The Transparent Reference Fab: A Scalable, Open Blueprint for European Semiconductor Sovereignty

- Can we make use of putting a whole FAB to Open Source? -

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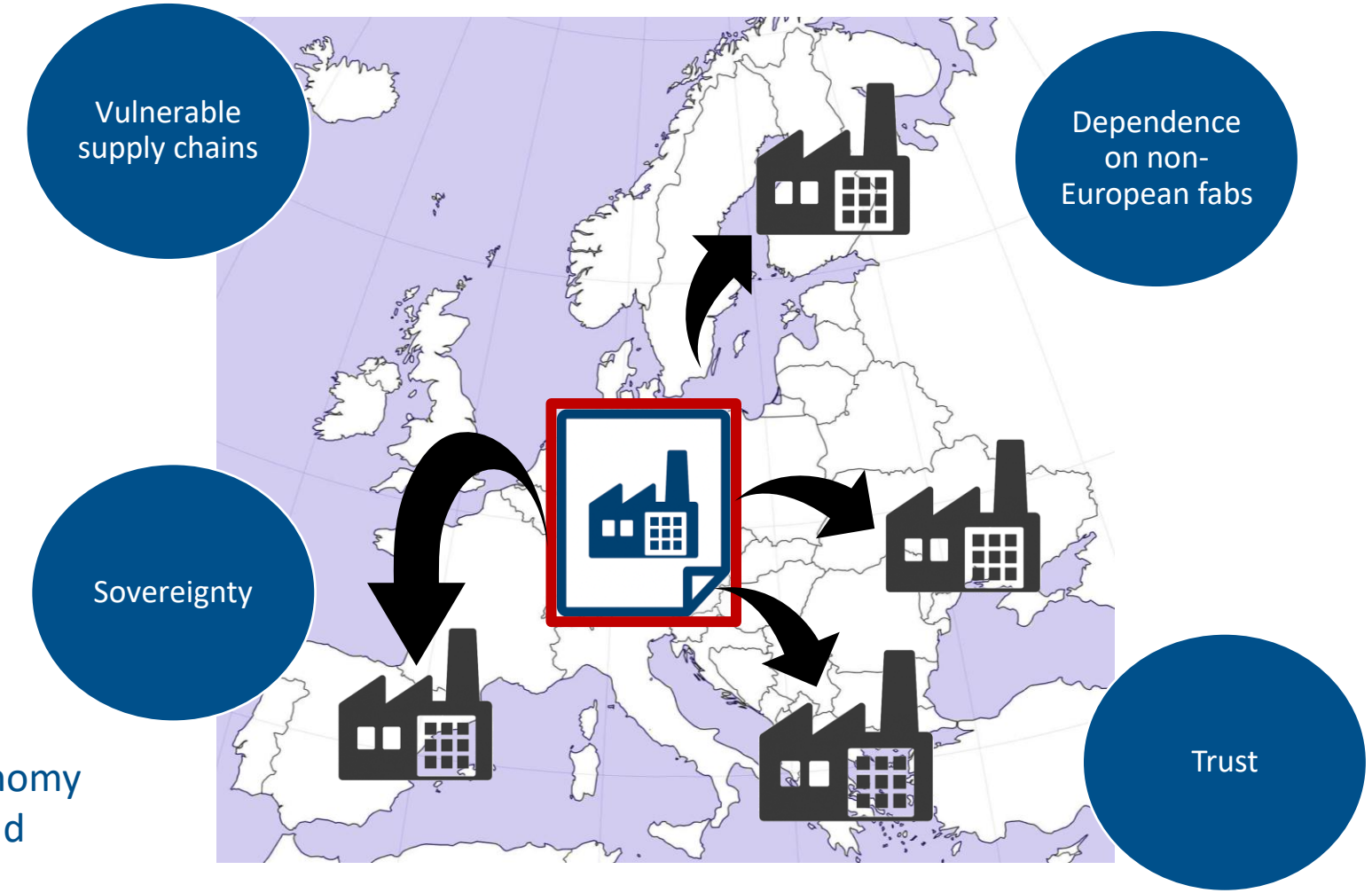
Why Europe Needs a Reproducible Chip Fab – Now

Europe aims for 20% chip production by 2030.

But what it lacks isn't just fabs –
it's a model that can be trusted, scaled, and shared.



Europe's competitiveness, digital autonomy and security depend on trustworthy and resilient semiconductor production

Why Europe Needs Open Manufacturing – Now

Europe aims for 20% chip production by 2030

https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-chips-act_en?utm_source=chatgpt.com

Great News

Europe already reached 20% market share... in 2003.

1. Others includes Malaysia, Singapore, India, and the rest of the world
Note 1: Rounding errors. All values shown in 300 mm (12") equivalents; excludes capacity below 5K wspm or produced on wafer sizes less than 8"
Note 2: May not total 100% due to rounding.
Source: SEMI; BCG analysis

https://www.semiconductors.org/wp-content/uploads/2024/05/Report_Emerging-Resilience-in-the-Semiconductor-Supply-Chain.pdf?utm_source=chatgpt.com

Why Europe Needs Open Manufacturing – Now

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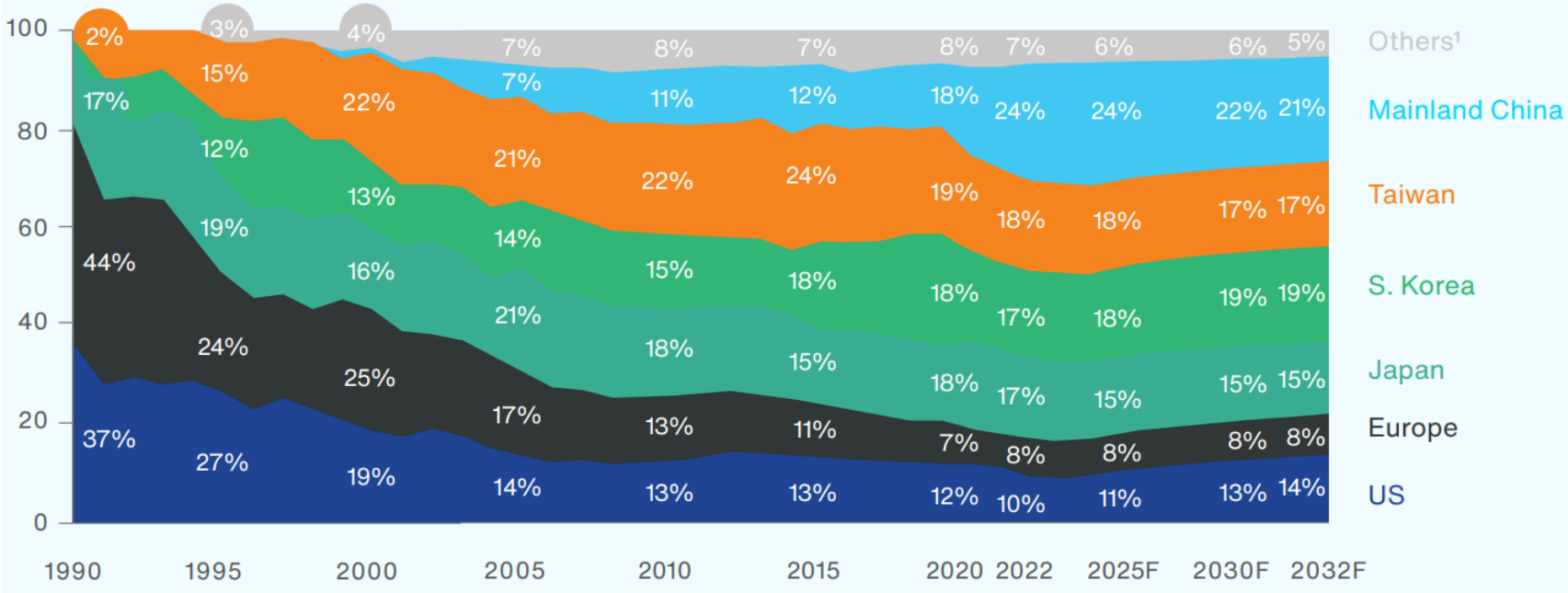
Great News

Europe already reached 20% market share... in 2003.

We've got some bad news. . .

We lost it.



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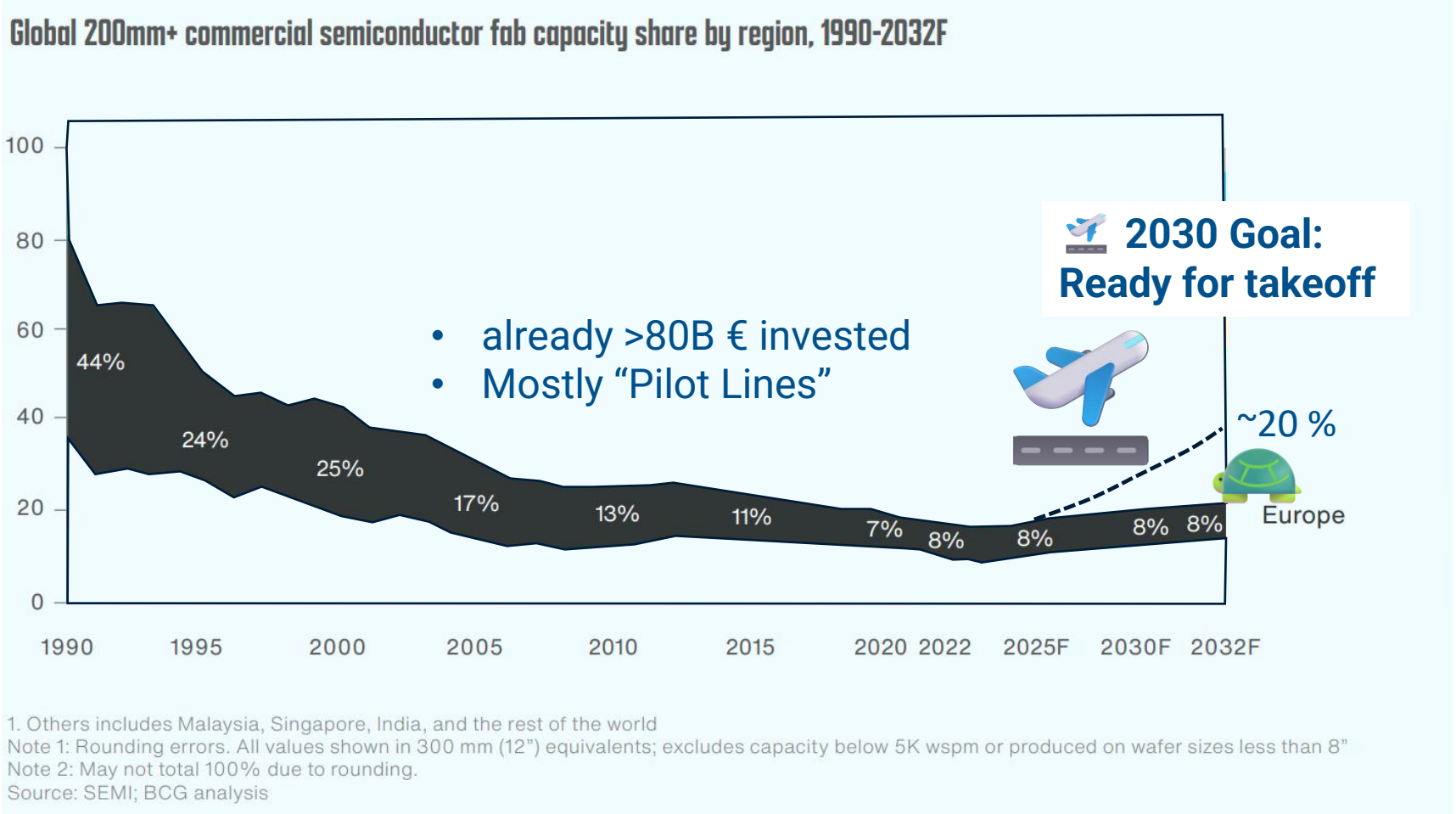
Why Europe Needs Open Manufacturing – Now

"meeting [the 20 %] would require us to approximately **quadruple our production capacity by 2030**, but we are **nowhere close to that** with our current rate of progress"

https://www.eca.europa.eu/ECAPublications/SR-2025-12/SR-2025-12_EN.pdf



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The Problem: Scaling Requires More Than Pilot Lines

Pilot Line	Reference Fab
Research & Prototyping	Mid-Volume production model
Limited throughput	Cost optimized
Partially open	Industrial-grade scaling
Technology development	Fully transparent architecture
	Capacity multiplication

We're trying to solve a supply chain problem – with a research pipeline.

Billions in investment — but no scalable model

- 💶 EU investments flow into **flagship projects** and **pilot lines**
- 🧠 Innovation ≠ industrial capacity
- 🔍 Focus on advanced nodes (<10 nm) misses the bulk of **actual demand**
- 📉 Over 67% of chips rely on **≥90 nm** nodes – and will continue to
- 🧩 What's missing: a **reproducible, open model** to scale volume fabs across regions

An Open Blueprint for Scalable Chip Production

Digitalisation

Transparent Data Flows

Transparent Tool Recipes

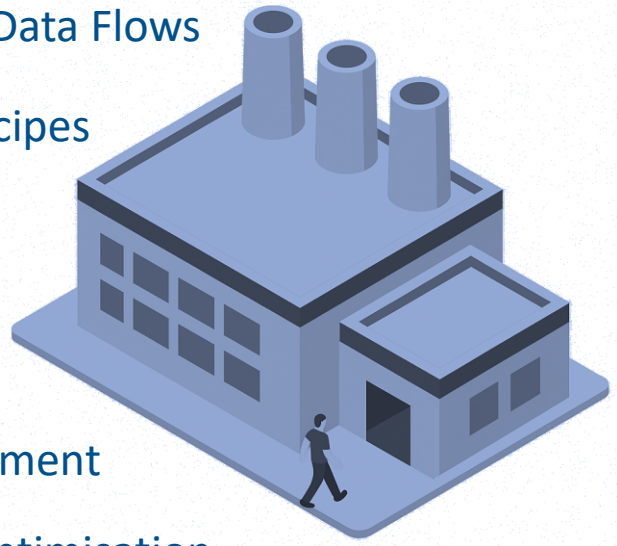
Open PDK

Available Tool List

Yield Management

Cost Optimisation

Industrial Throughput



What makes it different?

- 🧠 **Blueprint approach**: built for attracting **joint ventures** and **dedicated manufacturers**
- 📖 **Validated stack**: from PDK and process recipes to digital twins
- 🔐 **Trust-focused**: built for secure, sovereign chip production
- 🏭 **Scales fast**: lowers entry barrier for building new European fabs

A production model you can trust – and build on

65 nm: The Strategic Node for Scalable Sovereign Production

- **Legacy nodes aren't going away.**
  Demand for ≥65 nm remains strong, especially in automotive, industrial, and secure embedded sectors.
  https://www.mckinsey.com/industries/industrials-and-electronics/our-insights/will-the-supply-demand-mismatch-persist-for-automotive-semiconductors
  https://www.datainsightsmarket.com/reports/legacy-chips-wafer-foundry-158447
- **Strategic autonomy doesn't need bleeding-edge tech.**
  What we need are **auditable, affordable, and available** processes — not 2 nm AI accelerators.
- **65 nm is the sweet spot.**
  Mature, cost-effective, and compatible with existing European fabs — without EUV or FinFETs.

Why 65 nm hits the sweet spot:

📈 Persistent global demand
→ mature nodes still dominate

🧠 Mixed-signal capable
→ logic density fits industrial-grade SoCs

🔒 Trustable by design
→ known process, no hidden logic layers

🧩 Analog, digital, NVMs
→ all supported

🏗️ Fab-compatible
→ can be implemented in upgraded 130 nm lines (Bulk process)

EU EU-ready
→ manufacturing ecosystem already in place

From Blueprint to Backbone: A roadmap

Blueprint Phase

- Publicly owned architecture
- Full process transparency incl. PDK, recipes
- Cost and BOM analysis
- Consortium setup

First Implementation

- Government-financed infrastructure (national or EU)
- Operated under public trust mandate
- Validated open process stack & flows
- Serves as training and security-grade manufacturing site

Replication & Scaling

- Blueprint offered to other EU member states (Worldwide?)
- Support for national/regional adaptation
- Tech package for trusted SMEs or verticals (health, mobility)
- Stable anchor for long-term capacity buildup

Financial Considerations

- **Estimated CAPEX:** €600–800 M for 65 nm fab
- **Target output:** 5–10k wafers/month
- **Estimated OPEX:** ~€50–80 M/year (based on $70/wafer benchmark × ~100–200 k wafers/yr production)
- **Reference:** 3–5 nm fabs = €10–15 B+

Disclaimer: These numbers are early estimates — carefully researched, but not yet based on full bottom-up costing.

Designed to be replicated / Transparent and auditable / Fully government-owned & trusted

Why Public Ownership Enables Trust

Trust is built, not branded.

- Public Ownership
- Full Control of Fab Infrastructure
- Open tools, PDKs & process flows
- Verifiability & auditability
- Strategic and digital sovereignty

✅ **1. Sovereignty requires full-stack control**

- No external IP dependencies
- No hidden actors or data flows
- Security starts at the foundry

✅ **2. Openness enables verifiability**

- Transparent processes can be inspected and certified
- Independent reproducibility is possible
- Ensures integrity in critical systems (e.g. defense, energy)

✅ **3. Rooted in security best practice**

"In security, what you hide is the key – not the system."

– Based on **Kerckhoffs' Principle** (1883)

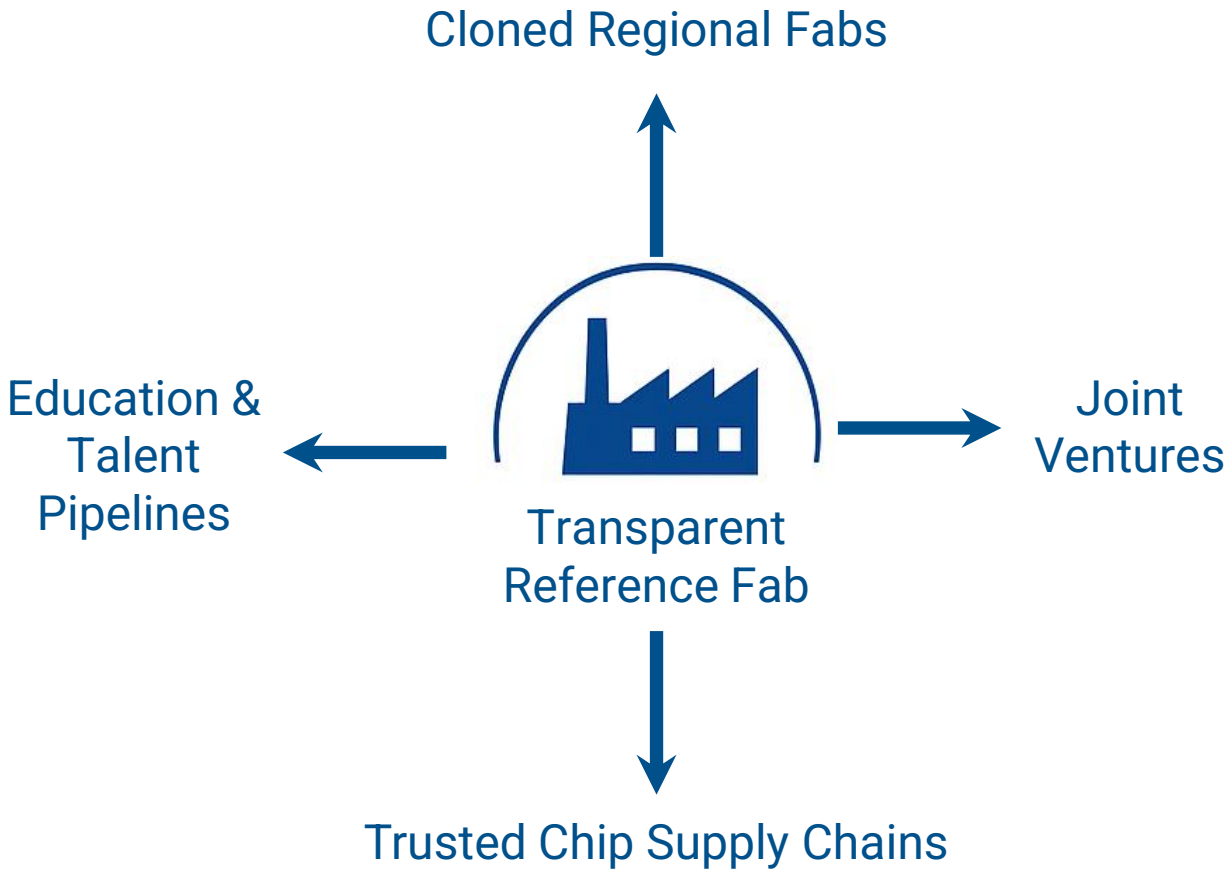
→ Trust arises from open designs, not obscurity

What Makes This Fab Different?

	🏛️ Transparent Reference Fab	🏭 Commercial Fab	🔬 Pilot Line
Ownership	Public	Private	Mixed
Transparency	Full stack (tools to PDK)	None	Partial
Purpose	Trust & strategic reuse	Profit, scale	R&D, protos
Replicability	Designed as a replicable blueprint	Not intended	Limited
Target Output	Med, Critical sectors	High volume	Low volume
Flow architecture	Reproducible versioned stack	Proprietary, locked	Project-specific
Yield/data feedback	Designed for learnability	Internal, closed	Often ad hoc
PDK/IP accessibility	Open & audit-friendly	Closed & NDA-locked	Mixed, not reusable
Digital infrastructure	Built for blueprint replication	Internal optimization	No system-wide reuse

“This Fab is not a competitor. It’s a catalyst.”

Beyond One Fab: Strategic Impact for Europe



✅ **Strategic sovereignty**
- Publicly controlled manufacturing backbone for secure domains

✅ **Industrial multiplier**
- Enables smaller companies and sectors to access trustable production

✅ **Standardization catalyst**
- Shared open PDK, toolchain, verification flow

✅ **Talent & capability development**
- Platform for hands-on training in real manufacturing

One fab. Many copies. Systemic trust.

Enabling the Transparent Reference Fab

What We Have

- 🧠 **The concept**: technically structured and security-aligned
- 🏗️ **Existing infrastructure**: can be extended (e.g. LETI, Fraunhofer, IHP)
- 🤝 **Stakeholder interest**: early support from research and policy actors
- 🔍 **Market justification**: persistent demand for mature, trustable nodes

What's Missing

- 💶 **Dedicated funding track**
  e.g. under Chips Act Pillar II
- 📜 **Political alignment at EU and national level**
  clarity on governance and ownership
- 🧰 **Formalization of the blueprint**
  yield management, digitalisation, flow integration
- 👥 **Public champion institution**
  needs to be anchored somewhere

What We Propose

- ✅ Start a **structured blueprint initiative** under public lead
- ✅ Plan a **fully public reference implementation fab**
- ✅ Make the full architecture available for **replication and scale-out**
- ✅ Embed this as part of **Europe's strategic semiconductor capacity**

The Transparent Reference Fab in One Sentence

- **Scalable, Reproducible,**
- **Gets better with adoption**

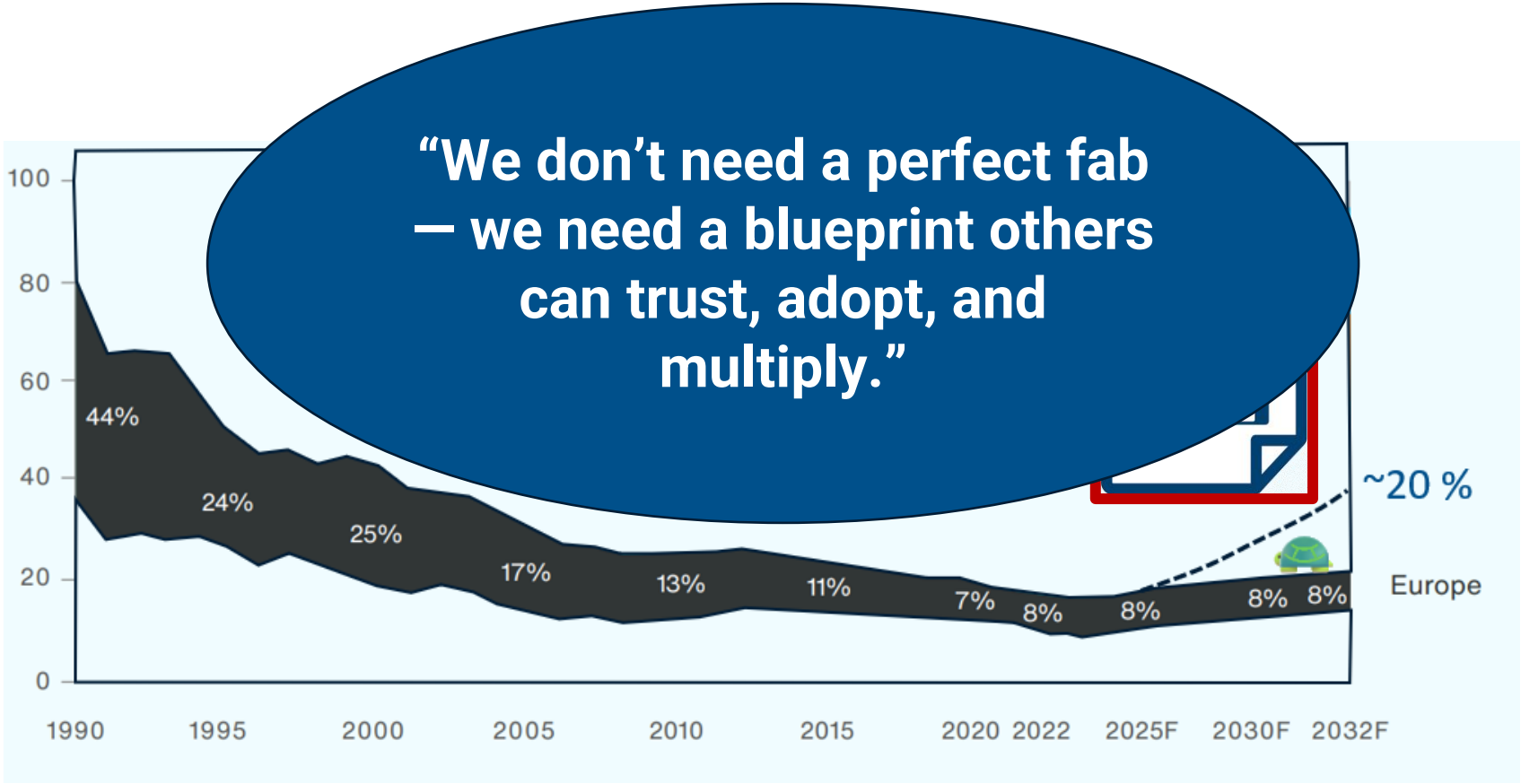
  Shared Feedback, shared learning, shared trust
- **not be the most cost efficient way to manufacture chips**

“What can trust and sovereignty cost?”

- **Empowers setting up more fab**

  Reference implementation granted and predictable performance

20% global chip production by 2030



Back-Up

Q1: Is a public reference fab really competitive with commercial foundries?
A: No — and it doesn't have to be. It's not meant to compete on cost or volume, but to provide a trusted, reproducible baseline.

Q2: Isn't a single trusted fab too small to matter?
A: The goal isn't one fab — it's a scalable model that others can adopt across Europe.

Q3: Won't this be expensive?
A: Yes, but so are all strategic infrastructures. The real question is: *What are trust and sovereignty worth?*

Q4: Will industry actually adopt and replicate this fab model?

Q5: How will governance and IP issues be handled?

Candidate Joint Ventures

- **Automotive industry** — OEMs and Tier 1s with in-house chip design.
- **Telecom providers** — Secure routing and 5G infrastructure.
- **Aerospace & defense** — Sovereign electronics in critical systems.
- **Energy infrastructure** — Secure control and metering systems.
- **SME consortia** — Companies dependent on global fabs for secure ASICs.

Back-Up

Typical Points of Skepticism:

1. “Feasibility study” sounds vague. Who would lead and fund this?

Fair concern. Without an **anchoring institution** (like IHP, IMEC, LETI, etc.) and a real budget commitment (e.g. Horizon Europe, Chips Act Pillar II), Phase 1 risks becoming a PowerPoint project.

2. Phase 2: Building a fab is expensive. Where does the €600–800 M come from?

True — this phase only works if either:

an **existing pilot line** (e.g. IHP) is upgraded,

or a **public–private co-investment** is pre-committed (like what happened with Intel Magdeburg or TSMC Dresden).

3. Open reuse sounds great — but who would actually replicate it?

You’re right to doubt vague hopes. A realistic model would identify:

Specific **regions with unmet demand** (e.g. East/Central Europe, Spain, Scandinavia)

Use-case-driven JV models (e.g. for secure automotive, telecom baseband, medical ASICs). This has to be analyses in more detail.

4. Wouldn’t this compete with existing EU fab investments?

Ideally, it **complements** them — by providing blueprints, toolchains, and risk reduction. The Reference Fab should *not* be a megafab, but a **trusted design for others to adopt**.

Back-Up

Joint Venture Motivation: Cost vs. Resilience

External Foundry			Joint Venture Fab
Manufacturing costs		↓	higher but predictable
Planability	market- and load-dependent	🔴	high influence & foresight
Supply security	often volatile	🔴	directly controllable
Transparency & auditability		🔴	fully achievable
Dependencies	high	🔴	minimized
Reproducibiiity	none	🔴	yes (reference fab)

- **Why a Joint Venture Makes Sense**
- **Shared investment – long-term supply control**
- **Transparency across process, IP, and flow**
- **Resilience for critical sectors through trusted infrastructu**

And than there is the Open Source effect: You never know what other creative minds develop

Back-Up

The key question many companies are asking is:
Why invest in your own manufacturing capacity, when external foundries can produce more cheaply?

The answer lies in the balance between cost efficiency, supply chain control, and resilience.

Yes — foundries in Asia or the U.S. often have lower per-unit costs.
But they come with limited control, long lead times, and exposure to geopolitical or logistical disruptions.

In a Private-Private Joint Venture, costs are shared — but the partners gain:

Direct access to capacity and process control

Predictable long-term supply for critical applications

Full transparency across the stack — from process recipes to tooling

Especially in sectors like automotive, industrial automation, defense, and energy, these aren't just technical preferences — they're strategic necessities.

And with a modular, open-source fab blueprint, this kind of JV doesn't need to start big.
It can begin lean, focus on key processes, and grow over time — all while benefiting from shared standards and verified trust.

The result is not just control — it's a path to long-term resilience, built on cooperation and transparency.

Back-Up

- Why 65 nm?

Because it's the strategic middle ground.On the one hand, it’s mature: the equipment is available, the processes are stable, and the cost per wafer is reasonable.On the other hand, it’s modern enough to support integrated mixed-signal systems, RF modules, and moderately complex SoCs.It’s widely used in automotive, industrial, and secure embedded systems — precisely the sectors where Europe is strong and sovereignty matters most.And unlike 5 nm, you don’t need a $10B fab to get started.This makes 65 nm the ideal entry point for building sovereign capacity — especially in a modular, reference-fab approach.