors in major producing regions in the Global South—can improve empirical accuracy and practical feasibility. Monitoring review times for new datasets and data providers, audit outcomes, and geographic participation can help assess whether participation is widening or existing asymmetries persist. Over the longer term, broader collaborations among statistical offices, industry consortia, and research institutes can support the development of shared datasets and methods across jurisdictions while maintaining integrity.

Progress toward more inclusive evidentiary governance will require navigating real-world constraints related to industrial competitiveness, data sovereignty, and control over critical material supply chains. Reforms are therefore likely to proceed incrementally. Near-term efforts can focus on methodological reconciliation and flexible data use, whereas longer-term progress will depend on building verification capacity and strengthening international coordination. Emerging initiatives such as the United Nations Environment Programme's Global LCA Data Access (GLAD) network offer initial platforms for such cooperation (*14*).

CREDIBILITY OF EVIDENTIARY SYSTEMS

Evidentiary systems now underpin several forms of sustainability governance, but with different scopes and consequences. Biofuel standards under the EU Renewable Energy Directive rely on life-cycle accounting and supply-chain traceability to certify whether fuels meet sustainability criteria; the Paris Agreement's transparency framework depends on standardized reporting of national greenhouse gas inventories; and multilateral agreements such as the Convention on Biological Diversity rely on comparable environmental indicators to monitor progress. Across these frameworks, governance hinges on credible and comparable environmental evidence, and the Batteries Regulation goes further by turning regionally defined evidentiary requirements into legally binding conditions for market entry in globally distributed supply chains.

Other recent EU market-entry regulations, notably the Carbon Border Adjustment Mechanism (CBAM), also embody this evidentiary turn, but with a more bounded reach. CBAM currently applies to selected commodities with relatively simple supply chains (e.g., steel and cement) and relies primarily on embedded-emissions reporting, rather than the multistage life-cycle data, modeling rules, and verification required for batteries (*15*).

The EU Batteries Regulation is therefore not an isolated case but an early and revealing indicator of the shared evidentiary system needed to govern sustainability credibly across supply chains that are, in many sectors, unavoidably global. Ultimately, credibility should depend not on where evidence originates, but on whether it accurately reflects production conditions, is transparently documented, and can be compared across methodological systems. Inclusiveness is therefore not a secondary equity concern, but a condition for credible evidence-based sustainability governance. □

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SUPPLEMENTARY MATERIALS

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