

Building Europe's Digital Grid Together

How Building Software Together Delivers Speed,
Interoperability and Technological Sovereignty

October 2026

Contents

	Executive Summary	3
1	Digitalisation as the Foundation of Europe’s Energy Future	5
2	Why Digitalisation Is Not Scaling at the Pace Required	7
3	How Other Industries Broke Through	10
4	Why Energy Is the Strongest Case for Open Source Yet	12
5	A Neutral Steward for the Sector’s Shared Open Source Software	15
6	Recommendations	18
7	Conclusion	20
	References	21

AUTHORS

Lucian Balea
RTE

Sven Fritzsche
Elia Belgium & 50 Hertz

Paula Grzegorzewska
LF Europe

Jonas van den Bogaard
Alliander

Christophe Villemer
Savoir-faire Linux

Stephan Gross
LF Energy

Hugo Pfister
TenneT Netherlands

David Bekaert
Coreso

Executive Summary

Europe's energy transition has become a digitalisation challenge. Grids cannot be built fast enough to keep pace with renewable generation and electrification, so system operators must make far better use of the capacity that already exists. That depends on software for observability, modelling, forecasting and control. Yet digitalisation in the energy sector is not scaling at the pace required.

This paper argues that open source collaboration, supported by a neutral home such as LF Energy, is the delivery model that can change this. Making it the norm requires action from system operators and their suppliers, the European Commission, and ACER, CEER and the national regulatory authorities.

THREE CALLS TO ACTION

System operators and their suppliers should commit engineering capacity to shared open source projects, check what already exists before procuring something new, place new shared tooling under neutral governance from the start, and apply an open source first principle in procurement. Suppliers should build their products and services on the shared foundation rather than around it.

The European Commission should give energy an entry in the EU Open Source Strategy, with a named anchor institution and concrete supporting actions, as it already has for chips, software-defined vehicles and rail. It should make open source the default outcome of publicly funded energy research, fund the hardening and stewardship of proven tools beyond the demonstrator stage, and apply the logic of the Interoperable Europe Act to energy.

ACER, CEER and the national regulatory authorities should provide a comprehensive, supportive framework that encourages system operators to develop software together with peers and partners. They should confirm that contributing to shared open source tooling is an efficient and recoverable cost, and recognise avoided duplication, vendor neutrality and resilience when assessing the quality of digital investment.

The case for this is straightforward. Digitalisation is not held back by a lack of ambition, funding, standards or skills, but by the way software is delivered. European system operators are diverse, so no single product fits them all. Each operator customises and integrates the same non-differentiating functions separately, through procurement cycles that are too slow for a rapidly changing grid, and ends up dependent on suppliers it cannot easily replace.

Other industries facing the same problem, from the internet to telecommunications and cloud computing, found the same answer. Competitors build the shared layer together, in the open and under neutral governance, and compete above it. They do so for speed, interoperability, security and resilience as much as for cost. Energy is an even stronger case. System operators do not compete with one another, and standards such as the IEC Common Information Model and IEC 61850 need shared implementations to deliver the interoperability they promise. Open source complements those standards. It also lets operators solve today's problems quickly while building the capability and digital sovereignty they will need tomorrow.

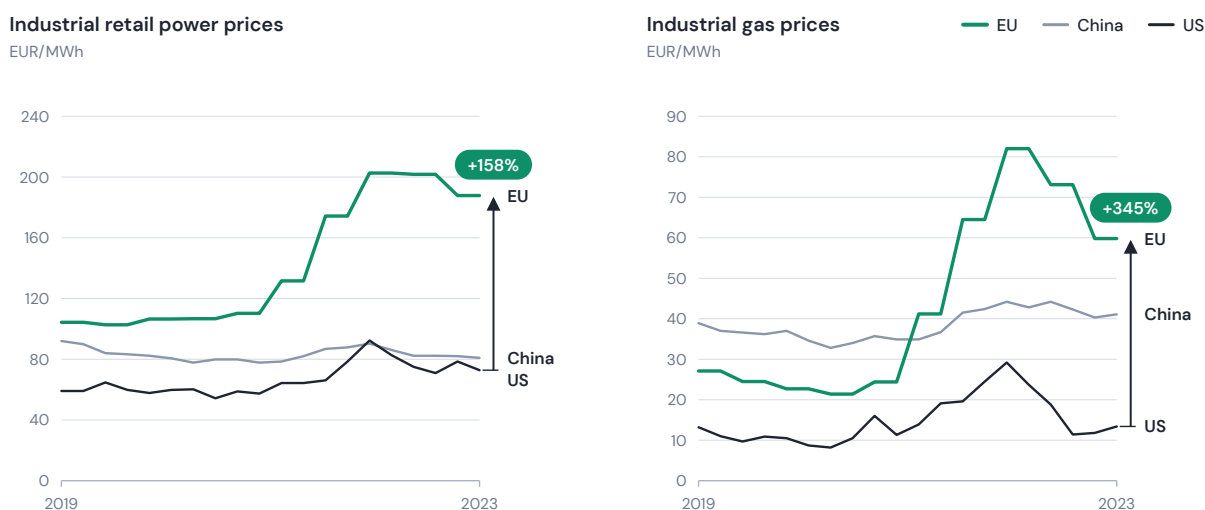
LF Energy already provides this neutral home. Under the open governance of the Linux Foundation, and with a framework for collaboration under European jurisdiction through Linux Foundation Europe, it supports around 40 open source projects. Several of them already run in production across Europe, from PowSyBl in Coreso's TSCNet European Merging Function tool to Power Grid Model at three Dutch distribution system operators. With clear signals from the Commission and regulators and committed engagement from operators, open source can become the delivery model that accelerates Europe's energy digitalisation.

1

Digitalisation as the Foundation of Europe's Energy Future

Europe's energy future is more than climate policy. It is how Europe reduces its dependence on imported fuel, lowers energy costs for households and industry, and closes the competitiveness gap described in the Draghi report. That gap is wide. EU companies pay two to three times more for electricity than companies in the United States and China, and three to five times more for gas (see Figure 1) [1]. Every unit of imported fuel replaced by European renewable generation keeps value inside the European economy and reduces the influence of the countries that supply that fuel. The speed of the energy transition and the strength of Europe's strategic position have become the same question.

Figure 1 Comparison of industrial retail power and gas prices in the EU, China, and the US (2019–2023)



Source: Draghi, *The Future of European Competitiveness, Part A* (2024), based on European Commission data from Eurostat (EU), EIA (US) and CEIC (China).

That speed is set by the electricity grid. On the generation side, renewable capacity is built faster than the grids needed to transport it. On the demand side, electrification of the heating, industry and transport sectors is raising demand to new levels throughout the grids, with rapidly expanding data centre loads concentrating that demand in particular regions. Across Member States the consequences look similar: longer connection queues, excessive curtailment of renewable output, rising congestion and redispatch costs, and reinforcement programmes that cannot be permitted and built as fast as demand and generation patterns are changing. Together, these consequences cost Member States billions of euros. More grid capacity is needed, but it cannot be built fast enough.

Closing this gap will require making better use of grid capacity that already exists but is not used to its full potential. This requires a more granular and near-real-time understanding of how the grid is actually operating. Congestion management, flexibility activation, dynamic line rating, scenario-based planning and operational forecasting require sufficient system observability, modelling and control enabled by further digitalisation of the energy system. Thus, the energy transition increasingly becomes a digitalisation challenge.

The European Commission has reached the same conclusion and said so twice on the same day. On 3 June 2026, the European Commission adopted the Strategic Roadmap for Digitalisation and AI in the Energy Sector [2] together with the Communication on European Technological Sovereignty [3], as parts of a single Tech Sovereignty Package. The pairing is deliberate. The Commission treats the digital layer of the energy system and Europe's technological sovereignty as one question rather than two.

The consequence is direct. If Europe's energy system increasingly relies on software, then who controls this software becomes part of Europe's energy sovereignty. Dependence does not disappear when it moves from fuel to software. It only becomes harder to see. The Commission states the requirement plainly: the EU *"must retain sovereign control over the digital solutions, AI models and algorithms on which its energy system increasingly depends."* [2, Section 1]

2

Why Digitalisation Is Not Scaling at the Pace Required

The strategic case for digitalising Europe's electricity grid has been made many times and is not in dispute. Delivery is the challenge. When the Commission consulted the sector while preparing its digitalisation roadmap, the barriers stakeholders named were practical rather than strategic: limited access to high-quality data, lack of data interoperability, and cybersecurity [2, footnote 34].

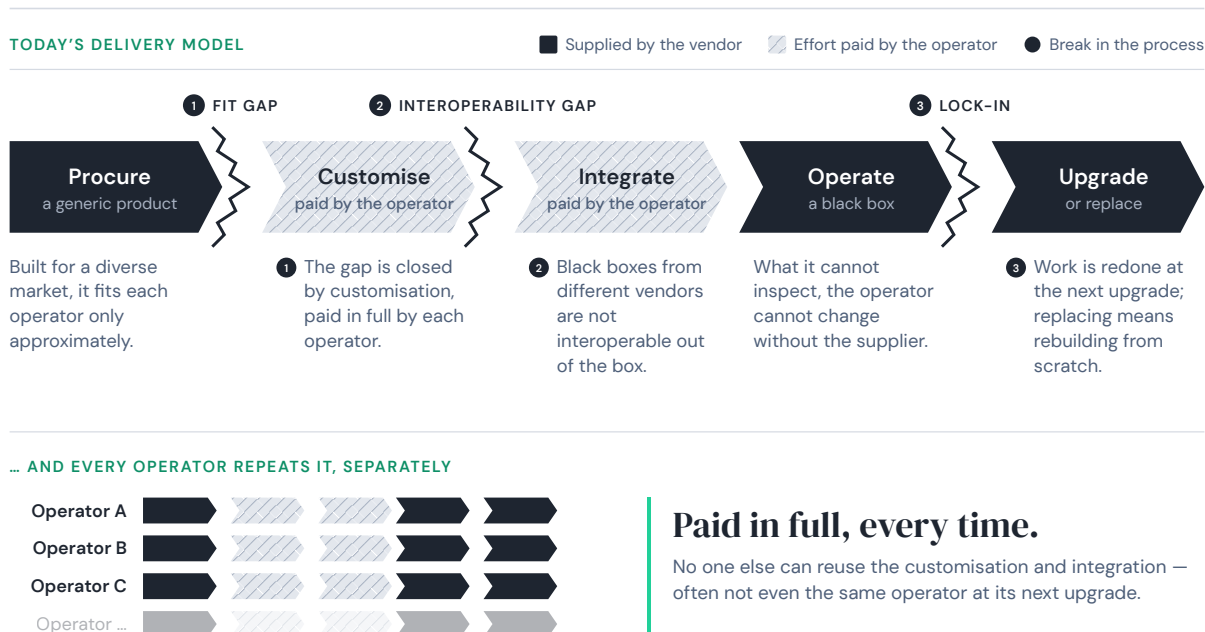
Distribution and transmission operators describe the same difficulty in their own words. At the distribution level, the most recent European assessment of digital twin adoption found progress to be early and fragmented, with fully integrated and continuously updated environments present in only a very small number of organisations [4, Executive Summary and Sections 3.2 and 4.2]. At the transmission level, ENTSO-E has published a full position paper on vendor-agnostic solutions and has made vendor-agnostic architectures a formal objective of its research and innovation roadmap [5], [6, Mission 4]. Different vocabulary, same underlying challenge.

That challenge is not a lack of skill, and it is not a lack of data. Expertise across the sector is strong, and smart metering, substation automation and market platforms have increased the volume of available data considerably. The challenge is integration. Planning tools, operational systems, asset databases and external data sources are frequently not aligned with one another, so operators run several parallel digital environments instead of one coherent picture of their grid. Organisational separation between IT functions and grid operations adds a second layer of the same issue. The pieces exist. They do not fit together. Every operator in Europe is working on that fit, and each one is working on it alone.

This fit challenge cannot be solved once and then sold to everyone. European system operators are a diverse group, and the differences are not only between transmission and distribution. They are just as large within each group. Grid topology, level of electrification, renewable penetration, regulatory regime, ownership structure and the inherited layout of existing infrastructure all shape what an individual operator needs. Size is not a reliable predictor either. Some smaller operators are further ahead than much larger ones because they made deliberate strategic choices in the past. There is no average European system operator, and therefore no single architecture that one product can be built for.

This is where the current delivery model for software breaks down. A solution designed for a diverse market fits each buyer only approximately. The remaining gap is closed through customisation. Moreover, off-the-shelf components from different vendors are usually not interoperable out of the box. The integration of black-box digital products typically requires substantial effort. Each operator pays for that customisation and integration in full, and no one else can reuse it, often not even the same operator at its next upgrade. What an operator cannot inspect, it cannot change without the supplier's help. What it cannot change, it cannot replace without rebuilding from scratch. European law already recognises this problem. The Data Act identifies "vendor lock-in, which undermines competition and the development of new services" as precisely what interoperability rules exist to overcome [7, Recital 90].

Figure 2 Overview of gaps and inefficiencies in the current proprietary delivery model across system operators



Note: Schematic illustration of the delivery model described in this section.

System operators across Europe face similar challenges at the same time. Load flow calculation, state estimation, load and generation forecasting, congestion analysis, substation automation, scenario-based planning, asset management: these are the shared basis of operating a grid, and in none of them does one European system operator compete with another. Each is nevertheless specified, procured, integrated and maintained separately by every operator, each time at full cost and through procurement cycles that are too slow to keep pace with a rapidly changing grid.

Regulation often reinforces this pattern instead of correcting it. CEER has described the capital expenditure bias in grid regulation, under which *“lower cost solutions, based on OPEX, may seem unattractive to the system operator compared to the higher profits of higher cost solutions from a CAPEX investment [8].”* Regulatory frameworks differ across Europe, but the risk is common: where the rules do not clearly recognise joint development as a legitimate and valuable use of operators’ resources, they can favour buying products over building shared solutions. European regulatory authorities should therefore provide a comprehensive, supportive framework that encourages system operators to develop the software the energy sector needs together with partners.

Public research has not closed the gap either, and not because of weak quality or insufficient funding. Successive Horizon programmes have paid for the conceptual groundwork for software solutions such as: digital twins, energy data spaces and, most recently, AI foundation models for grid operations, where the AI.grids initiative has brought together 49 partners including 19 transmission and distribution system operators [9]. The results are consortia, reference architectures, demonstrators and published knowledge. These are real assets that lay the foundation for solid software. What is usually missing is long-term maintenance, clear ownership, a security process and a home after the project ends. This is structural rather than accidental. European research funding is built to produce knowledge. It is not built to produce operational software that outlives the project and becomes widely adopted.

What is missing is therefore not ambition, funding, standards or engineering skill. Europe’s system operators have all four. What they lack is a delivery model for software that works and scales

across the sector. Open source is that model. Solutions are developed jointly and shared openly, so that every operator and supplier can inspect, reuse and improve them and the effort of building them is no longer repeated in every organisation. For open source to succeed at scale, however, a neutral home is an important enabler. LF Energy is such a home for open source development in the energy sector. It provides the neutral ground for a thriving, sustainable ecosystem around each jointly developed software project: structured governance, clean legal and IP frameworks, security best practices, and a community of operators, vendors and researchers who build on the result and keep it alive. It also gives every participant confidence that no single party can take control of that result. Together, an open source delivery model and a neutral home such as LF Energy give operators a common foundation that helps them meet their individual obligations, making collective effort in building software a sensible choice for every operator.

3

How Other Industries Broke Through

The problem described in the previous section is not unique to energy. Several industries have faced the same combination: slow and costly delivery of software that gives no competitive advantage, dependence on a small number of suppliers, and good standards that never turned into working interoperability.

Each of them found the same way out. Competitors agreed to build the shared layer together, in the open, under governance that none of them controlled alone. A 2025 Linux Foundation study of vertical industries, including telecommunications, energy, automotive and finance, identifies innovation speed, interoperability and cost as the main drivers of shared software creation [10]. That approach has a name. It is open source, and in these industries it is not a philosophy. It is a strategic decision to get dependable software deployed faster, with more security and less dependence on any single supplier.

The internet is the clearest early example. Its protocols were written down as open specifications, and those specifications were good. They were not what made the internet work. What made it work were shared implementations that anyone could use, inspect and improve. The Apache web server carried the majority of the early web. The BIND name server was for decades the standard way the internet translated names into addresses. The lesson is worth stating directly, because it applies to energy without modification. **Interoperability is produced by shared proven software, not by shared documents.** Open source projects in other industries show the same effect: instead of each company implementing a standard in its own way, they build a shared implementation that becomes a neutral reference on which everyone can build competitive offerings.

Interoperability is produced by shared proven software, not by shared documents.

Telecommunications is the closest commercial parallel as an infrastructure- and regulation-heavy industry. Mobile network operators compete hard for the same customers. They still concluded that their dependence on a small number of integrated equipment vendors held back their pace of innovation and limited their choice of suppliers more than working together would, and they acted on that conclusion jointly. European operators were among the leaders. Through shared initiatives on open radio interfaces, network automation and cloud infrastructure, they jointly developed common specifications and software. They focused on the parts of the network where being different brings no competitive advantage. One example is Sylva, a Linux Foundation project started by European operators to build a shared cloud software stack for their networks [11]. The operators continue to compete on coverage, price and service.

Cloud computing makes the point most sharply. The companies that compete most fiercely in global cloud infrastructure run their platforms on a shared foundation that none of them owns. The operating system, the virtualisation tooling and the orchestration layer beneath the major cloud services are developed in public, maintained jointly, and hosted by neutral foundations. Each provider assigns engineers to develop software its direct rivals also use. They do this because many contributors develop, test and secure a shared layer faster than any single company could, because owning that

layer privately would add cost without adding advantage, and because a common foundation grows the market they all sell into.

The pattern is consistent across all three cases. Organisations that compete identify the layer where competition creates no value. They build that layer together in public, which lets them deploy faster, benefit from broader scrutiny of the code and innovate on a common base. They place it under governance that no single participant controls. Then they go on competing above it. A 2020 McKinsey study of 440 large enterprises found that open source adoption, which goes beyond using open source to contributing to it, has three times the impact on innovation at companies with top-quartile software development performance as at companies in the other quartiles [12]. Neutral governance is not a detail in this arrangement. It is the condition that makes participation safe. An organisation will commit real engineering effort to shared software only when it is confident that no competitor, supplier or government can later take control of the result.

The European Commission has already recognised this pattern and has begun to act on it. Its Open Source Strategy describes industrial platforms in which competitors *"share non-sensitive information and develop common non-differentiated open source building blocks to increase efficiency, while continuing to compete on final products."* [3, Section 4.1] The Commission points to two sectors where this is already established in Europe, and it names the organisation behind each one: the Eclipse Software Defined Vehicle working group in the automotive industry, and the OpenRail Association in the railway industry. Both were created by companies that compete directly with one another. Both are now part of how the Commission understands European industrial software strategy.

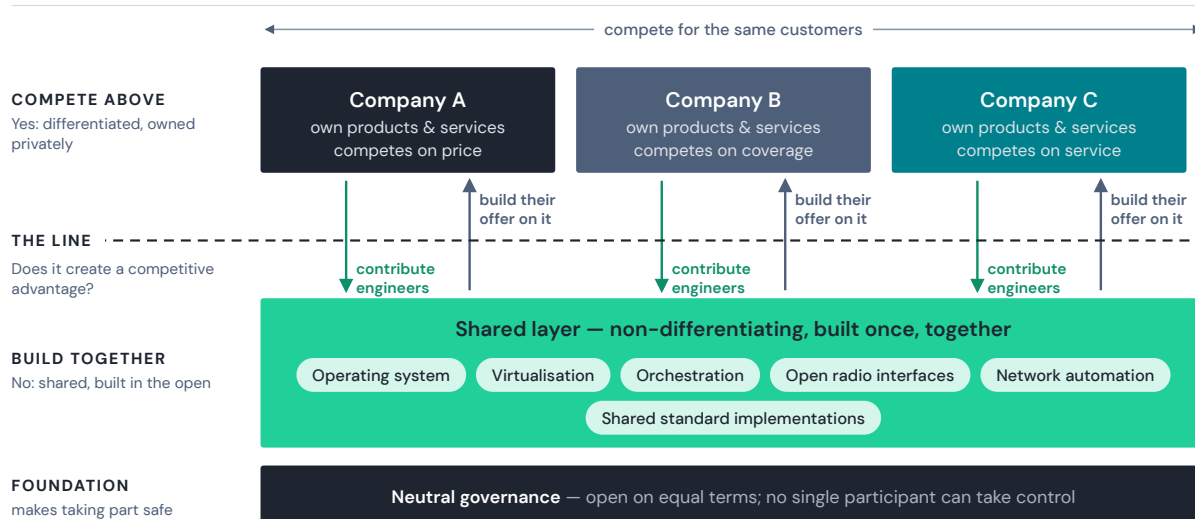
4

Why Energy Is the Strongest Case for Open Source Yet

Everything described in the previous section happened in industries made up of direct competitors. That is what makes those examples remarkable. Companies fighting each other for the same customers still found it worthwhile to build shared software together. Europe's system operators are not in that position. A German distribution system operator and a Spanish one share no market. Two transmission operators in different areas do not bid against each other for the same business. They are regulated system operators with defined territories and public obligations. The strongest argument against open collaboration, that it helps a competitor, does not apply to them at all. Telecommunications and cloud computing made the open source model work between competitors. DSOs and TSOs can make it work without that obstacle.

Figure 3 Collaborative delivery model on a shared, non-differentiating open foundation as seen in telecommunications and cloud industries

HOW COMPETITORS BUILD TOGETHER — E.G. TELECOMS AND CLOUD



In energy, the case is even stronger.

European system operators do not compete for customers at all — the main argument against building together, that it helps a competitor, does not apply.

Note: Schematic illustration of the pattern described in section 3.

The diverse nature of the European system operators also supports this approach. If there is no average European system operator, no single digital product can be built for the average. Open source is the only delivery model that answers this without breaking the sector into fragments. A shared core is maintained in common, and each operator adapts it to its own regulatory regime, grid topology

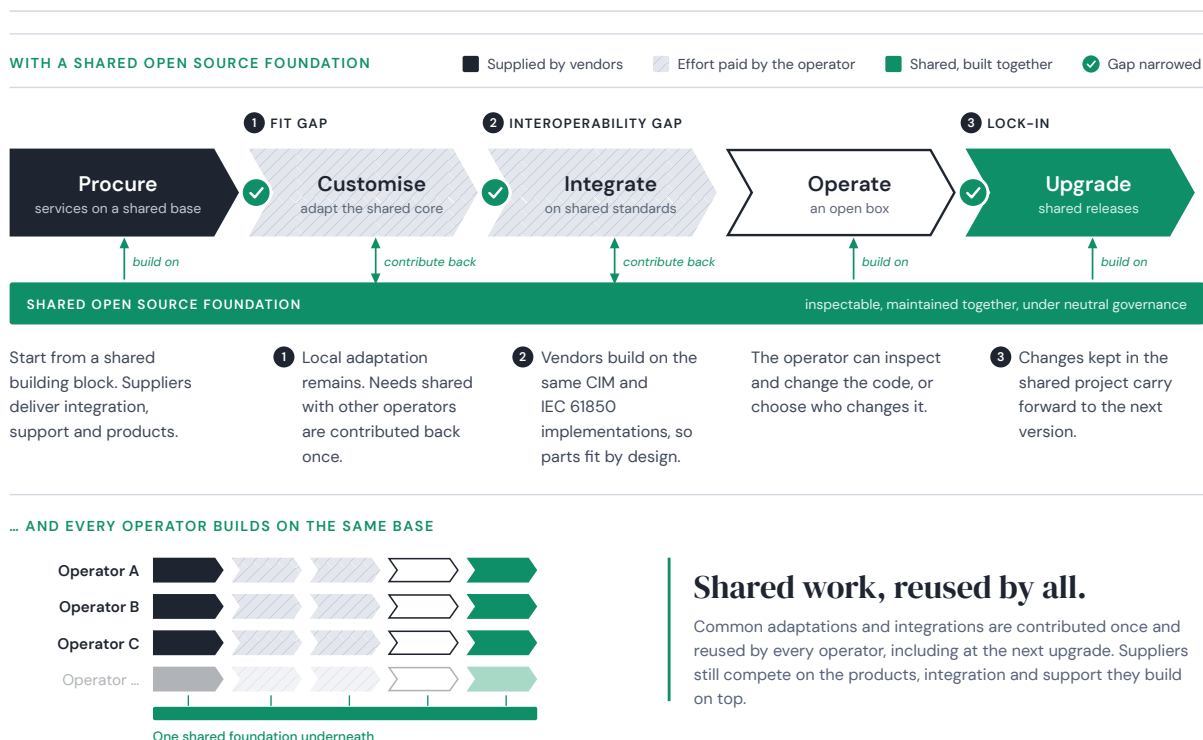
and internal processes, while the common parts stay common. This makes a decisive difference. An operator that buys software receives someone else's roadmap. An operator that contributes to open source software puts its own requirements into the roadmap. It gets a tool shaped to its needs without paying to build the whole tool.

Open source does not remove the work of customisation and integration, and it does not replace complete products. Operators will still adapt software to their own grids, and suppliers will still deliver integration, support and finished products. What changes is the foundation that work is built on, and who can reuse it. Measured against the three gaps in Figure 2:

- **Fit:** operators start from a shared building block instead of a generic product. Adaptations that others also need are contributed back, so the next operator does not pay for them again.
- **Interoperability:** when vendors and operators build on the same implementation of the CIM or IEC 61850, components fit together by design, and integration effort falls instead of being repeated at every operator.
- **Lock-in:** the operator can inspect what it runs and change it, or choose any competent supplier to change it. Changes maintained in the shared project carry over to the next version instead of being rebuilt at every upgrade.

Procurement shifts accordingly, from buying a licence for a closed product to buying services around a shared foundation.

Figure 4 Delivery model on a shared open source foundation, narrowing the gaps shown in Figure 2



Note: Schematic illustration of the delivery model described in this section. Customisation and integration remain with the operator, and suppliers continue to deliver products and services.

The sector has already invested heavily in standards. The IEC Common Information Model and IEC 61850 represent many years of careful work. Interoperability nevertheless keeps falling short of what those standards promise, because each vendor and each operator implements them slightly

differently. Standards turn into interoperability when there is shared code that implements them. Open source therefore does not replace standards; it complements them. Standards define what systems must do, and shared code gives every vendor and operator the same implementation of it. Experience from that shared code in turn flows back into the standards and helps improve them. The sector knows this already. ENTSO-E publishes its own CIM profiling tools as open source under the Apache 2.0 licence [13]. That is not an argument being made from outside the sector. It is an established practice within the sector's own association.

Open source starts by solving the problems operators face today, and there are concrete examples with measurable results. TenneT in the Netherlands, for example, faced significant performance constraints in its grid security analysis. The solution they found was PowSyBI, an open source framework hosted by LF Energy. Using PowSyBI, they built an orchestration platform called ReFlow, which allowed TenneT to achieve a tenfold improvement in calculation performance in just five months [14]. This case demonstrates that open source is not merely an architectural ideal; it is a production-grade delivery model that enables operators to bypass lengthy procurement cycles and immediately tackle critical scaling challenges with shared, high-quality tools.

The same choice also prepares operators for tomorrow. Building blocks that operators can inspect, adapt and run themselves reduce dependence on any single vendor, so that an acquisition, a licensing change or a shift in a supplier's roadmap cannot put infrastructure with a lifetime of decades at risk. They also build in-house expertise and keep critical digital capability under the sector's own control. This is the practical meaning of digital sovereignty: it is not a reason to wait for a strategic debate, but a benefit that accumulates with every solution operators deploy today.

Security deserves a direct answer rather than a footnote, because it is the objection raised most often about open source in critical infrastructure. The Commission's own assessment is that open source *"can contribute to cybersecurity because public availability of source code enables independent inspection, audit and vulnerability detection, while facilitating peer review, coordinated remediation and software supply-chain transparency [3, footnote 25]."* For infrastructure that has to be defended, an operator's ability to see what is running in its own control room is a strength rather than an exposure. European law has already settled this question. The Cyber Resilience Act creates a light and specifically tailored regime for open source software stewards, and provides for voluntary security attestation schemes designed around open development practices [15, Recitals 19 and 21 and Article 24]. The legislator did not treat stewarded open source as a risk to be tolerated. It treated it as a model to be supported.

None of this means the sector has already decided. ENTSO-E's own position paper on vendor-agnostic solutions treats open source as one of three options, alongside proprietary and commercial software, and notes fairly that open modules may need adaptation to fit specific needs [5, pp. 19–20]. That is an accurate description of where the discussion stands today. The same paper also expects that self-developed and open source modules will be exchanged between transmission operators. The direction is therefore already set. What this paper argues is that the sector should stop treating open source as one option among three for its shared, non-differentiating layer, and start treating it as the default for that layer, because it lets operators solve today's problems while building tomorrow's capability.

5

A Neutral Steward for the Sector's Shared Open Source Software

Successful open source projects are maintained by a healthy community supported by a neutral facilitator, because no organisation commits engineering effort to a project whose direction someone else can take over. European organisations recognise this: according to the *2026 State of Open Source in Europe* report, foundation-hosted, neutrally governed projects are the model they are most likely to adopt [16]. Under open governance, funding a project does not give control over its technical direction, either to the sponsors or to the foundation itself. Such a neutral facilitator must meet four requirements:

1

The governance structure must be open, non-discriminatory, published and transparent, and accessible to all interested parties on equal terms.

2

No single organisation, individual, member, supplier or government can control the direction of the project.

3

There must be a legal entity and hosting arrangements in Europe, so that the community infrastructure sits under European law.

4

The community, supported by the neutral facilitator, must be able to outlive the departure of any individual organisation or member and the end of any funding cycle.

LF Energy meets these requirements today. It operates under the open governance rules of the Linux Foundation, with a published technical governance model, a Technical Advisory Council, and membership open on equal terms to system operators, suppliers, researchers and public bodies. Its project community, both at technical and strategic governance levels, is largely European and is built around the problems European operators actually have. Linux Foundation Europe provides a European legal entity, which allows the community infrastructure to be hosted and operated in Europe. Behind it stands the largest facilitator of open source communities in the world, with the security, licensing and release processes that come with that scale.

Already today, LF Energy supports open source projects and their communities with shared expertise, knowledge and services, from governance, legal and security guidance to community building, training and project infrastructure. This gives projects the support they need to succeed and scale, and open source software developed this way is already running in the European energy system. PowSyBl, originally developed by RTE and open sourced under LF Energy, is now used by transmission system operators, regional coordination centres and vendors across Europe [17]. Modules based on it underpin the European Merging Function tool of Coreso and TSCNET, which consolidating the grid models of every TSO into a single Common Grid Model [17], [18]. Power Grid Model, a calculation

engine for distribution grids, runs in production at Alliander, Enexis and Stedin, so that three Dutch distribution operators use one shared engine instead of three separate ones. It has passed ten million downloads [19]. RTE runs OperatorFabric across eight control centres. The same platform now also underpins PEMMDB, the Pan-European Market Modelling Database that RTE international developed for ENTSO-E. Through a single secure interface, the 40 TSOs that make up ENTSO-E submit the data behind Europe's strategic planning studies [20]. SEAPATH provides a proven open source platform that enables the virtualisation of substation automation and control functions on standard server hardware, combining real-time performance, high availability and vendor independence. RTE uses it as the virtualisation layer of R#SPACE, its new generation of multi-vendor protection, automation and control systems. The first substation has been running on SEAPATH since the end of 2023, and RTE plans to reach 100 substations by 2030 [21]. In Great Britain, National Grid Electricity Transmission intends to pilot the SEAPATH architecture on its network before 2030 [22].

After eight years of operation, LF Energy supports around 40 open source projects that span grid analysis, substation automation, forecasting, flexibility and electric vehicle charging. Many of them go beyond demonstrating concepts: they are production-ready solutions that anyone can inspect, operate, modify and contribute to.

Figure 5 Funding allocated for open source initiatives across EU sectors in Annex II of the EU Open Source Strategy



Note: Amounts as stated in Annex II; "around" and "more than" values shown at the stated figure; EUR 1.2 billion is their approximate sum. Further named programmes not shown.

Source: European Commission, European Tech Sovereignty, COM(2026) 503 final, Annex II.

The EU Open Source Strategy, part of the Tech Sovereignty Package, contains a gap. It states that leading European players in key sectors, naming energy alongside automotive and aviation, have already taken the lead in setting up open source industrial platforms [3, Section 4.1]. Annex II of the same document lists the concrete actions the Commission is funding, sector by sector: around EUR 500 million for open hardware and chips, around EUR 250 million for software-defined vehicles, more than EUR 250 million for IoT and edge computing, EUR 190 million for the Next Generation Internet, and further named programmes [3, Annex II]. Energy has no entry. Automotive has the Eclipse Software Defined Vehicle working group. Rail has the OpenRail Association. Energy, named in the main text as a sector already leading, has no institution named and no action listed. LF Energy already supports the European energy sector in leading open source development that addresses the sector's challenges at every level. LF Energy also provides a framework for collaboration under European jurisdiction,

through Linux Foundation Europe. This framework is already in use across several key projects and is now being extended into a symmetrical framework in which European and US participants can take part on equal terms, enabling genuinely global collaboration.

6

Recommendations

Further developing a strong open source ecosystem for the European energy sector relies on three decisions, held by three different actors. System operators and their suppliers can supply the engineering effort, the Commission can set the strategic direction and create the right conditions, and regulators can remove the disincentives to shared open source development.

6.1 To European System Operators and Their Suppliers

- 1 **Contribute to the shared projects you rely on.**
Shared software is built by people, and technological resilience comes from the expertise gained by taking an active part. Operators should treat contributing as both a strategic responsibility and a strategic benefit, and contribute improvements back to the shared project rather than maintaining their own copies. Shared software becomes more resilient when those who depend on it also help shape and maintain it.
- 2 **Adopt before building.**
Check what already exists and is used by other operators before specifying a new procurement.
- 3 **Put new shared tooling under neutral and trustworthy governance from the start.**
Placing a project in a neutral foundation at the beginning costs very little. Doing it years later, once it has become an internal maintenance burden, is far harder and frequently does not happen at all.
- 4 **Suppliers: build on the shared foundation.**
An open core does not remove the market for integration, support, deployment and differentiated products. In every industry described in Section 3, it enlarged that market.
- 5 **Apply the open source first principle.**
Every software procurement should follow an open source first approach. For newly developed solutions, open source should become the standard; when procuring existing products, open source solutions should be favoured where they are available and equally suited.

6.2 To the European Commission

- 1 **Give energy an entry in the EU Open Source Strategy.**
The next iteration of the strategy should name an anchor institution for open source in energy and list concrete supporting actions, on the same basis as chips, software-defined vehicles, rail and the Next Generation Internet. LF Energy puts itself forward for that role and is ready to be assessed against whatever criteria the Commission applies to the equivalent institutions in other sectors.
- 2 **Make open source the default outcome of publicly funded energy research.**
Software produced under Horizon Europe energy calls should be released under an open licence with a named long-term host, rather than deposited in a repository that goes quiet

when the grant ends. This should apply to the Al.grids work on foundation models for grid operations now, while its licensing and governance arrangements are still being decided.

3 Fund the step that research funding leaves out.

Support the hardening, maintenance, security process and community stewardship of tools that have already proven themselves at demonstrator stage. This costs a small fraction of the research that produced them, and without it that research does not reach production.

4 Apply the logic of the Interoperable Europe Act to energy.

Article 4(6) requires public sector bodies to prioritise interoperability solutions that do not carry restrictive licensing terms, where those solutions are equivalent [23, Article 4(6)]. The same principle should guide digital funding and procurement guidance in the energy sector.

6.3 To ACER, CEER and the National Regulatory Authorities

Nothing here asks regulators to choose technologies. That is not their role and they have rightly avoided it. Instead, these recommendations point to an approach to the shared development of software that is both cost-effective and resilient. Shared open source tools reduce dependence on single suppliers and strengthen the security and continuity of supply of critical infrastructure. These questions concern how the regulatory framework treats and assesses the joint development of software, which is squarely within the regulators' remit.

1 Confirm that contributing to shared open source tooling is an efficient and recoverable cost.

Engineering time and resources an operator contributes to shared open source development should be treated like any other efficient spending on software, not as a discretionary extra. Shared development spreads the cost of building and maintaining common functions across many operators, lowering it for the sector as a whole and for the contributing operator itself.

2 Provide a comprehensive, supportive framework for joint development.

Regulatory frameworks differ across Europe, but operators should be able to rely on the same principle everywhere: developing software together with peers and partners is a legitimate and valuable use of their resources. Applying CEER's existing recommendation of TOTEX and technology-neutral approaches to joint development ensures that the way spending is classified does not decide whether an operator buys a product or builds a solution together with others.

3 Count avoided duplication and reduced exit costs when assessing efficiency.

An operator that adopts a shared tool instead of procuring its own should be recognised for the saving. Vendor neutrality, switching cost and resilience should become reportable dimensions of digital investment quality. All three follow directly from the neutrality and non-discrimination objectives that ACER and CEER already state.

7

Conclusion

Europe's competitiveness and its technological sovereignty increasingly depend on its electricity grid. As this paper has argued, the digital layer of that grid is no longer a support function. It is critical infrastructure in its own right. It determines how quickly Europe can bring down energy costs for households and industry, how far it can reduce its dependence on imported fuel and on technology it does not control, and how securely it can operate the system on which its economy runs.

Europe does not need to build this digital infrastructure in isolation. System operators share many of the same challenges and can collaborate on common digital capabilities. By embracing open source as a strategic delivery model, the sector can move beyond fragmented and proprietary silos towards a common, scalable foundation that it can inspect, adapt and control. This approach enables organisations to pool resources and expertise, deploy faster, improve interoperability, and keep critical digital capability under the sector's own control.

LF Energy will act as the neutral and trustworthy steward needed to make this open source collaboration work at scale. Through Linux Foundation Europe, it offers a framework for collaboration under European jurisdiction, and it supports open source projects and communities that work together to turn the digital layer from a costly operational burden into a secure, shared foundation, in line with Europe's technological sovereignty ambitions.

The opportunity is therefore bigger than reducing the cost of digitalisation. It is about changing how Europe builds its critical digital energy infrastructure: openly, collaboratively, and at scale. Open source collaboration can become the strategic delivery model for Europe's energy digitalisation. This is the surest path for Europe to secure its technological sovereignty, accelerate the energy transition, and build a competitive, sustainable future for all.

References

- [1] M. Draghi, 'The Future of European Competitiveness. Part A: A Competitiveness Strategy for Europe', Sep. 2024. [Online]. Available: https://commission.europa.eu/topics/competitiveness/draghi-report_en
- [2] European Commission, 'Strategic Roadmap for Digitalisation and AI in the Energy Sector', COM(2026) 501 final, Jun. 2026. [Online]. Available: https://energy.ec.europa.eu/document/download/fbe97b7a-20ff-4361-a8b2-9a4055695f3a_en?filename=COM_2026_501_1_EN_ACT_part1_v9.pdf
- [3] European Commission, 'Communication on European Tech Sovereignty, accompanied by an EU Open Source Strategy', COM(2026) 503 final, Jun. 2026. [Online]. Available: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52026DC0503>
- [4] DSO4DT, 'State of Digital Twins for the Electricity Grid Across Europe, First Iteration', EU DSO Entity, Task Force on Digitalisation of the Energy System, Deliverable D3.1, grant agreement 101213413, 2026. [Online]. Available: https://eudsoentity.eu/wp-content/uploads/2026/07/StateofDigitalTwins_submission.pdf
- [5] ENTSO-E, 'Vendor Agnostic Solutions (VAS) for Next-Generation Control Room Eco-Systems', position paper, May 2025. [Online]. Available: https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/Publications/Position%20papers%20and%20reports/2025/entso-e_pp_VAS_Position_Paper_250507.pdf
- [6] ENTSO-E, 'Research, Development and Innovation Roadmap 2024–2034', Jul. 2024. [Online]. Available: https://eepublicdownloads.entsoe.eu/clean-documents/Publications/RDC%20publications/entso-e_RDI_roadmap_2024-2034_240710.pdf
- [7] *Regulation (EU) 2023/2854 of the European Parliament and of the Council of 13 December 2023 on harmonised rules on fair access to and use of data and amending Regulation (EU) 2017/2394 and Directive (EU) 2020/1828 (Data Act)*. 2023. [Online]. Available: <http://data.europa.eu/eli/reg/2023/2854/oj>
- [8] CEER, 'CEER Paper on Incentives in Regulatory Frameworks with a Focus on OPEX/CAPEX Neutrality', May 2025. [Online]. Available: <https://www.ceer.eu/wp-content/uploads/2025/05/CEER-Paper-on-incentives-in-regulatory-frameworks-with-a-focus-on-OPEX-CAPEX-neutrality.pdf>
- [9] Cresym, 'AI.grids'. Accessed: Oct. 19, 2026. [Online]. Available: <https://cresym.eu/ai-grids/>
- [10] Linux Foundation, 'Software-Defined Vertical Industries: Transformation Through Open Source', 2025. [Online]. Available: <https://www.linuxfoundation.org/resources/publications/software-defined-vertical-industries-2025>
- [11] Linux Foundation Europe, 'Project Sylva'. Accessed: Oct. 13, 2026. [Online]. Available: <https://sylvaproject.org/>
- [12] S. Srivastava, K. Trehan, D. Wagle, and J. Wang, 'Developer Velocity: How software excellence fuels business performance', McKinsey & Company, Apr. 2020. [Online]. Available: <https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/developer-velocity-how-software-excellence-fuels-business-performance>
- [13] ENTSO-E, 'Common Information Model (CIM): CIM Profiling Tools (CimConteXtor, CimSyntaxGen)'. Accessed: Oct. 13, 2026. [Online]. Available: <https://www.entsoe.eu/data/cim/>
- [14] LF Energy, 'Grid Security at Scale: How TenneT Built a 10× Faster Analysis Platform on PowSyBl', case study, Apr. 2026. [Online]. Available: https://lfenergy.org/wp-content/uploads/sites/18/2026/04/LF_Europe_Case_Study-GridSecurity-042126.pdf
- [15] *Regulation (EU) 2024/2847 of the European Parliament and of the Council of 23 October 2024 on horizontal cybersecurity requirements for products with digital elements and amending Regulations (EU) No 168/2013 and (EU) 2019/1020 and Directive (EU) 2020/1828 (Cyber Resilience Act)*. 2024. [Online]. Available: <http://data.europa.eu/eli/reg/2024/2847/oj>
- [16] M. Boehm, P. Grzegorzewska, and M. Gerosa, '2026 State of Open Source in Europe: Navigating AI and Digital Sovereignty Through Open Governance', The Linux Foundation, Oct. 2026. [Online]. Available: https://www.linuxfoundation.org/hubfs/Research%20Reports/WorldofOS_EUSpotlight_2026_final.pdf

- [17] Linux Foundation Europe, 'Case Study: PowSyBl. A Community-Led Open Source Project for European Grid Sovereignty', 2025. [Online]. Available: https://linuxfoundation.eu/hubfs/LF%20Europe%20Reports/lfeu_cs_powsybl_102125.pdf
- [18] Coreso, 'CorNet Milestone: CGM Go-Live successful'. [Online]. Available: <https://www.coreso.eu/cornet-milestone-cgm-go-live-successful/>
- [19] LF Energy, 'Global adoption of Power Grid Model surpasses 10 million downloads'. Accessed: Oct. 13, 2026. [Online]. Available: <https://lfenergy.org/power-grid-model-surpasses-10-million-downloads/>
- [20] RTE international, 'RTE international modernises ENTSO-E's energy data collection with an open-source solution'. [Online]. Available: <https://www.rte-international.com/en/open-source-solution-entsoe-data-collection/>
- [21] LF Energy, 'RTE Deploys LF Energy SEAPATH for Virtual Protection Automation and Control'. Accessed: Oct. 14, 2026. [Online]. Available: <https://lfenergy.org/rte-deploys-lf-energy-seapath-for-virtual-protection-automation-and-control/>
- [22] LF Energy, 'A Case Study on Testing LFE Seapath at National Grid Electricity Transmission'. Accessed: Oct. 14, 2026. [Online]. Available: <https://lfenergy.org/testing-lfe-seapath-at-national-grid-electricity-transmission/>
- [23] *Regulation (EU) 2024/903 of the European Parliament and of the Council of 13 March 2024 laying down measures for a high level of public sector interoperability across the Union (Interoperable Europe Act)*. 2024. [Online]. Available: <http://data.europa.eu/eli/reg/2024/903/oj>



About LF Energy

LF Energy is the Linux Foundation's neutral home to build the digital foundation for energy together. We host more than three dozen open source projects used to plan, operate, and modernize energy systems. The portfolio spans from transmission system modeling to substation virtualization, smart meter integration to EV charging. We provide the trust layer: neutral governance, legal frameworks, security practices, and community of practitioners that turn open source software, standards, and data into infrastructure the industry can depend on for decades. Members include utilities, energy companies, vendors, researchers, and technology providers, aligned to deliver affordable, reliable, safe, and clean energy. For more information, please visit lfenergy.org.

