

OPEN TECHNOLOGY RESEARCH SYMPOSIUM, BARCELONA

Extending Digital Sovereignty Down the Stack

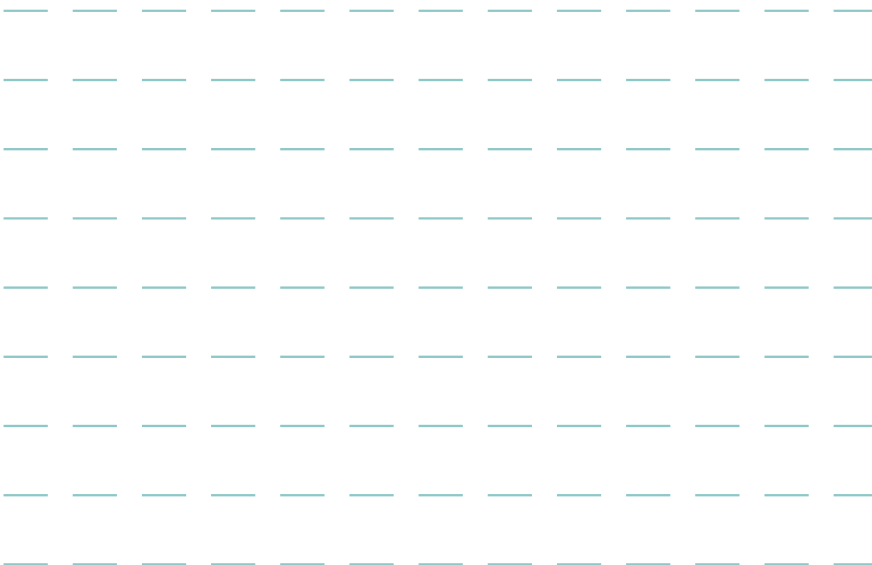
The Role of Open Source Hardware

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Sovereignty debates have stopped at the software layer

- Europe's sovereignty agenda has centred on software, data and platforms
- Yet control over digital infrastructure depends on the hardware underneath
 - Five foundries hold around 90% of the global foundry market
 - Europe's share of the semiconductor market is below 10%
 - Three vendors dominate chip design tools, two non-European
- The 2026 Tech Sovereignty package now calls for “a full European technology stack”



“Hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design”

Open Source Hardware Association (OSHWA), Open Source Hardware Definition

Policy sees only part of the hardware stack

- RISC-V is the main focus of EU investment, reiterated in the proposed Chips Act 2.0
- Open source EDA tools are proposed for investment to reduce reliance on proprietary design tools
- UNESCO recognises open hardware as part of open science
- Data centre, electronics, mechanical and scientific hardware receive little policy attention

EU OPEN SOURCE STRATEGY 2026

- Defines open source as software only
- Hardware appears once: open hardware IP such as RISC-V, and open EDA tools under Chips Act 2.0

Research questions and approach

- RQ1: Which areas of OSH are critical for Europe's digital sovereignty, competitiveness and open strategic autonomy?
- RQ2: What challenges and opportunities shape the role of OSH, and how can public policy address them?
- Exploratory qualitative study
- 17 expert interviews across academia, industry, non-profits and research institutes
 - 14 based in Europe, 3 in North America
- Inductive thematic analysis with member checking
- Continuous desk research of scientific and policy literature

FINDINGS

Five areas of open source hardware

Five areas across the stack

Area	Covers	Role for sovereignty	Examples
Open source silicon	Processor cores, IP blocks, chip design tools	Less reliance on foreign design tools and IP	RISC-V, PULP, Yosys, OpenROAD
Data centre & networking	Servers, storage, switches, power, cooling	Interoperable, vendor-neutral infrastructure	Open Compute Project
Electronics	Circuit boards and embedded devices	Local design and production of devices	Arduino, BeagleBoard, KiCAD
Mechanical hardware	Physical products, tools and machines	Distributed, local manufacturing	RepRap, FreeCAD, Open Footwear
Scientific hardware	Research instruments	Affordable, reproducible research infrastructure	OpenFlexure, White Rabbit, OSI ²

Open source silicon

- Foundry access is costly and slow; focus on legacy and special-node chips for European industry
- Three proprietary design tool suites dominate, two of them non-European
- Open EDA tools need “thousands of person years” to catch up
- Skills gap of 100,000+ engineers; open tools lower barriers for education

DEFINITION

Silicon chips, such as processor cores, accelerators, IP blocks and system-on-chip components, whose design is open in its entirety, from the hardware description down to the layout.

Data centre and networking hardware

- Proprietary architectures (x86) and software stacks (CUDA) create lock-in and geopolitical exposure
- Open standards for instruction sets, interconnects and process design are key
- RISC-V lowers barriers, but chips still rely on proprietary tools, fabs and vertical software support
- OCP standardises racks and servers, yet Europe has limited influence

DEFINITION

Open designs and specifications for servers, storage, networking equipment, power and cooling, including the microprocessors that perform compute inside the servers.

Open source electronics

- Mature tools and platforms: KiCAD, Arduino and BeagleBoard
- Collaboration is mostly knowledge sharing, without fork-and-merge workflows
- Factory-specific certification and USB or Bluetooth vendor IDs limit replication
- High-layer PCBs and passive components are largely produced in Asia

DEFINITION

Complete electronic systems, devices, modules and boards at circuit and PCB level, shared with schematics, layouts, bills of materials and firmware, but not the internal silicon design.

Open source mechanical hardware

- Distributed manufacturing gives agency in science, healthcare and crises
- FreeCAD is catching up, but lags in usability and simulation
- Code-native CAD enables Git-based collaboration, but raises entry barriers
- Openness in 3D printing is under pressure from low-cost global competition

DEFINITION

Tools, methods and processes for designing and fabricating physical and mechanical products, which can be given digital capabilities through electronics.

Open science hardware

- Average savings of 87% compared with proprietary equivalents
- Growing community through GOSH and the Open Science Hardware Foundation
- Calibration, validation and certification needs remain poorly supported
- White Rabbit and OpenFlexure show viable stewardship models

DEFINITION

Scientific instruments that researchers can design, share and adapt openly, promoting transparency, reproducibility and cost-efficiency.

ANALYSIS

Why hardware is harder than software

Challenges by perspective

	Key challenge	Where policy should act
Legal	Licences hard to enforce across mixed IP regimes; certification built for single manufacturers	Transferable certification and verifiable openness standards
Business	Limited knowledge of OSH business models; capital needs for SMEs	Business model knowledge and hardware skills
Policy	Value hard to quantify; attention focused on silicon	Funding across the full stack, beyond RISC-V
Developer	Costly fabrication and verification; proprietary design tools	Shared prototyping, foundry access and open design tools
Governance	Control concentrated in companies; patent-oriented technology transfer	Neutral stewards and academic OSPOs

The legal perspective

Key challenges

- OSH spans many artefact types, each under different legal regimes
- Licences are hard to enforce for physical designs, often acting as social signals
- CE and FCC certification assumes a single manufacturer and is not transferable
- Technology transfer offices default to patents and exclusive licences

Where policy should act

- Clarify licensing across mechanical, electronic and software artefacts
- Adopt verifiable openness standards, such as DIN SPEC 3105
- Develop modular, transferable certification pathways
- Turn technology transfer offices into facilitators of open licensing

The business perspective

Key challenges

- Limited culture and knowledge of OSH business models
- Proprietary components such as USB and Bluetooth IDs shape what can be replicated
- SMEs lack capital to compete with incumbents in corporate-led projects
- Skills shortage in chip and hardware design

Where policy should act

- Clarify implementation-specific details that enable modular business models
- Build knowledge of OSH business models, including commodity versus differentiating technology
- Foster a culture of sharing and collaboration
- Scale hands-on education using open tools, such as Edu4Chip

The policy perspective

Key challenges

- Policy attention concentrated on silicon and RISC-V
- Leading-edge fabrication is costly and access to foundries slow
- The value of OSH is hard to quantify
- Funding scarce outside semiconductors and open science

Where policy should act

- Build open ecosystems and shared infrastructure under the Chips Act
- Develop capacity in legacy and special-node technologies
- Widen access to open design tools for SMEs, researchers and educators
- Measure OSH value and establish an NGI-like funding programme for hardware

The developer perspective

Key challenges

- Mistakes are expensive, with patent and security risks in contributions
- Capable design and simulation tools are mostly proprietary
- Fabrication and verification are costly and slow
- Projects are often opened when ready, with tacit documentation

Where policy should act

- Shared validation, simulation and prototyping infrastructure
- Open, sovereign design and simulation tools
- Shared foundry access and open manufacturing hubs
- Verification frameworks, documentation standards and collaboration platforms

The governance perspective

Key challenges

- Governance concentrated in companies: open files, closed participation
- Few neutral stewards comparable to OSS foundations
- Research institutions oriented towards control and exclusivity

Where policy should act

- Open up governance in commercial OSH projects
- Build independent, non-profit stewards
- Align technology transfer offices with open collaboration
- Establish OSPOs across research organisations

“Stewardship in open source hardware extends beyond neutral hosting of design files, to managing liability, design knowledge, certification and manufacturing”

Key implication for policy

CONCLUSION

Digital sovereignty is a full-stack concern

Open Source Hardware is a necessary extension of Open Source Software, not merely a complement



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