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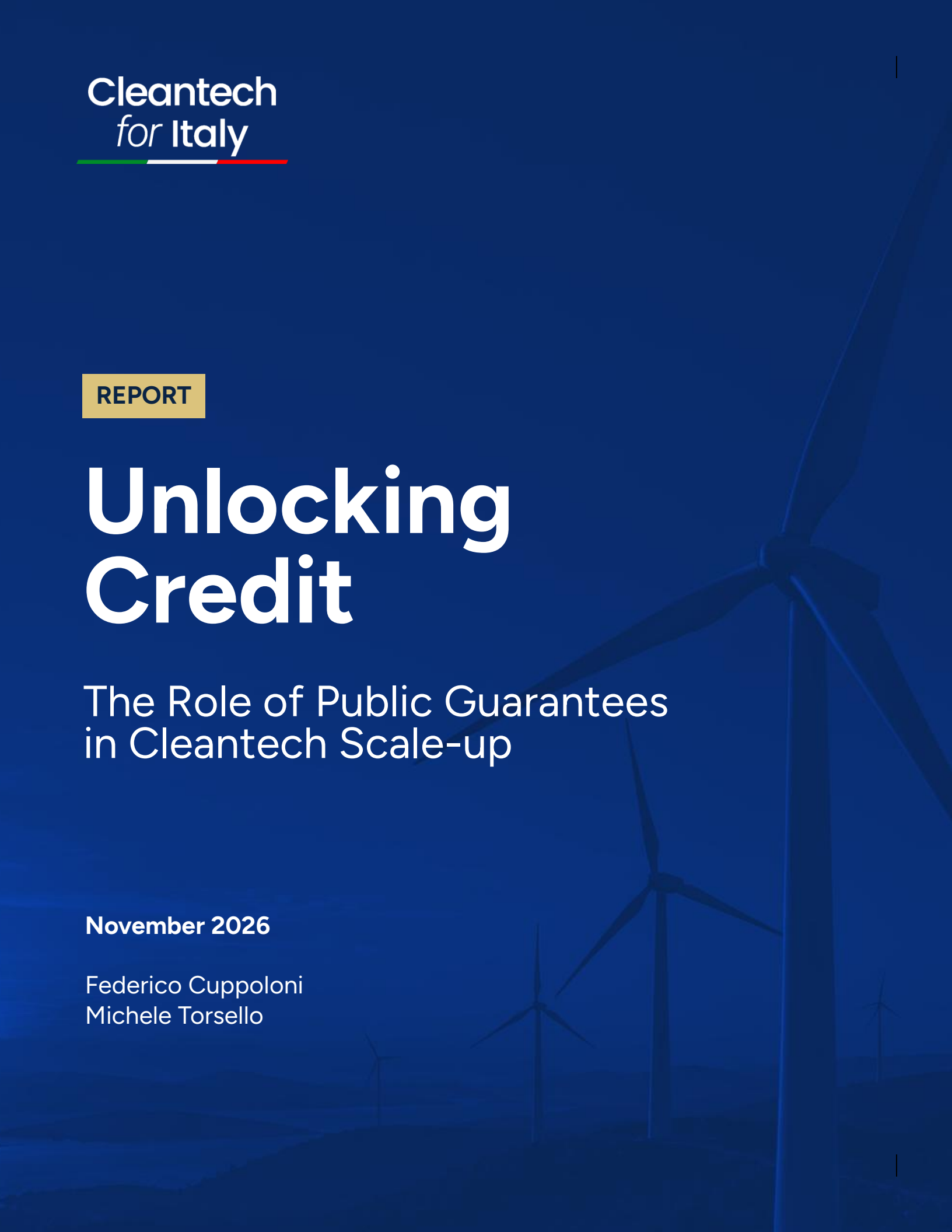
REPORT

# Unlocking Credit

## The Role of Public Guarantees in Cleantech Scale-up

**November 2026**

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**Cleantech for Italy**

Cleantech for Italy is a coalition bringing together organisations active across the entire Italian clean technology value chain: universities, research centres, innovative companies and investors. The initiative fosters dialogue between leading cleantech innovators, industrial players and policymakers, contributing to the design of an industrial policy framework that can support the development and deployment of technologies that are key to Italy's future. Cleantech for Italy is part of the Cleantech for Europe network.

**The report**

*Unlocking Credit: The Role of Public Guarantees in Cleantech Scale-up* examines why the public guarantee instruments currently available in Italy struggle to reach cleantech companies in the scale-up phase. The report identifies two bottlenecks: debt financing for first commercial plants, and the working capital needed for market access. It analyses both in light of the main international models and two case studies. It then sets out recommendations to recalibrate existing instruments, so that public guarantees become an effective lever of industrial policy.

**Suggested citation**

Cuppoloni, F. and Torsello, M. (2026), *Unlocking Credit: The Role of Public Guarantees in Cleantech Scale-up*, Cleantech for Italy.

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**Published by Cleantech for Italy, November 2026**
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# Executive Summary

In recent years Italy has built up a significant base of cleantech innovation. **Since 2019, start-ups and scale-ups active across the various clean technology segments have raised more than €1.4 billion**, thanks to the catalytic role of CDP Venture Capital and a growing presence of specialised investors. A significant share of these companies has moved beyond technology development and now faces the most delicate step of its journey: building the first commercial plant (First-of-a-Kind, FOAK) and starting production at scale.

It is precisely at this step, however, that the available financial architecture shows fundamental gaps. A FOAK typically requires between €20 and €100 million of investment and two to three years to build. It is too large and too slow for venture capital, and too new for project finance, which requires an operating track record and predictable cash flows. **The result is a financial Valley of Death, in which the debt-to-equity ratio, around 80/20 in mature infrastructure sectors, is inverted or absent altogether**. Three factors block access to debt precisely when it becomes indispensable: the residual technology risk perceived by banks, the lack of an operating history, and the limited creditworthiness of young companies.

The same barrier reappears, in a different form, in the next phase. Companies that move beyond the FOAK and begin commercialisation must provide industrial customers with bank guarantees (advance payment, performance and warranty guarantees) that can tie up as much as 50% of each contract's value. **Without a strong balance sheet, the bank will issue them only against liquid collateral. As a result, each new sale absorbs working capital instead of generating it**, and the capacity to grow ends up depending on the size of the balance sheet rather than on the quality of the technology or the existence of demand.

Public guarantees are the instrument designed to address both barriers. **They do not inject public capital into the project but reshape its risk profile until it becomes bankable**. The credit remains private, and the State takes on a contingent liability that materialises only if the guarantee is called, a rare event in banking practice. For a FOAK, the guarantee therefore does not operate as a subsidy. It is the precondition for debt to enter the financing structure and, with it, for the other sources of capital to fall into place. Programmes such as the US Department of Energy's Loan Programs Office and Export Development Canada's Account Performance Security Guarantee show that instruments of this kind can provide targeted support both for building first plants and for market access.

In Italy, the problem is not so much a lack of instruments as their calibration. The current pipeline counts around twenty-one first plants in the design phase, with an estimated financing need of €450-500 million. Including follow-on plants, the need rises to €750-800 million. SACE already operates large guarantee instruments backed by a State counter-guarantee, starting with Garanzia Green and Garanzia Archimede, the latter with an allocation of €60 billion through 2029. **Their eligibility requirements, however, designed for mature companies, systematically exclude the scale-ups that public intervention should serve**. Garanzia Green requires at least three sets of financial statements and excludes start-ups, while Garanzia Archimede is closed to SMEs.

**The two case studies analysed in the report measure both the impact and the limits of these instruments.** Arsenale Bioyards has designed an industrial facility in Porto Marghera to develop, validate and produce bio-based molecules at industrial scale, with an investment of

more than €100 million. Private capital alone cannot sustain a project of this kind: according to the company's estimates, even under the most favourable assumptions the expected return remains below that required by risk capital, and cash flows turn positive only after several years. The case shows the limits of guarantees: when the problem is not only the cost of debt but a return profile incompatible with private capital, direct public support is needed. The guarantee then becomes decisive again for financing construction and, above all, the production plants that will follow. Energy Dome is already in the market-access phase with its $CO_2$ Battery. On an order book of six contracts worth €390 million, an 80% counter-guarantee would reduce peak tied-up collateral from around €42 million to €8.5 million. Liquidity that is currently insufficient would thus become adequate to support the entire commercial pipeline.

The response set out in this report is a targeted recalibration of existing instruments, complemented by the elements needed to complete the financing structure of projects. The recommendations are organised along three lines:

- **Credit guarantees for the first plant.** We propose adapting Garanzia Green to readiness-to-deploy criteria, such as technology maturity, quality of offtake agreements and strength of industrial partners, in place of financial track record. We also propose opening Garanzia Archimede to SMEs and innovative companies at the first-plant stage, and preventing the unguaranteed portion from falling on the scale-up's balance sheet, including by combining CDP's *Fondo Rotativo per le Imprese* with the SACE guarantee.
- **Counter-guarantees for market access.** We propose raising SACE cover on commercial guarantees to 80%, from the current 50% under the framework agreement with banks and 60% under Garanzia Archimede. We further propose introducing a single contract-level counter-guarantee, extendable to a pre-approved guarantee facility for companies that have passed a technical and industrial due diligence.
- **Completing the capital stack.** We propose an equity and first-loss capital vehicle for the industrial demonstration phase, and non-dilutive resources for the phases preceding the final investment decision. Finally, we propose a public technical assessment capability, with a coordination forum among SACE, CDP and Invitalia, and a single point of access for industrialisation projects.

This report shows that **Italy already has the instruments and resources needed to make the industrialisation of its cleantech sector bankable, and that what is missing is their orientation towards the companies that are currently excluded from them**. Acting first on the eligibility criteria of existing instruments makes it possible to move quickly and with a limited commitment of public resources. It is the condition for technologies developed in Italy to be industrialised in Italy, rather than in better-equipped jurisdictions.

CHAPTER 1

# The financial Valley of Death in Italian cleantech

*Italy is making rapid progress in developing technologies that are critical to its energy security and industrial competitiveness. From advanced energy systems to biomanufacturing, from critical materials to the decarbonisation of industrial processes, many cleantech solutions have successfully completed technology development and are moving towards industrial-scale demonstration. At this stage, however, the capital needs of innovative companies grow beyond what can be met by the public and private financial instruments, such as venture capital and R&D grants, that specialise in earlier phases. At the same time, the actors that finance the phases following technology demonstration, such as banks and infrastructure funds, whose mandate is to deploy technologies with an established implementation record, lack the tools to take on a residual technology risk that, however limited, falls outside their assessment parameters. The result is a financial Valley of Death, in which technologies that are fundamental to the country's industrial development find no way to finance their transition to manufacturing scale.*

*This chapter analyses the structure of the problem, focusing on two critical phases in a technology's passage from the lab to industrial scale: the first commercial plant (First-of-a-Kind, FOAK) and manufacturing scale-up, phases in which the traditional financial architecture proves inadequate. The chapter shows how access to bank financing, in the form of credit for an industrial plant or of commercial guarantees, is essential to this end, and how these phases do not require new forms of capital but a public guarantee mechanism capable of making bankable an industrial project with high technological value and structured market demand.*

## From lab to market: a systemic financing gap

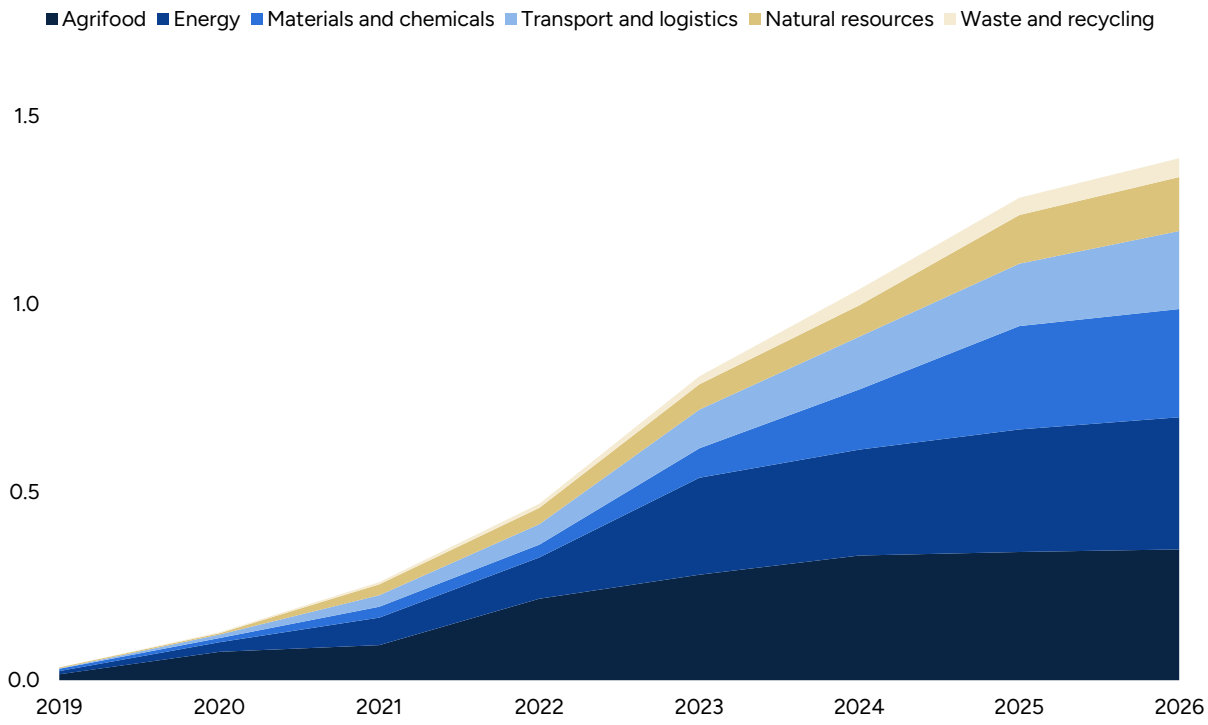
Europe is undergoing a profound transformation of its industrial base. The transition to new energy systems, new materials and new production processes has become an economic policy priority for the entire continent, driven by the convergence of regulatory constraints, geopolitical pressures and market opportunities. In key sectors, from renewable hydrogen to long-duration energy storage, from advanced materials to biomanufacturing, the technologies needed for this transformation exist and have, in many cases, already been validated. Often, **this technology development is carried forward by innovative start-ups which, in Italy, have raised a total of more than €1.4 billion since 2019**[1] (Figure 1), thanks to a growing presence of institutional investors focused on cleantech or its many verticals.

[1] Cuppoloni, F., Massa, L., Torsello, M. (2026), *Q2 2026 Quarterly Briefing*, Cleantech for Italy.

FIGURE 1

**Cumulative investment in cleantech companies, 2019–26**

Including risk capital, grants and debt, € billion




Sources: Cleantech for Italy and MITO Technology (2026), "Cleantech for Italy Q2 2026 Briefing"

The ability to take these players from technology validation to manufacturing is at the heart of Europe's industrial policy priorities. **The European Commission's Net-Zero Industry Act and Clean Industrial Deal respond to a need that is at once about energy security, industrial competitiveness and strategic autonomy**, with the aim of building domestic manufacturing capacity for transition technologies, in a global context in which the United States and East Asia are investing massively to consolidate their advantage in the most relevant value chains. Turning Europe's cleantech innovators into industrial champions is therefore a condition for defending the continent's manufacturing base and for maintaining a competitive position in some of the markets that will shape the economy of the coming decades.

However, **it is precisely at this stage of technology maturation, when investment in research and development finds an industrial outlet with economic and social spillovers, that Europe faces its greatest challenges**. This journey can be summarised in four distinct phases, each matched by dedicated financial resources (Figure 2):

- In the **discovery phase**, corresponding to TRL 1 to 3, the technology is still the subject of fundamental research and proof of principle. The prevailing risk is scientific, and the financing need is modest, typically covered by public grants and pre-seed investment.
- In the **development phase**, corresponding to TRL 4 to 6, the technology is prototyped and tested in a controlled or semi-operational environment. The risk gradually

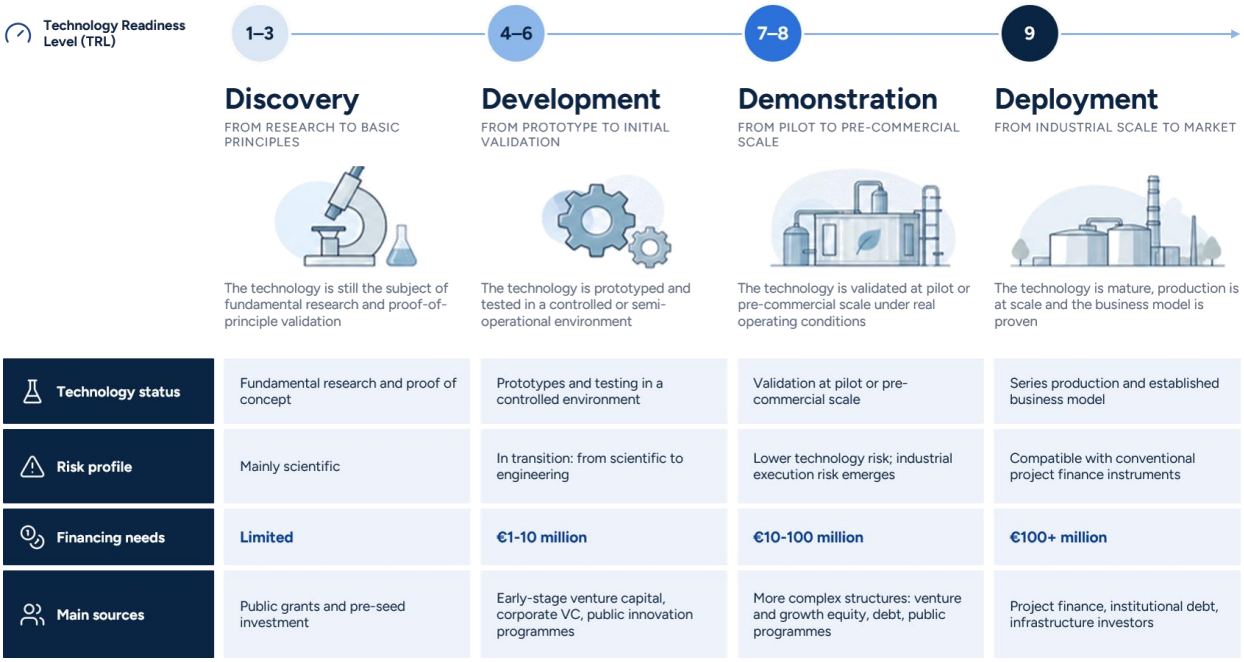
shifts from scientific to engineering, and the capital required, in the order of €1–10 million, comes mainly from early-stage venture capital, corporate venture capital and public innovation support programmes.

- In the **demonstration phase**, corresponding to TRL 7 to 8, the technology is validated at pilot or pre-commercial scale under real operating conditions. Technology risk falls significantly, but industrial execution risk emerges and the financing need rises, depending on the case, to over €100 million, requiring more complex financing structures.
- In the **deployment phase**, corresponding to TRL 9, the technology is established, production is in series and the business model is proven. The risk profile is compatible with traditional project finance instruments, and the volumes of capital that can be mobilised are, in principle, unlimited.

FIGURE 2

## Technology evolution from lab to market

Development phases of a technology from research to industrial scale




**The capital stack reveals a structural shortage of resources dedicated to the technology demonstration phase**, where capital needs grow to a scale comparable to infrastructure, but with a risk profile still comparable to venture capital. **This fracture, typical of first industrial plants (First-of-a-Kind, FOAK), is referred to by practitioners as the "Valley of Death"**, denoting a systemic financing gap for capital-intensive projects whose construction can take more than two years[2]. In other words, the Valley of Death can be defined as a grey area

[2] The size of this gap varies depending on the technology and the specific features of the project: the greater the residual technology risk and capital intensity, the greater the complexity of financing a first plant. See, in this regard, Richter, G. et al. (2025), *Orchestrating Europe's deep-tech funding: A blueprint to bridge the financial gap*, McKinsey & Company.

between two well-defined asset classes, each with specialised investors (venture capital on one side, private equity and project finance on the other) and clear return profiles.

The main gap in financing a FOAK project lies in coordinating different financial instruments. If all-equity financing is unsustainable, owing to the high cost of capital and the scale-up's limited capitalisation, it becomes necessary to mobilise non-dilutive resources such as dedicated grants, and debt in the form of project finance, bank loans or hybrid instruments which, by their nature, require lower risk profiles and predictable cash flows. Specifically, **the shift from equity to debt is the condition that allows the investment model to be replicated and scaled**: in mature infrastructure sectors, projects are typically financed with a debt-to-equity ratio of around 80/20. In FOAK projects, this ratio is inverted or non-existent, and this imbalance effectively prevents the transition from demonstration to production at scale.

What holds back access to debt for scale-ups in advanced demonstration, that is, with drastically reduced technology risk and binding offtake agreements with end users, can be summarised in three key factors:

- First, **the residual technology risk perceived by the lender**. Even when a demonstration plant has operated successfully, commercial banks tend to associate innovation with an intrinsic risk factor. In general, banks' credit committees struggle to assess the technology risk of innovative processes and, lacking the in-house expertise to carry out adequate technical due diligence, apply prohibitive risk premiums or refuse the exposure altogether[3].
- Second, **the absence of a track record**. A FOAK project is by definition the first commercial plant of a given technology in a target market. The banking requirement of a prior operating history creates a circular paradox that blocks access to credit precisely when it is most needed.
- Finally, **counterparty risk**. Cleantech scale-ups are relatively young entities, often without a public rating, with limited balance sheets and still negative cash flows. The creditworthiness of the company is a key parameter in the exposure decisions of a bank subject to stringent regulatory constraints. Financing a counterparty with these characteristics requires collateral that the scale-up, at this stage, does not have[4].

None of these barriers is irrational from the bank's point of view, as it operates according to established risk assessment parameters. However, **this financial short circuit lies at the root of the difficulty in industrialising the innovation produced in Europe, and is one of the main obstacles to rebuilding manufacturing capacity on the continent**. Specifically, this gap materialises at two distinct points along the path of technology demonstration: the initial one, relating to the construction of the first plant at scale, and the more advanced one, relating to systematic market access.

[3] See, in this regard, Lechtenfeld, T. et al. (2023), *Public Credit Guarantees: Unlocking Private Investments for Climate Technologies*, Tech for Net Zero Alliance.
[4] Besnainou, J., Davis, R. (2024), *Public Guarantees for Cleantech Manufacturing: How to free up working capital for the industrialisation of EU clean technologies*, Cleantech for Europe.

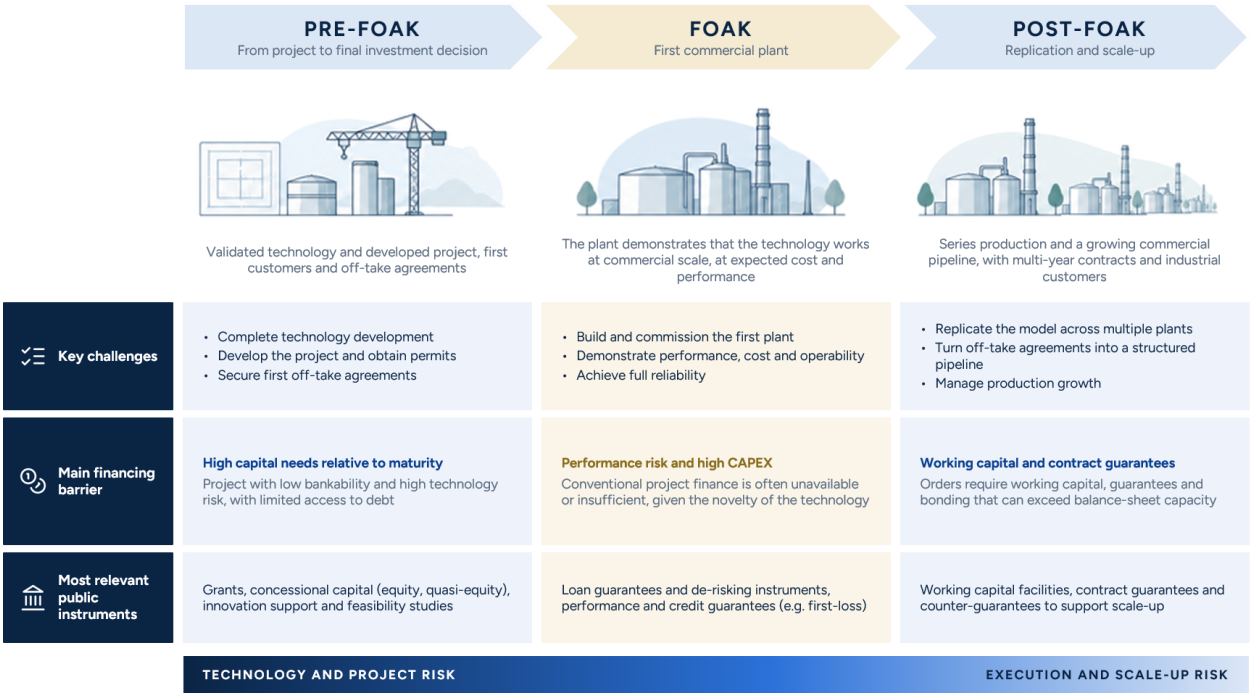
## The twofold challenge of cleantech industrialisation

These challenges, from the FOAK to production at scale, follow a precise logical sequence (Figure 3). The success of the first plant, which proves that the technology works at commercial scale with costs and performance in line with expectations, is what enables the move to series production. Series production is, in turn, what transforms initial purchase commitments (offtake agreements), often non-binding or limited to pilot volumes, into a structured commercial pipeline, with multi-year contracts and industrial customers. Finally, **it is precisely the growth of this pipeline that brings out, with increasing force, the financial constraint of working capital**. At each of these stages, the traditional financial system shows specific shortcomings which, if left unaddressed, halt the company's progress.

FIGURE 3

**Challenges and instruments by development phase**

Needs and useful instruments across the life cycle of a FOAK project




The first of these challenges, already anticipated in the previous section, concerns the construction of the first plant. A cleantech FOAK project can take various forms: for example, a 100 MW electrolyser, a utility-scale energy storage system or a production line for low-emission materials. **Depending on the technology and the specific use case, a FOAK typically requires between €20 and €100 million of investment and a construction timeline of two to three years**. This order of magnitude requires the simultaneous use of multiple sources of capital, each with its own logic, timing and entry requirements.

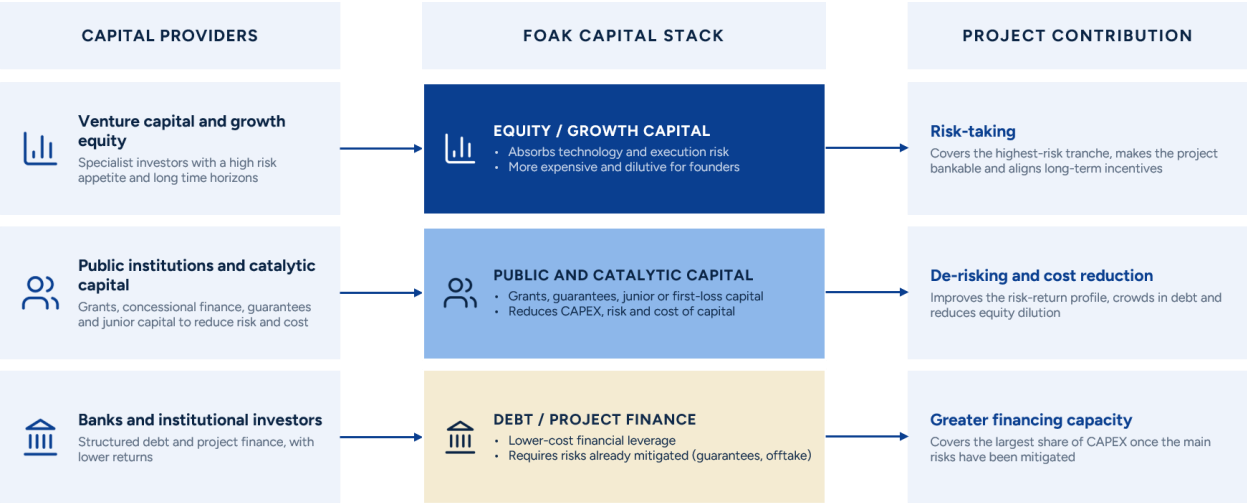
Financing a FOAK does not follow the linear model of earlier phases, in which a single instrument – typically venture capital, sometimes combined with grants – covers most of the need. It is rather an exercise in composition: **assembling a capital stack that combines equity, debt and public resources in proportions that make the project sustainable without imposing**

**excessive dilution on founders or unacceptable risk exposure on banks**. In short, a FOAK requires investors with different mandates and time horizons to converge on a single transaction whose structuring complexity is itself a barrier to entry (Figure 4). These investors include venture capital and growth equity for the highest-risk component, structured debt or project finance for leverage, and grants and catalytic capital to reduce the overall cost.

FIGURE 4

## Financial instruments in FOAK projects

Type and role of capital sources in financing a FOAK




The central issue, and the main focus of this analysis, is access to debt. As shown in the previous section, traditional project finance is not structured to take on the residual technology risk of a first commercial plant, and **banks in most cases lack the in-house expertise to carry out technical due diligence on innovative processes**. Due diligence itself, which in a project finance transaction includes Independent Engineering Reports, technical review of EPC contracts, modelling of construction contingencies and credit analysis of offtakers, costs in the order of hundreds of thousands of euros and can take more than a year. A full-wrap EPC contract with a highly reputable general contractor, the instrument that transfers construction risk in traditional project finance, is rarely obtainable for a FOAK: no contractor is willing to take on the entire delivery risk at a fixed price for a technology with no operating precedent at that scale.

The result is a structural misalignment along the financing path: from a venture capital perspective, a €100 million FOAK exceeds the fund's scope of intervention and liquidity horizon, while from a project finance perspective, the same project does not meet the minimum requirements of track record and cash flow predictability. **As the sector literature observes, the FOAK sits in a financial no man's land between two classes of investors with opposing risk-return logics**: too large and too slow for venture capital, too new and too uncertain for infrastructure investors.

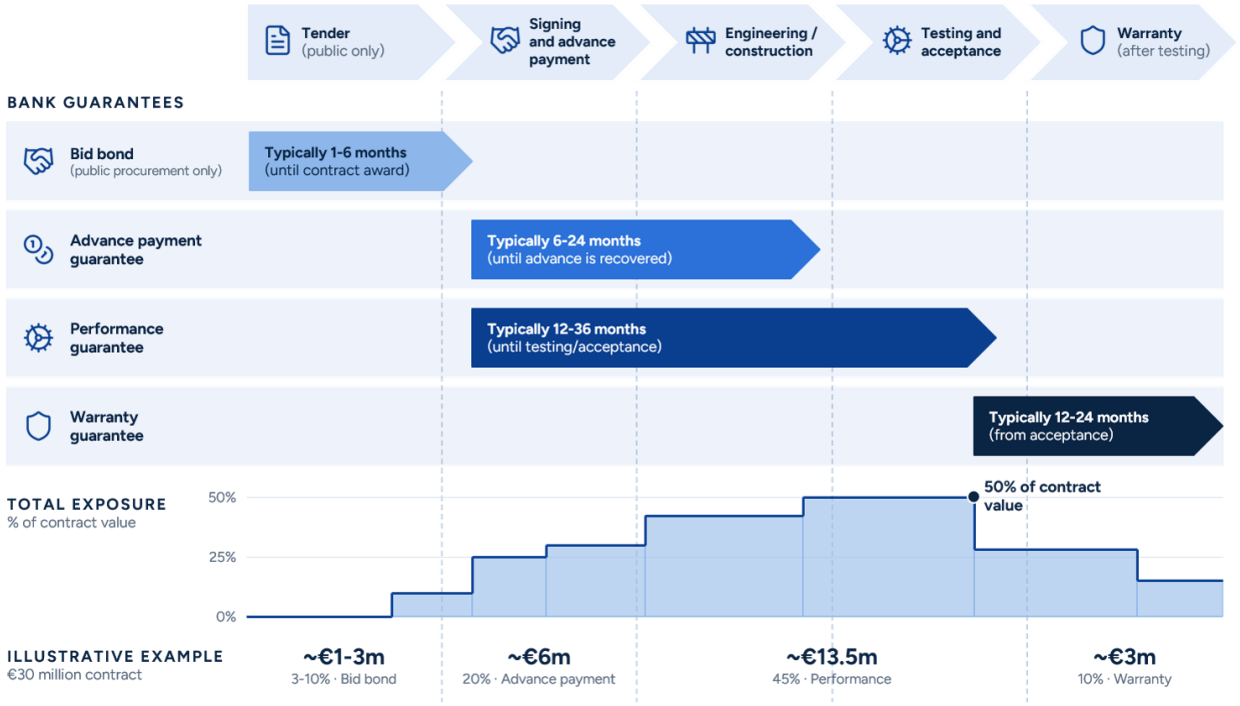
The second challenge concerns the phase immediately after: commercialising the product at scale. For companies that move beyond the FOAK and start series production, the financial barrier takes on a new form: **the problem shifts from raising capital to build a plant to having the working capital needed to serve a growing commercial pipeline**.

A cleantech company in the scale-up phase typically operates with individual contracts of between €10 million and €50 million. **In line with established industrial practice, the customer requires the supplier to provide a series of bank guarantees covering contractual risks**: advance payment guarantees protecting the down payments made, performance guarantees on compliance with the agreed technical parameters, and warranty guarantees covering any malfunctions in the post-commissioning period. In public procurement, there may also be bid bond guarantees, which protect the contracting authority against the risk that the tender is not honoured at the contract stage. Taken together, these guarantees can tie up as much as 50% of each contract's value (Figure 5).

FIGURE 5

## Sales cycle and overlap of guarantee types

Types of guarantee, typical duration and total exposure by contract phase




For an established industrial player with an investment-grade rating, solid financial statements and long-standing banking relationships, issuing these guarantees is a routine operation, with a marginal cost and no impact on available working capital. For a cleantech scale-up, the situation is different. **Unable to rely on the company's balance sheet strength, the bank requires the guarantee to be fully covered by liquid collateral: the entire amount must be placed in an escrow account, withdrawn from any productive use**. On top of this come issuance fees significantly higher than those applied to incumbents, which accumulate over the entire life of the guarantee.

The effect is counterintuitive and paralysing, as each new sale absorbs working capital instead of generating it. A company with €100 million in orders may find itself able to serve only €20 million of them, not because of production capacity limits but because it cannot post the collateral needed to activate the guarantees on the remaining contracts. The constraint compounds over time, as guarantees overlap: the advance payment guarantee on a

new contract is still active when the performance guarantee on the previous one has not yet been released. Commercial growth becomes its own financial bottleneck.

This asymmetry has implications beyond the individual company. Industrial incumbents, which enjoy uncollateralised access to bank guarantees and established relationships with national Export Credit Agency (ECA) networks, can scale up production without working capital constraints. New industrial players cannot, for the reasons set out above. The result is a competitive distortion in which **the ability to industrialise depends not on the quality of the technology or the existence of demand, but on the size of the balance sheet**, even as innovation policy supports start-ups precisely as a lever of industrial transformation.

These barriers are not permanent but specific to a limited window of time, in which public intervention can achieve maximum leverage with minimum use of resources. **Instruments already operating in other jurisdictions show that this gap can be closed in a targeted, temporary and fiscally efficient way**. The next chapter introduces the concept of the public guarantee within the broader context of industrial policy, identifying good practices for addressing the challenges described in this section.

CHAPTER 2

# Guarantees as an industrial policy tool

*Once the market failure described in the previous chapter is recognised, the question facing policymakers is not whether to intervene, but with which instrument. The available options can take quite different forms: a direct grant transfers resources but does not change the banking system's risk assessment; an equity investment exposes the public balance sheet to the same return profile as private capital; and direct lending replaces the role of the market instead of helping to activate it. Public guarantees belong to a distinct category: they do not inject capital into the system but reshape its risk architecture, making it possible to finance with private resources a transaction that the market, on its own, would be unable to price. This distinction has important consequences in a European context of tight budget constraints, since it makes it possible to pursue ambitious industrial policy objectives while committing the public budget only on a contingent basis. In other words, it is not a subsidy in a different guise, but an instrument that acts on the precondition for private investment: bankability.*

*This chapter examines public guarantees as an industrial policy tool for cleantech industrialisation. The first section sets out their anatomy: how they work, the actors involved and the design variables whose calibration determines the effectiveness of the intervention. The second analyses the main international benchmarks to identify the configurations that have proved effective and the limitations of existing ones. The two concluding sections apply this analysis along the two lines corresponding to the barriers identified in the previous chapter: the credit guarantee, which makes bank debt accessible for building a first plant, and the counter-guarantee, which frees up the working capital needed to serve a growing commercial pipeline. For both, the chapter identifies the criteria for designing an instrument calibrated to the needs of a company in the industrialisation phase, rather than to those of a mature company.*

## Anatomy and function of public guarantees

The financial barriers described in the previous chapter, namely the inaccessibility of debt for FOAK projects and the tying-up of working capital in the commercialisation phase, are not without solutions**. Public guarantees emerged as a class of industrial policy instruments specifically designed to intervene where private capital is available but fails to be deployed** because of a risk profile that exceeds the parameters of the banking system.

**A public guarantee is, in essence, a form of insurance that a public institution provides to a private financial party**, typically a bank, covering a share of the risk associated with a credit transaction or a contractual commitment. The capital disbursed remains private, since the State does not finance the project directly but reduces its risk profile until it is compatible with the lender's assessment parameters. Public outlay occurs only if the guarantee is called, an event that is rare in established practice: according to international data from the International Chamber of Commerce, over 2016–2020 only 0.2% of performance guarantees and

1.7% of financial guarantees issued were actually called and paid out[5], which implies a significant leverage effect: **for every euro committed by the guarantor, tens or hundreds of euros of private capital are channelled into investments that would not have happened without the instrument**.

This feature makes public guarantees one of the most fiscally efficient industrial policy instruments. **Unlike direct grants, which involve an immediate transfer of public resources, guarantees are contingent liabilities**: they commit the public budget only if and when the guaranteed risk materialises. The expected cost to the taxpayer is, in most cases, a marginal fraction of the investment volume mobilised. For policymakers operating under tight budget constraints, as in today's European context, guarantees offer the possibility of pursuing ambitious industrial policy objectives without resorting to large-scale subsidy programmes.

The architecture of a public guarantee typically involves three categories of actors:

- The **guarantor**, i.e. the public institution that issues the guarantee and takes on its risk, such as multilateral development banks, national promotional or export credit agencies (such as Bpifrance in France, KfW in Germany, or SACE in Italy), or government agencies with a specific sectoral mandate (such as the US Department of Energy's Loan Programs Office). In some cases, the guarantor operates through a dedicated vehicle funded by a public budget allocation.
- The **financial intermediary**, typically a commercial bank, which extends the credit or issues the commercial guarantees in favour of the beneficiary company. The public guarantee changes the intermediary's risk calculation: the portion covered by the public guarantor reduces the bank's exposure and, consequently, the regulatory capital requirements and the collateral required from the beneficiary. The intermediary retains an active role in assessing creditworthiness and, in two-tier models, can be delegated by the guarantor to carry out due diligence and activate the guarantee autonomously, within predefined criteria.
- The **beneficiary company**, which in most cases does not deal directly with the guarantor, thanks to the bank's intermediation. This allows the programme to scale without the public body having to manage each transaction individually.

In the specific context of cleantech, public guarantees can be deployed along two lines, corresponding to the two critical phases identified in the previous chapter. The first is the credit guarantee (or loan/project guarantee), which covers a share of the bank debt used to build a plant. The second is the counter-guarantee, which covers the counterparty risk the bank takes on when issuing the commercial guarantees required by industrial customers (advance payment, performance and warranty guarantees), allowing the scale-up to reduce or eliminate the collateral required.

Both instruments share a common architecture, made up of a series of building blocks whose configuration determines the effectiveness, scope and cost of the intervention:

- The **coverage rate** indicates the share of the underlying exposure covered by the public guarantee. In the main European credit guarantee schemes, coverage rates

[5] International Chamber of Commerce United Kingdom & Global Credit Data (2023), *Update to ICC/GCD 2022 Performance Guarantees Paper*.

typically range between 50% and 80%[6]. Some non-EU programmes provide higher coverage: in the United States, the Department of Energy can guarantee up to 100% of the principal and interest on bank-issued loans, within limits on total project cost[7]; in Canada, Export Development Canada's Account Performance Security Guarantee covers 100% of the risk taken on by the bank in issuing letters of guarantee[8].

- The **scope** defines the restrictions on what the guarantee can be used for. A tied guarantee is reserved for specific purposes, such as a technology sector, a geographical destination or an export transaction. An untied guarantee can be used on a broader basis, without sectoral or geographical restrictions. National ECAs typically operate with export-linked guarantees, while multilateral programmes such as InvestEU, or those implemented by development institutions, have a more flexible scope. For cleantech, scope matters: an instrument limited to individual sectors (such as the European Investment Bank's current counter-guarantee for wind) excludes equally strategic technologies.
- The **party conducting due diligence** determines who assesses the technical and credit merit of the project or beneficiary company. In a centralised model, the guarantor carries out the assessment directly, a method that ensures rigour and consistency but takes longer. In a delegated model, the guarantor sets the eligibility criteria and the commercial bank carries out the assessment, activating the guarantee autonomously. The delegated model scales more quickly and is typically adopted as programmes mature, once criteria have stabilised and transaction volumes grow.
- The **type of risk covered** specifies the nature of the guaranteed exposure. A programme may cover technology risk (the risk that the technology does not perform as expected), counterparty risk (the risk that the beneficiary company is unable to meet its obligations), execution risk (the risk of construction delays or cost overruns), market risk (the risk that demand for or the price of the product does not materialise as expected), or combinations of these. The definition of the risk covered is the element that most directly affects the instrument's additionality: an effective guarantee covers exactly the risks that the market is unable to price or absorb, without extending to those that the private sector routinely manages.

[6] In the European framework, 50% coverage is a typical level for guarantees on individual financing transactions under InvestEU, but the rate can be increased for transactions considered particularly relevant to policy objectives. The framework also provides that the financial intermediary should normally retain at least 20% of the exposure at its own risk, thus leaving room for coverage of up to 80%. This limit is also consistent with EU State aid rules: the Commission generally considers that a public guarantee should not cover more than 80% of the loan or financial obligation, so that the lender retains an adequate incentive to assess and manage the risk. See European Commission (2021), *Commission Delegated Regulation (EU) 2021/1078 of 14 April 2021 supplementing Regulation (EU) 2021/523 by setting out the investment guidelines for the InvestEU Fund*, Official Journal of the European Union, L 234.

[7] Under the *Title 17 Energy Financing Program*, the Department of Energy can guarantee 100% of principal and interest on loans made by the Federal Financing Bank (FFB). The 100% coverage therefore applies to the guaranteed loan, not to the entire project cost: Title 17 financing cannot exceed 80% of *eligible project costs*. For loans made by private financial institutions, by contrast, the guarantee can cover up to 90% of the loan. See U.S. Department of Energy (2026), *Program Guidance for the Title 17 Energy Financing Program*.

[8] Export Development Canada's Account Performance Security Guarantee (APSG) is a particularly relevant benchmark for contract guarantees, because it does not guarantee project financing but directly replaces the collateral the bank requires to issue letters of guarantee or standby letters of credit. EDC provides the bank with a 100% guarantee and, if the underlying guarantee is called, EDC covers 100% of the risk taken on by the bank. This allows the company to issue, among others, *advance payment guarantees, performance bonds* and *warranty bonds* without tying up an equivalent amount of cash or other assets as collateral.

- The **guarantee price** comprises the cost borne by the beneficiary to access the guarantee (issuance fee, annual fee, any risk premiums) and the guarantor's remuneration structure. Pricing that is too high cancels out the benefit of the guarantee, while pricing that is too low may constitute State aid under EU law. The balance between accessibility and the programme's financial sustainability is one of the most delicate design variables.
- The **duration** and **release mechanism** define the guarantee's term and the conditions for its expiry: for example, on reaching operational milestones, on completion of commissioning or on repayment of a predefined share of the debt. A duration calibrated to the specific phase of the company's life cycle is essential to ensure that the instrument acts as a temporary bridge and not as permanent support.
- Finally, the **call trigger** identifies the event that activates payment by the public guarantor, such as the borrower's default, a contractual breach or a failure of technical performance. The trigger must be defined precisely enough to protect the guarantor against opportunistic calls, yet clearly enough to give the private lender certainty of payment when needed.

## International examples of public guarantees in practice

There are several examples of public guarantees in the cleantech sector, with programmes operating in various jurisdictions and multi-year track records. Analysing the main international benchmarks, according to the taxonomy introduced in the previous section, makes it possible to identify the most effective configurations for the European industrial policy context.

The US Department of Energy (DOE) loan guarantee programme, operating since 2005 and significantly strengthened by the Bipartisan Infrastructure Law (BIL) and the Inflation Reduction Act (IRA), is the largest public guarantee instrument for cleantech worldwide. **Under the Biden administration, the programme announced more than $60 billion in loans and loan guarantees, across 25 transactions**[9].

In terms of configuration, the programme has distinctive features**. Coverage reaches up to 100% of principal, with guarantees that can extend up to 30 years**. The risk covered is explicitly technological: the LPO finances companies facing traditional barriers to commercial credit, including uncertainty related to construction, operations, supply chain and counterparty risk[10]. Due diligence is centralised and carried out by the DOE to standards comparable to those of the private sector. The institutional mandate explicitly provides for accepting a degree of risk, with the portfolio's actual loss rate standing at 3.1% of total disbursements[11].

For the purposes of this report, the most relevant cases are those in which the programme financed first commercial plants of innovative technologies. In 2022, the DOE closed a guarantee of over half a billion dollars for the Advanced Clean Energy Storage project in Utah, the

[9] U.S. Department of Energy (2025), *LPO Year in Review 2024*.
[10] U.S. Department of Energy, Office of Energy Dominance Financing (2024), *How the DOE Loan Programs Office Understands and Manages Portfolio Credit Risk*.
[11] *Ibid.*

world's largest clean hydrogen storage facility[12], which combines 220 MW of alkaline electrolysis with salt caverns for seasonal storage. In this case, **the financing unlocked private investment that would not have materialised without the guarantee**.

On a different front, that of counter-guarantees supporting manufacturing, the most mature reference is the Account Performance Security Guarantee (APSG) of Export Development Canada (EDC), Canada's export credit agency. The APSG has been operating for more than twelve years and allows cleantech manufacturers to obtain letters of guarantee from their commercial bank without placing liquid collateral in a dedicated account. As noted earlier**, coverage is 100% of the collateral for all types of guarantee** (advance payment, performance and warranty).

The operating mechanism has two tiers. EDC carries out centralised due diligence on the individual cleantech company, assesses its creditworthiness and technology profile, and authorises the commercial bank to issue guarantees drawing on EDC's instruments. The process requires the company to fill in a form, which the bank forwards to EDC so that the guarantee can be activated. As documented by Cleantech for Europe, **EDC's risk assessment capability has been refined over time as it has built up experience in the cleantech sector, making the programme progressively more efficient**[13]. The APSG is directly relevant to the second of the two barriers identified in the previous chapter: it frees up scale-ups' working capital, enables them to serve growing order books and removes the competitive asymmetry with industrial incumbents.

In Europe, the picture is changing rapidly but remains fragmented. **The European Investment Bank (EIB) has a well-established set of guarantee instruments, but until recently none of them was calibrated to the specific needs of cleantech scale-ups in the industrialisation phase**. The first sign of change came with the European Commission's *Wind Power Package*, which tasked the EIB with developing a counter-guarantee instrument for wind turbine manufacturers. In 2025, the facility was expanded from €5 billion to €6.5 billion, reflecting demand from the sector. In parallel, the EIB approved new instruments under the TechEU programme: €1.5 billion in counter-guarantees for manufacturers of electricity grid components and a €250 million CleantechEU scheme designed to provide liquidity and working capital to innovative cleantech SMEs. The latter offers counter-guarantees to commercial banks, easing collateral requirements and unlocking working capital for companies.

These are significant developments, but with clear limitations. Scope is still sectoral: wind and electricity grids are covered, but equally strategic technologies (electrolysis, long-duration energy storage, low-emission materials) have no dedicated instruments of comparable scale. **The €250 million CleantechEU scheme, while a first step in the right direction, has a limited allocation relative to the estimated need**. On loan guarantees for FOAKs, the EIB's venture debt programme supports early-stage scale-ups but is not designed to finance capital-intensive industrial plants, while existing European Investment Fund (EIF) guarantees have individual caps of €7.5 million.

[12] U.S. Department of Energy (2022), *DOE Announces First Loan Guarantee for a Clean Energy Project in Nearly a Decade*.
[13] Cleantech for Europe, op. cit.

## Design criteria for a credit guarantee

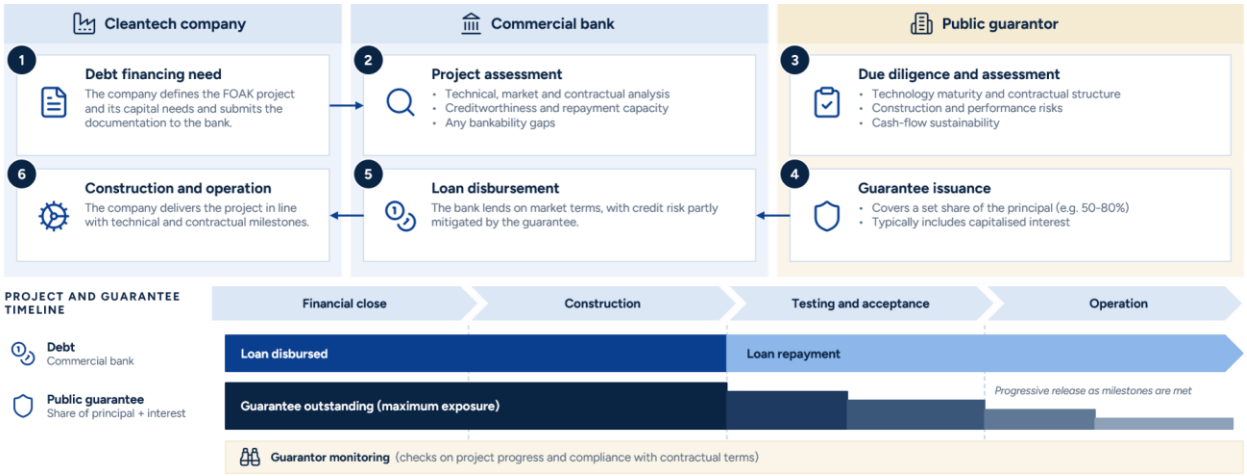
This section analyses the design criteria for a public guarantee instrument capable of addressing one of the challenges described earlier: financing a technically mature FOAK (or follow-on) project, with structured offtake agreements and drastically reduced technology risk, that cannot access bank debt because of a missing financial architecture. The credit guarantee is ideally suited to this: **a public body covers a share of the principal of the debt used to build the plant, reducing the bank's exposure until it is compatible with its risk parameters**. The capital disbursed remains entirely private, but the State takes on a contingent obligation that materialises only if the guarantee is called.

The operational flow can be outlined as follows (Figure 6). The company identifies the debt requirement for the FOAK project and opens discussions with one or more commercial banks. The bank assesses the project and, where there is a bankability gap attributable to the factors described in Chapter 1, requests the guarantor to activate the public guarantee. **The guarantor carries out, or in more mature models delegates to the bank itself, a technical and credit due diligence on the project, assessing its level of technology maturity, the robustness of its contractual structure and the sustainability of its projected cash flows**. If the assessment is positive, the guarantee is issued to cover a predefined share of the principal[14]. With its downside protected by the guarantee, the bank extends the loan at market terms. Throughout the life of the loan, the guarantor monitors project progress, and the guarantee is progressively released as agreed operational milestones are reached.

FIGURE 6

### Guarantee issuance and debt disbursement process

The operational flow of a public guarantee for a FOAK project




The effectiveness of the instrument depends decisively on the criteria by which the guarantor and, in turn, the bank assess the project's merit. **For cleantech scale-ups, the traditional parameters of bank credit assessment are structurally inadequate**. The historical financial statements of a fast-growing hardware start-up contain no metrics predictive of the future risk of a loan for an industrial plant: revenues are still limited, cash flows often negative, and

[14] The guarantee amount typically also includes capitalised interest.

assets concentrated in intellectual property and pilot plants[15]. Assessing the bankability of a FOAK project on the basis of these indicators amounts to excluding by definition the entire category of companies the instrument is designed to serve.

**An effective assessment should be based on readiness-to-deploy indicators**: the technology readiness level (TRL) achieved, the presence and quality of offtake agreements, a standardised cash flow forecast built on the parameters of the specific project, and the strength of the industrial partners involved (EPC contractors, suppliers, operators). This approach requires specialised technical due diligence capabilities that commercial banks typically lack, which argues, at least in the programme's start-up phase, for centralised assessment by the guarantor.

However, even when all these elements are in place, access to existing guarantee instruments is often blocked by administrative requirements reflecting a logic designed for mature companies rather than for scale-ups in the industrialisation phase. Many public guarantee programmes require, for example, a minimum number of years of profitable accounts, minimum turnover or net worth thresholds, or credit ratings that a pre-revenue scale-up cannot, by definition, meet. **These bureaucratic constraints, while understandable in their prudential origin, act in practice as barriers to entry that neutralise the instrument's effectiveness with respect to its stated target**. A guarantee programme calibrated for cleantech should replace these requirements with eligibility criteria based on project maturity rather than company history.

Yet the European Union's industrial policy objectives call for intervention at these stages, to facilitate the crowd-in of private capital and the financing of the delicate industrialisation phases of Europe's leading technologies. The box below analyses three scenarios with different levels of bank debt in the financing of the plant.

### Box 1 – The effect on the capital stack: three scenarios compared

To illustrate the concrete impact of a credit guarantee on the financing structure of a FOAK project, three scenarios are considered for a typical €100 million investment. The underlying assumptions are: a cost of equity of 18-20% (the return expected by venture/growth investors at this stage), a cost of grant funding of zero, and a cost of guaranteed debt of 6-7% (consistent with the terms observed in US DOE programmes). This yields three scenarios:

- In scenario A, with no debt, the project is financed with 70% equity and 30% grants. The resulting WACC is in the order of 12-14%. The company must mobilise €70 million of equity, an amount that exceeds the fundraising capacity of the vast majority of scale-ups and that, even if obtainable, would entail dilution large enough to deter founders and investors. In practice, this structure is unsustainable for

[15] Tech for Net Zero Alliance, op. cit.

almost all FOAK projects.

- In scenario B, a public guarantee on 50% of the principal unlocks a debt component equal to 30% of capex. The structure becomes 40% equity, 30% grants and 30% guaranteed debt. The WACC falls to 9-10% and the equity required drops to €40 million. The project becomes feasible for a larger number of companies, although the cost of capital remains significantly higher than in mature infrastructure sectors.
- In scenario C, an 80% guarantee allows the debt component to rise to 45%. The structure becomes 25% equity, 30% grants and 45% guaranteed debt. The WACC is 7-8% and the equity required falls to €25 million, an order of magnitude within reach of a scale-up that has completed a Series B round. The project achieves a financing structure close to that of an early-stage infrastructure investment and becomes replicable.

Moving from scenario A to scenario C halves the weighted average cost of capital and reduces the equity required by almost a factor of three. The public guarantee does not introduce additional capital into the system: it changes the composition of the capital stack, making it possible for private debt to come in. The effect is, in practice, that of a multiplier: every euro of public guarantee unlocks several euros of private investment.

**Designing a credit guarantee programme for cleantech FOAKs requires balancing the instrument's effectiveness with compatibility with the European regulatory framework**. Discussions with banks active in the sector highlighted two specific needs:

- The first concerns the **level of coverage**. Commercial banks express a preference for guarantees covering 100% of principal, which would eliminate credit risk entirely. This configuration is adopted by the DOE programme in the United States and is consistent with the logic of an instrument designed for projects with high perceived technology risk. However, EU State aid rules currently limit the coverage of public guarantees to 80% of the underlying loan. Within this constraint, 80% coverage is the maximum achievable level and, as illustrated in scenario C of Box 1, is sufficient to have a transformative effect on the project's financing structure.
- The second need concerns the **management of the period between a possible project default and the actual payment of the guarantee by the public body**. In existing programmes, calling the guarantee requires a verification and settlement process that can take several months. During this interval, the bank must book the loss, with implications for its regulatory capital requirements and prudential position. To address this, banks suggest setting up a temporary cover fund, financed by a share of guarantee fees or by a dedicated allocation, allowing the bank to absorb the provisional loss until the guarantee is actually paid. Without a mechanism of this kind, banks' willingness to participate in the programme risks being significantly reduced, undermining its additionality.

The other design variables can be set out as follows:

- **The risk covered should primarily include technology risk and counterparty risk**, the components that the market is currently unable to absorb for FOAK projects.
- **Due diligence should be centralised with the guarantor in the programme's start-up phase**, and then progressively delegated to accredited banks as sectoral expertise and experience accumulate.
- **Scope should not be restricted to individual technology sectors**, as is currently the case with the EIB counter-guarantee limited to wind, but open to the full range of strategic cleantech technologies identified by the Net-Zero Industry Act and subsequent legislation, allowing the instrument to respond to the evolving technology landscape without requiring ad hoc regulatory changes.
- **The duration of the guarantee should be aligned with the project's specific timeline**, with a progressive release mechanism tied to construction and operational milestones that reduces the guarantor's exposure as project risk declines.

## Design criteria for a counter-guarantee

The second instrument addresses the working capital barrier: a company that has moved beyond the FOAK phase, has a validated product and a growing order book, but cannot serve its commercial pipeline because each contract ties up a significant share of working capital in liquid collateral for the bank guarantees required by customers.

In this context, a counter-guarantee follows a logic similar to that of a credit guarantee but applies to a different object. Here, **the public body guarantees a commercial bank against the counterparty risk associated with issuing the commercial guarantees required by industrial customers**. With its counterparty risk partly covered by the guarantor, the bank can issue the guarantees while proportionally reducing the collateral required from the scale-up. **The capital the company would otherwise have had to place in an escrow account thus remains available to scale up production, hire staff and keep investing in research and development**. It is therefore not only a form of financial efficiency for the company, but also a measure with direct effects on growth and employment opportunities.

The operational flow mirrors the structure already described for the credit guarantee: the scale-up signs a supply contract, the customer requests the guarantees, the bank checks that the company meets the programme criteria and activates the counter-guarantee, issuing the letter of guarantee with reduced collateral. As in the previous case**, the capital mobilised is private, and the public body bears a contingent obligation that materialises only if the guarantee is called**.

Unlike the FOAK, where the main barrier is the lack of an operating track record, in the commercialisation phase there is a natural mitigating factor that strengthens the robustness of the instrument: **the commercial guarantee is activated only when there is a signed order, with an identified customer, a structured contract and an expected cash flow**. What prevents the bank from issuing the guarantee without full collateral is therefore not the quality of the underlying project but the creditworthiness of the counterparty: a parameter that, as discussed in the previous section, existing programmes tend to assess on the basis of indicators unsuited to scale-ups in the industrialisation phase.

The instrument's configuration can be set out along the same variables discussed for the credit guarantee, with some adaptations. Coverage should be at least 80% of the collateral required, in line with the operating model of the Canadian APSG. Scope should encompass the full range of strategic cleantech technologies identified by the NZIA, overcoming the current sectoral fragmentation of European instruments. As for the types of guarantee covered, a progressive approach seems preferable: **starting with the advance payment guarantee, which has the lowest risk profile, being anchored to a signed order and a payment flow already under way, and then extending coverage to performance and warranty guarantees as the programme builds up a track record and loss data**. Finally, due diligence should follow the programme's maturation path: centralised with the guarantor in the pilot phase and progressively delegated to accredited commercial banks. The box below offers an example of how counter-guarantees work for a project in the market-access phase.

### Box 2 – The effect on working capital

To illustrate the concrete impact of a counter-guarantee, consider a scale-up with an order book of five contracts worth €20 million each, for a total value of €100 million. The company has €20 million of available cash. For each contract, the customer requires bank guarantees that come into force at successive stages of the production and delivery cycle:

- In the production phase, the customer makes progress payments against which it requires an advance payment guarantee, typically equal to 30-40% of the contract value. On a €20 million contract, the guarantee amounts to around €6-8 million. Without a counter-guarantee, the bank requires the full amount as collateral: the company must tie up €6-8 million before it has even delivered the product. With an 80% counter-guarantee, collateral falls to €1.2-1.6 million, and the difference (around €5-6 million per contract) remains available to finance production.
- At delivery and commissioning, the advance payment guarantee is progressively released, but the performance guarantee takes over, protecting the customer on compliance with the agreed technical parameters. This guarantee typically covers 10-15% of the contract value (€2-3 million in this example) and remains in force for between six months and two years after the acceptance test. Without a counter-guarantee, the collateral released from the previous phase is largely reabsorbed by the new guarantee. With the counter-guarantee, the impact is marginal: the collateral required for the performance guarantee falls to a few hundred thousand euros.
- In the operating phase, the performance guarantee expires and the warranty guarantee takes over, covering any malfunctions. The amount is smaller, typically between 5% and 10% of the contract value, but the duration can extend over several years, prolonging the tie-up of collateral well beyond delivery of the product.

The cumulative effect of this overlap brings the total collateral requirement to €40-50 million at peak, more than double the company's financial resources. As a result, with €20 million, the scale-up can activate at most two contracts. The remaining three, representing €60 million of potential revenue, go unfulfilled.

With an 80% counter-guarantee, total collateral for the entire order book falls to €8-10 million. The same €20 million of cash makes it possible to serve all five contracts, leaving €10-12 million to reinvest in production capacity, hiring or technology development.

CHAPTER 3

# Expected impact on cleantech industrialisation

*The previous chapters described the financial barrier that hinders the industrial demonstration of cleantech technologies and the instruments designed to overcome it. This chapter assesses their application to the Italian context through an empirical analysis, starting from the pipeline of first plants developed by Italian scale-ups and the related capital requirement. The analysis points to a potential investment volume several times the annual capacity of the Italian cleantech venture capital market, alongside an architecture of public and private instruments that tends to concentrate on the phases immediately before or after industrial demonstration. The result is a financial discontinuity precisely at the decisive step from technology maturity to the construction of the first commercial-scale plants.*

*On this basis, the chapter moves from the aggregate picture to the analysis of two technologically mature Italian companies, positioned at different stages of the industrialisation path and representative of the two main barriers identified. The case of Arsenale Bioyards, which has designed an industrial biomanufacturing plant, shows how far a credit guarantee can go and where direct public support is needed instead. The case of Energy Dome, already in the phase of systematic market access, makes it possible instead to examine the impact of a counter-guarantee on working capital and on the company's ability to sustain an expanding commercial pipeline.*

## The Italian capital stack and the industrialisation pipeline

A rough estimate of the capital requirement in the industrialisation phase of Italian cleantech can be built from the number of FOAK projects currently attributable to the portfolio of Italian cleantech companies in the scale-up phase. Based on the projects mapped, there are around twenty-one first plants in the design phase. **Applying an average value per cleantech vertical to each project yields an aggregate requirement of €450-500 million for the first-plant phase alone**. It is worth stressing that this figure is only a snapshot of the current situation, and does not take into account the many companies that will approach their first plant in the near future.

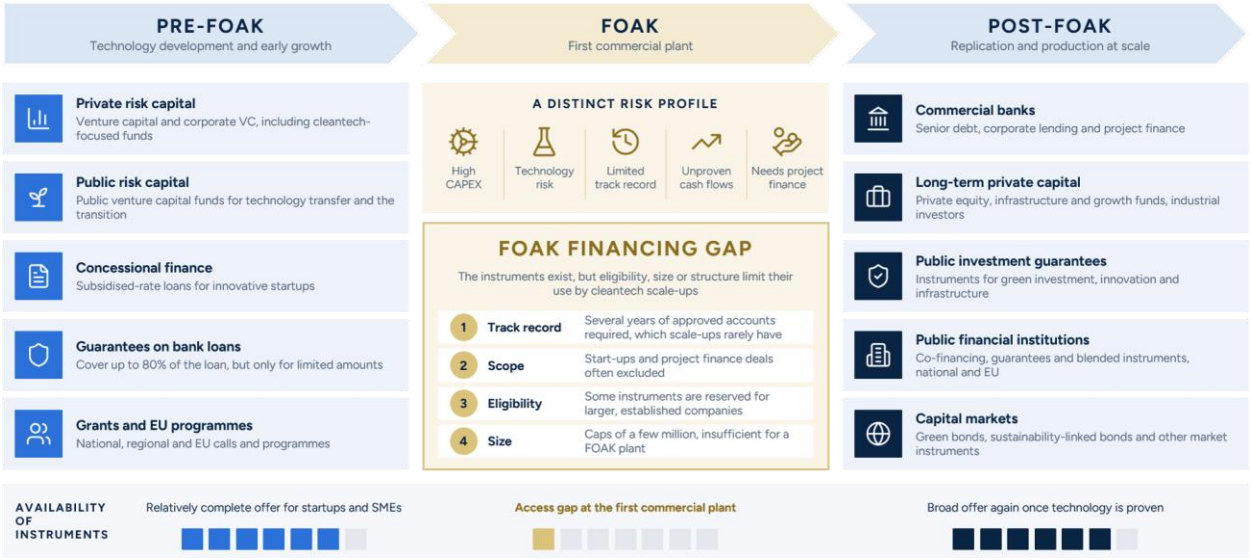
This figure, however, represents only the entry threshold: the industrial value of a FOAK lies above all in its ability to pave the way for replication at commercial scale (nth-of-a-kind, NOAK). **Adding the projects at this stage to the figure estimated above, the estimated requirement rises to €750-800 million**. In other words, this is the theoretical fundraising potential of all scale-ups currently about to build their first or follow-on plants, which alone is around three times the size of the Italian cleantech venture capital market.

This industrialisation pipeline, however, comes up against a capital stack built mainly for the adjacent phases: technology development and deployment (Figure 7).

FIGURE 7

**The Italian *capital stack* around the First-of-a-Kind phase**

Financial instruments available by technology development phase




In the early and intermediate phases, the offering is relatively complete**: private risk capital, from specialised venture capital funds to industrial corporate venture capital vehicles, is complemented by a structured public presence, deployed through the funds managed by CDP Venture Capital**: from the Fondo Tech Transfer for the earliest stages to the Evoluzione, Corporate Partners I and Green Transition funds for growth. This equity component is complemented by the first subsidised debt and guarantee instruments. Invitalia supports innovative start-ups through Smart&Start, a subsidised-rate loan, and, above all, the Fondo di Garanzia per le PMI (SME Guarantee Fund), managed by Mediocredito Centrale, guarantees up to 80% of bank loans for investment, but within a maximum guaranteed amount per beneficiary in the order of a few million euros.

At the opposite end of the curve, in the commercial phase, the stack fills up again and changes in nature. This is where the full set of public debt and guarantee instruments is concentrated, alongside private providers of mature capital such as commercial banks, project finance and private equity. On the guarantee side, SACE currently operates a range of instruments:

- **Garanzia Green** covers up to 80% of bank loans for environmental investment projects, for amounts up to €50 million, and automatically benefits from the State counter-guarantee;
- **Garanzia Futuro** extends the same logic to investment in technological innovation, digitalisation and infrastructure.
- **Garanzia Archimede**, introduced by the 2024 Budget Law, supports infrastructure and productive investments made in Italy, and is explicitly aimed at areas characterised by partial market failure, high risk, use of innovative technologies or a limited supply of financial products.

Compared with the other SACE instruments, Archimede has features that make it, in principle, the closest to the needs of a FOAK project: it has no amount limits, covers up to 70% of

the loan and also extends to bonds and signature commitments, thereby addressing both of the barriers identified in this report. **Commitments are borne 80% by the State and 20% by SACE, with an allocation of €60 billion through 2029**, and guarantees can also be issued in favour of the implementing partners of the InvestEU programme, including the European Investment Bank and Cassa Depositi e Prestiti.

Despite this breadth, the eligibility architecture still leaves uncovered precisely the segment that this report identifies as critical. Garanzia Green requires at least three sets of financial statements and explicitly excludes start-ups and project finance transactions; Garanzia Archimede, conversely, is reserved for companies other than SMEs and firms in difficulty. It follows that **a cleantech scale-up at the first-plant stage – which is, by definition, either a start-up or an innovative SME, with no history of financial statements or positive cash flows – meets the eligibility requirements of neither instrument**.

In short, guarantee instruments exist, have substantial resources and benefit from the State counter-guarantee, but their eligibility perimeter, designed for mature companies, systematically excludes the companies that public intervention should serve. The problem, in other words, is not the availability of instruments but their calibration.

## The first plant and the limits of guarantees: the case of Arsenale Bioyards

**Biomanufacturing is the production of complex molecules from living organisms such as yeasts, bacteria, algae and fungi, rather than from petrochemicals or animal sources**. Its main enabling technology is precision fermentation: by engineering the genetic code of microorganisms, they are instructed to produce a specific protein, enzyme or ingredient in fermenters. The principle has been established in pharmaceuticals for decades, but a still-high cost has so far held back its extension to mass markets such as food, cosmetics, chemicals and materials. Taking a process of this kind from lab scale to industrial scale still involves an element of technology risk, because the conditions in a small laboratory reactor only partly predict the behaviour of an industrial fermenter.

Producing by fermentation molecules that are currently derived from fossil or animal sources has benefits that go beyond the environmental sphere: **it makes it possible to shorten and relocate long, concentrated supply chains exposed to geopolitical and climate shocks, placing production close to demand**. For Europe, this means moving towards decarbonising chemicals and materials as much as towards reducing industrial dependence on foreign inputs and creating new high-value-added manufacturing value chains. It is no coincidence that in November 2025 the European Commission adopted a strategy for a competitive and sustainable bioeconomy that explicitly frames industrial biology as a matter of strategic autonomy and technological sovereignty[16]. In this emerging sector too, however, China has moved early, mobilising major industrial policy instruments: biomanufacturing is at the heart of the Five-Year Plan presented in October 2025[17], and the relevant ministries have already announced dozens of pilot projects that will receive public support.

[16] European Commission (2025), *New Bioeconomy Strategy to boost green growth, competitiveness and resilience*
[17] Ko, Justin (2026), *Biofactories: Behind China's Lead in Biomanufacturing*.

Arsenale Bioyards, an Italian company founded in 2023, headquartered in Milan with a pilot plant in Pordenone, operates in this sector. In February 2025 the company closed a first €10 million seed round led by Planet A and byFounders, with participation from, among others, CDP Venture Capital (Green Transition Fund) and Plug and Play. **Arsenale Bioyards has developed an integrated platform combining hardware, data and artificial intelligence to manage the entire biomanufacturing value chain, from designing the organism in the lab to large-scale production**. Industrial scalability is built around a logic of *scaling out* rather than scaling up: instead of building ever-larger fermenters, an approach that amplifies the technical risk of each jump in scale, Arsenale replicates standardised modules of industrial bioreactors (the "Bioyards"), cutting industrialisation costs and timelines by up to 90% according to company estimates, with industrial lines of up to 50,000 litres.

Arsenale Bioyards' current stage of maturity fits squarely within the analysis developed in this chapter: the company has already validated its technology at pilot scale and is preparing to build its first industrial plant. As seen earlier, **it is precisely at this crucial stage that the capital needed to industrialise a technology falls away**, as the technology, because of residual risk and the lack of a history consistent with credit parameters, is not bankable.

Arsenale Bioyards, with a team of 33 people and more than €10 million raised, has designed Nuovo Arsenale: an industrial facility in Porto Marghera (Venice) to develop, validate and produce bio-based molecules using fermentation processes designed by artificial intelligence models. The facility integrates a complete ladder of bioreactors with consistent instrumentation, from microbioreactors up to 50,000-litre lines with their associated downstream recovery units, so that processes can be transferred from one scale to the next without starting from scratch each time. **The project requires an investment of more than €100 million and is expected, at steady state, to create more than 170 direct jobs in Porto Marghera**.

It is a project that capital markets alone are unable to finance. Across construction, commissioning and the gradual ramp-up of capacity, cash flows remain negative for several years; according to the company's estimates, even under the most favourable assumptions the expected return with risk capital alone remains below that required by venture capital investors. Conventional lending, for its part, cannot finance a plant with no precedent at this scale and no cash flows in its early years. Moreover, a significant share of the value generated – processes validated at industrial scale, data, expertise – accrues to the wider value chain and cannot be fully captured by those who invest. **Lowering the cost of debt through a guarantee is not enough to close this gap: direct public resources are needed, in the form of grants or concessional finance, for the investment to go ahead on the planned timeline and scale**.

Guarantees nonetheless remain decisive at two stages. **During construction, public grants are generally disbursed against progress in spending, and both advance disbursements and concessional loans require bank or insurance guarantees**: commitments that a scale-up cannot provide without tying up liquidity, and that a public counter-guarantee would make sustainable, as we will see in the following section.

It is above all after validation, however, that the credit guarantee has its full effect. The processes validated in Porto Marghera are also intended for dedicated, separately financed production plants: among the options the company is considering is a production site in Ferrara (Betayard), to be developed through a dedicated vehicle. **For plants of this kind, the risk is mainly engineering risk and cash flows are tied to supply contracts: these are projects that**

**are bankable in principle**. Yet a newly established vehicle financed through project finance falls squarely within the exclusions of current instruments: Garanzia Green excludes start-ups and project finance transactions, and Garanzia Archimede remains closed to the vehicle if it is controlled by an SME. This is where a guarantee calibrated on readiness-to-deploy criteria would make the difference, allowing production capacity to be financed with debt and project finance rather than equity.

## Instruments for market access: the case of Energy Dome

The growing share of variable renewables in the power system is turning energy storage from an ancillary service into enabling infrastructure for the energy transition. Electricity generation and consumption must be balanced at all times: when wind and solar generation exceeds demand, surplus energy must be absorbed, while in hours of low renewable output resources must be available that can return it to the grid with adequate speed and reliability. The growing penetration of renewables also introduces greater variability in power flows, exacerbates congestion and can increase curtailment, making it necessary to complement generation with new flexibility resources on both the demand and supply sides. In this context, **storage systems can perform a range of functions: frequency and voltage regulation, fast reserve, peak shaving, arbitrage between hours with different prices, reduction of curtailment and deferral of grid investment**.

Electrochemical batteries remain particularly competitive for high-power, relatively short-duration services, thanks to their fast response and modularity. However, their use for longer durations can be constrained by material costs, cycle-related degradation, the need to oversize energy capacity and dependence on concentrated industrial supply chains. **Hence the interest in long-duration energy storage (LDES) technologies, designed to store significant amounts of energy and release it over several hours, or even longer periods**. These solutions can help decouple power sizing from energy capacity sizing, reduce the marginal cost of extending discharge duration and make renewable generation more dispatchable, especially in power systems with a high penetration of intermittent sources.

The development of these technologies also has an industrial and security-of-supply dimension. The global lithium-ion battery supply chain remains highly concentrated: **in 2024 China accounted for around 80% of global manufacturing capacity along the battery supply chain, with even higher levels of concentration for some materials and components**[18]. LDES technologies, including electrochemical ones such as flow batteries, can help diversify the technology portfolio used for stationary storage and reduce dependence on specific supply chains and critical raw materials associated with lithium-ion batteries. The strategic importance of storage is also evident from the investments under way in China, where storage projects of ever-larger scale are being built. Notable examples are the compressed air energy storage projects (compressed air energy storage, CAES) launched in Yingcheng, at 300 MW[19], and Huai'an, at 600 MW[20]. China's push on LDES technologies shows that, even in a

[18] International Energy Agency (2026), *Energy Technology Perspectives 2026*.
[19] Global Times (2025), *World's first 300 MW compressed air energy storage plant fully operated in Central China*.
[20] ESS News (2026), *World's largest compressed air energy storage station now fully operational in China*.

country that dominates the lithium-ion supply chain, it is strategic to invest in complementary solutions that are essential for a power system with an ever-higher penetration of renewables.

Energy Dome, an Italian company founded in Milan in 2020 by Claudio Spadacini, Dario Rizzi and Francesco Oppici, operates in this sector. **The company has developed a $CO_2$ Battery, a thermomechanical storage system that uses carbon dioxide as the working fluid in a closed cycle**. During charging, electricity is used to compress and liquefy the $CO_2$, while the heat generated by compression is stored; when energy needs to be returned to the grid, the process is reversed and the $CO_2$ is heated and expanded through a turbine that drives an electric generator. **The system achieves a round-trip efficiency of around 75% and uses mainly off-the-shelf industrial components and widely used materials** such as steel, water and carbon dioxide, without relying on lithium or rare earths. Energy Dome validated the technology principle in 2022 through a 2.5 MW / 4 MWh demonstration plant in Sardinia, and then developed a standard 20 MW / 200 MWh commercial unit capable of delivering energy continuously for ten hours.

The company's growth has been supported by a combination of private capital and public instruments. In 2023 Energy Dome completed a €55 million Series B, led in the first tranche by Eni Next and Neva SGR, with participation from Barclays, CDP Venture Capital and 360 Capital, among others. In the same year, construction of the first commercial, industrial-scale $CO_2$ Battery in Ottana, Sardinia, received support from Breakthrough Energy Catalyst and venture debt financing from the EIB. The 20 MW / 200 MWh plant is now grid-connected and in commercial operation, with ENGIE as counterparty to the company's first offtake agreement.

The Ottana FOAK, together with the use of established industrial component supply chains to build $CO_2$ Batteries, makes Energy Dome a different case from Arsenale Bioyards. **A technology already demonstrated at industrially relevant scale may have overcome a significant share of technology risk without the company yet having the track record and balance sheet strength needed to back, with its own balance sheet, the commitments required to deliver commercial-scale energy infrastructure**. Supply and EPC contracts normally require guarantees on execution, on advances received and on plant performance. For a scale-up, the need to fully collateralise these guarantees can tie up a significant share of the liquidity raised, precisely when capital is most needed to finance growth. The Energy Dome case therefore makes it possible to observe a barrier distinct from, but complementary to, the access-to-debt barrier analysed earlier: that of taking on the financial and contractual commitments needed to replicate the technology at commercial scale without tying up the capital needed for growth.

Turning to the specific case, **Energy Dome focuses its commercial activity on two main targets: utilities and hyperscalers**. For the former, the $CO_2$ Battery is a flexibility resource capable of absorbing energy in hours of peak renewable output and returning it when demand rises, reducing curtailment and congestion and increasing the availability of dispatchable capacity. For hyperscalers, by contrast, the value lies mainly in the ability to power large, continuous loads, such as those of data centres, with renewable energy made more stable and predictable by long-duration storage. In both cases, Energy Dome therefore targets large industrial counterparties, interested not only in the cost of energy but also in continuity of service and the plant's ability to meet precise availability and performance requirements.

The structure of the guarantees required of Energy Dome under a build-transfer contract, in which the battery is delivered to the customer and subsequently operated by it, consists of:

- An advance payment guarantee equal to 20% of the contract value, with a duration of 12 months;
- A performance guarantee of 45%, with a duration of 24 months;
- A warranty guarantee of 10%, also with a duration of 24 months.

Each guarantee is subject to a 25% collateral requirement and an annual bank fee of 1.5%. On an average contract worth €65 million, the total face value of the guarantees therefore reaches €48.8 million, implying a collateral requirement of around €12.2 million per contract.

The critical nature of the guarantees becomes apparent above all when considering their distribution over time and the progressive overlap of contracts. In a build-transfer contract, the advance payment guarantee is issued at signing and remains in place during the plant construction phase, assumed to last around twelve months. On completion and the acceptance test, it is released and gives way to the performance guarantee and the warranty guarantee, both of which remain in place for the following twenty-four months. **The collateral requirement is therefore not concentrated at a single point in time but accompanies the contract throughout its execution and post-delivery cycle**. Financial pressure, however, rises rapidly as the number of contracts grows: while the guarantees on the most recent contracts still cover the construction phase, those associated with plants already delivered continue to tie up capital during the performance and warranty period. **The consequence is a progressive build-up of tied-up collateral as the number of projects executed simultaneously grows**, which can turn an instrument that is manageable on a single contract into a significant constraint on the company's ability to scale commercially.

The effect of the counter-guarantee is particularly evident when considering an order book of six build-transfer contracts with an average value of €65 million each, for total potential revenue of €390 million. Without a counter-guarantee, applying the structure described above, the total collateral associated with the guarantees required across the cycle of the six contracts would amount to around €73.1 million. This amount would not, however, be tied up in full at the same time, since the advance payment guarantee is released at the end of the construction phase and replaced by the performance guarantee and the warranty guarantee. Assuming, for illustrative purposes, that the six contracts are signed at six-month intervals, peak collateral tied up at any one time would be in the order of €42 million. A public counter-guarantee with 80% coverage would instead reduce the residual exposure to 20%: total collateral associated with the entire order book would thus fall from €73.1 million to around €14.6 million, while peak tied-up liquidity would fall from around €42 million to €8.5 million. In other words, a cash position in the order of €15 million, insufficient on its own to sustain the growth of the order book in the unsupported scenario, would become sufficient to cover the collateral needs of six contracts with a total value of €390 million.

CHAPTER 4

# Proposals to recalibrate public guarantees

*The analysis in the previous chapters leads to a central conclusion: Italy lacks neither public guarantee instruments to support cleantech industrialisation nor the resources needed to fund them. It already has instruments with significant allocations and, in many cases, backed by the State counter-guarantee. The limitation lies rather in their calibration: eligibility requirements designed for mature companies and ordinary risks end up excluding precisely the scale-ups and projects that public intervention should support. The recommendations that follow therefore do not, save for residual cases, propose creating new instruments, but a targeted recalibration of existing ones. Acting on mechanisms that already have a mandate, resources and operational capacity makes it possible to reduce implementation times and costs to the public finances.*

*The chapter is organised in three sections. The first two address the barriers identified in Chapter 1 through the instruments suited to improving project bankability: the credit guarantee, to facilitate access to the debt needed to build first plants, and the counter-guarantee, to free up the working capital required by a growing commercial pipeline. The third section concerns the rest of the financing structure. Financing a FOAK project is, in fact, an exercise in combining different sources of capital, of which the public guarantee is a fundamental enabling condition.*

## Credit guarantees for the first plant

As illustrated in Chapter 3, the scale-up process for cleantech solutions at the first-plant stage and beyond is caught in a vice, remaining excluded from currently available guarantees because of their eligibility requirements. The first three recommendations therefore address credit guarantees.

**Recommendation 1: Adapt SACE's Garanzia Green to the risk profile of First-of-a-Kind projects.** SACE's Garanzia Green covers up to 80% of bank loans and is backed by the State counter-guarantee. Public risk-taking is therefore already in place, but the eligibility requirements for this instrument exclude scale-ups without an adequate history of annual financial statements. We recommend waiving these requirements for projects that meet readiness-to-deploy criteria, such as technology maturity (TRL), quality of offtake agreements, strength of industrial partners and coverage of the remaining financing, for example from venture capital and grants. This would allow a scale-up in the industrialisation phase to access bank debt, reducing the project's overall cost of capital.

**Recommendation 2: Extend Garanzia Archimede to scale-ups.** Among SACE's instruments, Garanzia Archimede is structurally the closest to the needs of a FOAK project: it is designed for investments involving high risk, the use of innovative technologies or a limited supply of financial products, has no amount limits, has a tenor of up to 25 years and is borne 80% by the State and 20% by SACE. Here too, its limitation is the explicit exclusion of SMEs, which cuts out most scale-ups in the industrialisation phase. We recommend introducing a dedicated eligibility channel for SMEs and innovative companies at the first-plant stage, allowing

them to access the instrument on terms calibrated to the project profile rather than to company size.

**Recommendation 3: Establish a dedicated fund to cover the residual risk.** The 80% ceiling imposed by EU State aid rules leaves 20% of the principal with the bank, which tends to pass it on to the scale-up in the form of additional collateral, eroding its financial efficiency. We recommend establishing a dedicated public fund to absorb this residual share, taking it off the company's balance sheet. As a temporary solution, an instrument already in operation such as Cassa Depositi e Prestiti's *Fondo Rotativo Imprese*, which provides subsidised financing at a rate of between 0.5% and 0.8%, could be combined with the SACE guarantee to inject low-cost debt in synergy with the banking system[21]. This low-cost debt could serve as collateral, which would however remain on the scale-up's balance sheet, and could also provide temporary cover in the event of default, bridging the interval between default and the actual payment of the guarantee.

## Counter-guarantees for market access

The second barrier concerns the working capital tied up in collateral for the commercial guarantees required by industrial customers. Here too, a review of existing instruments points to a problem of calibration rather than availability: SACE already counter-guarantees the full commercial range (advance payment, performance, warranty, bid bond) on the domestic market.

**Recommendation 4: Raise coverage of commercial guarantees to 80%.** SACE's cover on bonds is currently limited to 50% through the framework agreement with banks (MRPA), and to 60% under Garanzia Archimede. At these levels, the bank continues to require a significant share of collateral from scale-ups, only partly resolving the working capital constraint. We recommend raising coverage to 80%, in line with the Export Development Canada model.

**Recommendation 5: Introduce a single contract-level counter-guarantee, extendable to a guarantee facility.** Even at 80%, a counter-guarantee activated case by case forces the company into separate bank negotiations for each guarantee and each contract. We therefore recommend designing a dedicated contract-based counter-guarantee: a single intervention jointly covering the collateral associated with a given contract (advance payment, performance and warranty) through a single assessment. For companies that have passed a centralised technical and industrial due diligence conducted by the guarantor, cover could also take the form of a pre-approved guarantee facility, within a limit commensurate with the company's profile, that can be drawn on for each new contract without a new assessment. In this way, the assessment of merit shifts from a parameter the scale-up cannot meet, such as balance sheet strength, to one it can demonstrate: industrial maturity and the quality of the order.

[21] Cuppoloni, F., Torsello, M. (2026). *Verso la scala industriale. Una "politica primo impianto" per l'Italia* [Towards industrial scale: a "first plant policy" for Italy]. Cleantech for Italy.

## Completing the capital stack

The recommendations in the previous sections address the enabling condition for financing first industrial plants: making bank debt accessible to finance the project and freeing up the working capital needed to serve the market. However, as illustrated in Chapter 1, financing a FOAK project is not only a matter of disbursement but above all of assembling a complete and coherent capital stack. From this perspective, the public guarantee that makes debt available must be accompanied by an adequate equity component, a share of non-dilutive resources and a structure that allows the company to assemble these elements in a single transaction. The recommendations that follow address what remains uncovered once the guarantee issue is resolved, namely the instruments that complete the capital stack and the institutional conditions that make it possible to assemble it.

**Recommendation 6: Establish a dedicated equity and first-loss capital vehicle for the industrial demonstration phase.** The mapping of the Italian capital stack in section 3.1 shows a sharp discontinuity at TRL 7–8: public and private equity instruments are concentrated in the technology development phases, debt and guarantee instruments in the commercial phase, while the industrial demonstration phase is covered by a single public player. No debt guarantee can fill this gap, since guaranteed debt still requires an upstream risk capital component in order to be structured. We recommend establishing a vehicle dedicated to equity financing for first-plant projects, with a *first-loss* capital component able to absorb residual risk and attract private co-investors. Ticket sizes and time horizons should be calibrated to the needs of an industrial project, i.e. larger and longer than an average venture capital round.

**Recommendation 7: Provide an additional tier of non-dilutive resources for the pre-investment phases.** In the phase preceding the final investment decision, a FOAK project requires significant resources for feasibility studies, front-end engineering design (FEED) and contract structuring: these are costs that precede any cash flow and that no lender is willing to finance, but whose quality determines the project's bankability downstream. We recommend providing a tier of grant funding dedicated to this phase, linked to existing instruments.

**Recommendation 8: Build a public technical assessment capability and a forum for coordinating instruments.** The effectiveness of the whole framework depends on a condition that none of the instruments described meets on its own: the ability to assess a project's industrial maturity and to combine the interventions of the various public bodies around it. As noted in section 2.3, commercial banks lack the expertise to carry out technical due diligence on innovative processes, and the absence of this capability is itself a cause of exclusion from credit. We therefore recommend building a public technical assessment capability for FOAK projects, serving the guarantor and, under progressive delegation, the accredited banking system; and, on this basis, establishing a permanent coordination forum among SACE, CDP and Invitalia, tasked with defining for each project the sequence of interventions (guarantee, subsidised debt, equity and grants) and their respective activation conditions.

**Recommendation 9: Establish a single point of access for industrialisation projects.** The instruments described in this chapter fall under different bodies, each with its own eligibility criteria, assessment timelines and documentation: Garanzia Green and Garanzia Archimede at SACE, the Fondo Rotativo at Cassa Depositi e Prestiti, and the Contratti di Sviluppo (Development Contracts) at Invitalia. A company at the first-plant stage thus has to work out on its own the combination of instruments applicable to its project, submitting separate

applications and undergoing repeated assessments with each body, with outcomes that are not mutually conditional: a burden that, for a small organisation simultaneously engaged in building a plant, is a barrier in itself. We recommend establishing a single point of access for cleantech industrialisation projects, where the company submits a single project file, subject to a single technical assessment, on the basis of which the competent bodies each activate their own instrument in the sequence defined by the coordination forum. The aim is not to centralise the powers of individual bodies, which remain unchanged, but to shift the burden of assembling the package from the company to the institutions.

# Conclusions

Italy today has a base of cleantech innovation built up over years of public and private investment. It also faces a specific constraint that stands in the way of realising its value: **access to bank credit in the industrialisation phase**. The constraint takes two successive forms: the debt needed to build the first plant and the working capital needed to serve the market. Neither barrier is irrational from the bank's point of view. Both reflect assessment parameters designed for mature companies and applied to companies that, by definition, cannot meet them.

The instruments to intervene already exist, have substantial resources and are largely backed by the State counter-guarantee. What is missing is a calibration that makes them accessible to scale-ups at the first-plant and market-access stages. The recommendations in this report act first and foremost on the eligibility requirements and coverage levels of SACE and CDP instruments. They are complemented by the elements that make it possible to assemble a complete and coherent financing structure for each project. They are summarised in the table below.

| Measure | Function | Design |
|---|---|---|
| **Garanzia Green for FOAKs** | Makes bank debt accessible to technically mature projects without a financial track record, reducing the overall cost of capital of the first plant. | SACE waives financial statement requirements for projects meeting readiness-to-deploy criteria: TRL, quality of offtake agreements, strength of industrial partners, coverage of the remaining financing need. |
| **Garanzia Archimede for scale-ups** | Opens the instrument closest to the profile of FOAK projects, with no amount limits and 80% of risk borne by the State, to companies currently excluded because of their size. | SACE introduces a dedicated eligibility channel for SMEs and innovative companies at the first-plant stage, with terms calibrated to the project rather than to company size. |
| **Cover for the residual share** | Prevents the unguaranteed share from passing to the scale-up as additional collateral, and covers the interval between default and payment of the guarantee to the bank. | A dedicated public fund; in the short term, CDP combines the FRI with the SACE guarantee, injecting subsidised debt in synergy with the banking system. |
| **80% commercial counter-guarantees** | Reduces the collateral required on advance payment, performance and warranty guarantees, freeing up working capital to serve the order book. | SACE raises its cover on bonds from the current 50% (MRPA) and 60% (Archimede) to 80%, on the Export Development Canada model. |
| **Single contract-level counter-guarantee** | Replaces case-by-case negotiation with a single assessment per contract. Shifts the assessment from balance sheet strength to industrial maturity and the quality of the order. | SACE designs a counter-guarantee jointly covering all guarantees under a contract, extendable to a pre-approved guarantee facility with a limit commensurate with the company's profile. |
| **Equity vehicle for industrial demonstration** | Provides the risk capital component without which guaranteed debt cannot be structured, attracting private co-investors. | A dedicated vehicle with a first-loss component, with tickets and time horizon calibrated to an industrial project rather than a venture capital round. |

| Measure | Function | Design |
|---|---|---|
| **Pre-investment non-dilutive resources** | Funds feasibility studies, front-end engineering and contract structuring, on whose quality the project's downstream bankability depends. | A tier of grant funding dedicated to this phase, linked to existing instruments. |
| **Technical assessment and coordination** | Fills the technical expertise gap that is itself a cause of exclusion from credit. Combines the interventions of the various bodies on each project. | A public technical assessment capability serving the guarantor and, under progressive delegation, accredited banks, with a permanent coordination forum among SACE, CDP and Invitalia. |
| **Single point of access** | Shifts the burden of assembling the package of instruments from the company to the institutions, eliminating repeated and uncoordinated assessments. | A single project file, subject to a single technical assessment, on the basis of which each body activates its own instrument in the agreed sequence. |

The context makes this intervention urgent. The Net-Zero Industry Act and the Clean Industrial Deal have made manufacturing capacity in clean technologies a European priority. The United States and Canada have had dedicated guarantee instruments for years, and the European Investment Bank is progressively expanding its own. In emerging sectors such as biomanufacturing and long-duration storage, China has already mobilised its industrial policy instruments. Against this backdrop, every first plant that fails to find financing in Italy is built elsewhere, or not built at all, and with it the value of the investment already made in the research and development phases is lost. Building on the "First Plant Policy" already proposed by Cleantech for Italy, **existing guarantee instruments must be recalibrated now, where public intervention achieves the greatest effect with only a contingent commitment of the budget**. In the meantime, the institutional conditions (technical assessment, coordination, single access) must be built so that the bankability of industrialisation projects becomes a structural feature of the Italian system.

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