Bankability of Defossilised First-of-a-Kind Chemicals & Fuels Production Projects

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Industrial FOAK Projects Are the Gateway to Deploying Sustainable Technologies at Scale

Under the Clean Industrial Deal (CID), the EU is seeking a new balance between achieving climate goals for 2050 and maintaining industrial competitiveness and strategic autonomy. **Fossil-based resources need to be displaced by sustainable resources** through mobilizing new industrial assets and repurposing brownfield infrastructure. This will require large-scale deployment of novel technologies for converting biomass, waste, and CO_2 resources into sustainable platforms for commodity chemicals and fuels like SAF, methanol, second generation ethanol, pyrolysis oil, Fischer Tropsch liquids, and their derivatives, thereby **reducing Europe's fossil input while reinforcing industrial autonomy.**

The transformation of the industrial system requires large-scale deployment of multiple first-of-a-kind (FOAK) commercial-scale projects and value chains to build momentum and protect national interests. Nearly 45% of total CO_2 emission reductions for 2050 depend on technologies that are still at prototype or demonstration stage[1]. The ECB estimates a need for an additional annual €400 - €550 billion of investments until 2030 to meet Green Deal targets[2]. Leveraging private capital will be instrumental to the CIDs success, and active participation from banks, which finance ~70% of the EU's economy, will be key[3].

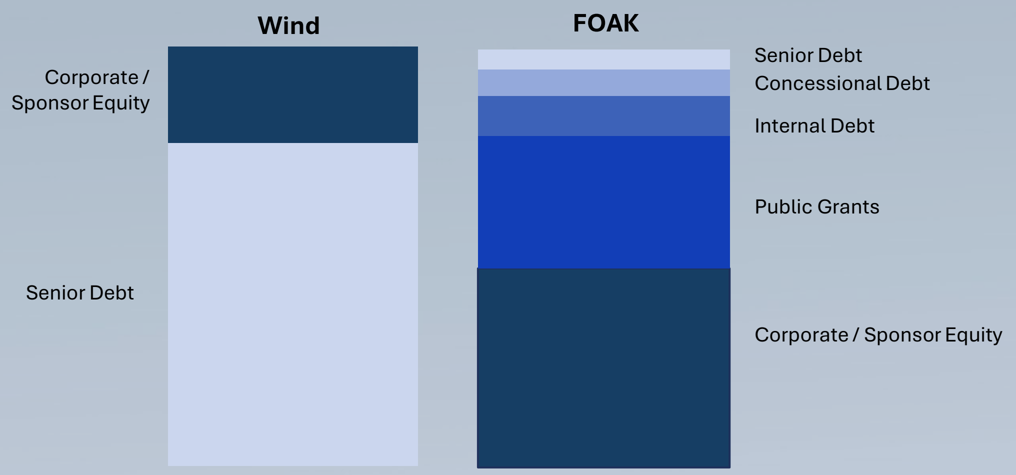
Yet despite the urgent need for FOAK projects, these projects face **significant challenges in reaching Final Investment Decision (FID) and accessing private sector financing** due to technology, market, and regulatory uncertainty, as well as lack of proven returns.

Europe now faces a narrow window to move from policy ambition to bankable deployment. Without decisive action now, Europe risks falling short of REDIII, ReFuelEU Aviation, and FuelEU Maritime targets and weakening industrial sovereignty. The window for action is closing fast, the next few years will determine whether Europe or other regions will lead the green transition. **Regulatory frameworks and targeted funding support must therefore be put in place to unlock private sector financing** and accelerate the shift from demonstration to commercial scale deployment of sustainable production processes.

[1] International Energy Agency (2022). The Need for Net Zero Demonstration Projects.
[2] European Central Bank (2025). Green investment needs in the EU and their funding.
[3] United Nations Environment Programme Finance Initiative (2025). Making the Clean Industrial Deal Bankable: Recommendations to Scale Sustainability Across EU Industry.

Bankability Challenges Prevent FOAK Projects from Reaching FID

Exhibit 1: Capital stacks in Wind vs. FOAK projects [%]



Advanced sustainable conversion technologies, such as gasification, pyrolysis, Fischer-Tropsch, and Power-to-X (P2X), are vital for expanding the feedstock base for the sustainable industrial transformation. The FOAK nature of these projects often stems from these technologies being applied to new feedstocks in new value chains. **Commercial-scale FOAK projects** face **high capital intensity** (€100 million – >€1 billion) and **unvalidated operational performance** related to yield stability, process efficiency, and full load hours. These characteristics make **FOAK projects difficult to structure under conventional project finance models**, which rely on proven performance and stable cash-flow generation.

The capital stack of FOAK projects remains fragmented (Exhibit 1), relying predominantly on equity instruments and grants while participation of commercial **debt is extremely limited**. In contrast, mature renewable assets, such as wind turbines, typically secure 70-80% debt financing through conventional project finance structures[1]. This results in a significantly **higher weighted average cost of capital** (WACC) for FOAK projects and restricts the scale of private investment available for deployment. According to the Office of Clean Energy Demonstrations, bankable projects are those that can access lower-cost forms of financing from traditional lenders, like commercial banks[2].

For independent developers, new entrants without strong balance sheets or credit ratings, achieving financial close requires **complex risk allocation frameworks** for distributing technology, completion, and performance risks across parties along the value chain. These negotiations often end in a **risk-allocation stalemate**, as parties fail to agree on how to best allocate these risks, specifically at the facility-level for distributing technology and system performance risk.

Without targeted de-risking instruments to strengthen bankability, FOAK projects remain stalled before FID. This delays replication of FOAK projects, slows technology learning, and limits Europe's industrial scale-up of defossilised fuels and chemicals.

[1] WindEurope (2023). Financing and Investment Trends - The European Wind Industry in 2022.
[2] U.S. Department of Energy, Office of Clean Energy Demonstrations (2024). Financing and Development Approaches from Recent First-of-a-Kind Projects.

Financing Pathways - Capital Structures Must Evolve from Grant-Driven Models to Conventional Project Finance Models

Main Funding Streams | *Debt* | *Equity* | *Subsidies & Grants*

TRL 1-3	TRL 4-6	TRL 7-8	TRL 9
<1MW	1-10 MW	10 – 50 MW	50 – 300+ MW
€50k - €1m	€1m - €10m	€10m - €50m	€50m - €200m+
Research & Concept	*Piloting*	*Demonstration*	*Commercialization*
Equity Grants	Equity Subsidies	Equity Specialised Debt Subsidies	*Pre-Development* → *Construction* → *Ramp-Up & Operations*

During the transition from **demonstration to commercialisation stage,** both the investment requirement and risk profile are high leading to **bankability challenges and a financing gap.**

Different financing strategies are utilized by different types of project developers across the 3 phases of Pre-Development, Construction, and Ramp-Up & Operations:

Strategic developers[1] - larger incumbent and corporate players, like oil & gas majors and large energy companies – favour **proven technologies** aligning with their current business offering and existing assets.

- These technologies are typically associated with **lower risk** and may already have been proven at scale
- Often use their operational cash flows or raise on-balance sheet **corporate finance** to develop these projects

Independent developers[1] - smaller companies and newer entrants to the sustainable chemicals & fuels market - focussing on **novel, advanced technologies** are faced with elevated construction, ramp-up and performance risk for developing FOAK projects.

- Will typically require an **off-balance sheet, non-recourse project finance** approach, which is accompanied by **complex risk allocation requirements** to reduce project risk and improve certainty on cash flows
- Often leads to **challenges in accessing project-based lending**, presenting a barrier to scaling advanced technologies

Strategic Developer

Corporate Finance Debt
Equity
Subsidies

Independent Developer

Pre-Development	Construction and Ramp-Up & Operations
Equity Subsidies	Limited or Non-Recourse Project Finance Debt Equity Subsidies

[1] European Investment Bank (2024). Financing sustainable liquid fuel projects in Europe: Identifying barriers and overcoming them.

FOAK Projects Face Intertwined Risks Across the Value Chain

Impacts of High or Unmitigated Risk for FOAK's:

- Higher required returns to offset unproven performance and elevated downside risk
- Reduced debt capacity, with banks demanding greater equity contributions ("skin in the game")
- Stricter collateral and covenant structures
- Prolonged due-diligence and credit approval cycles, delaying financial close and construction

FOAK projects exhibit heightened technology scale-up and system-integration risk due to limited operational references and unverified commercial performance. By contrast, **Next-of-a-Kind** (NOAK) projects operate on validated technologies, standardized contracts, and predictable performance within established supply chains. Technology risk is lessened, allowing optimized operations and conventional project finance structures.

Main Risks in FOAK Defossilised Chemicals & Fuels Production Facilities

Feedstock

Risk	Description
Feedstock Supply Risk	Shortage of supply, inconsistency in quality
Market Price Risk	Volatile merchant market price
Counterparty Risk	Non-delivery, lack of creditworthiness

Conversion Facility

Pre-Development → Construction → Ramp-Up → Operations

Pre-Development / Construction:

Risk	Description
Technology Risk	Equipment not performing as designed at scale
System Risk	Component integration and interface challenges
Completion Risk	Delays, cost overruns

Ramp-Up / Operations:

Risk	Description
Operating Performance Risk	Challenges and delays in system optimization, low system efficiency, product not on-spec

Offtake

Risk	Description
Offtake Risk	Lack of sufficient demand
Market Price Risk	Volatile merchant market price
Counterparty Risk	Buyer default, lack of creditworthiness

Policy and Regulatory Framework

Risk	Description
Policy / Regulatory Risk	Inconsistency in targets, mandates, subsidy schemes, emissions pricing, and sustainability criteria, in addition to lack of long-term outlook
Permitting Risk	Delays in permits based on environmental standards

Construction Stage Risks Affect Bankability

Conversion Facility

FID → Construction → Mechanical Completion → Ramp-Up → Performance Testing → Operations

Construction Stage Risks	Bankability Challenge

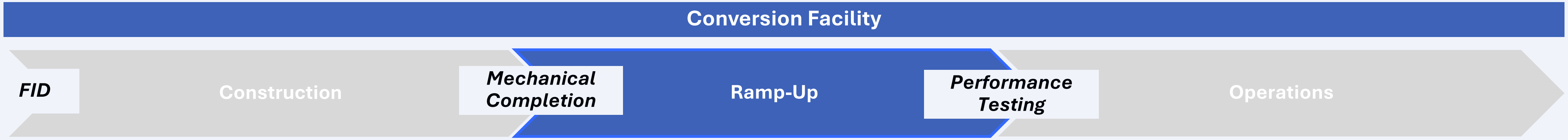
Construction of large-scale FOAK projects face unforeseen technology, system, and overrun risks:

- **Technology Scale Effects:** Physical phenomena such as heat transfer, fluid mixing, and catalyst or enzyme reactions behave non-linearly when scaling from demonstration scale to commercial scale. Substantial scaling changes reaction dynamics in unpredictable ways. At full industrial scale, these deviations multiply across unit operations, which can alter mass and energy balances and trigger design changes that were not predictable from the data of the demonstration plant.
- **System Interface Challenges:** Industrial plants depend on seamless integration between new conversion process units, existing utilities infrastructure like electricity & heat grids, wastewater treatment, waste steam integration, and associated control systems. Each interface grows uncertainty in system performance.
- **Potential for Cost Overruns:** Design additions and corrections can substantially increase total installed cost driven by, for example, unforeseen system interface needs, equipment procurement changes. This can lead to an iterative construction process once detailed engineering meets physical reality.
- **Potential for Completion Delays:** Non-standard equipment in the feedstock treatment and conversion processes, complex system integration, procurement delays stemming from single source equipment providers, and frequent re-testing may lead to construction inefficiencies that extend timelines.

Uncertainty around success of technology at scale and projected initial budget and timeline creates substantial risk for loan repayment.

Core technology process not operating at desired full load hours or delivering on-spec product at scale. This affects repayment capacity and increases project contingency needs. Uncertainty in cash flow stability remains and must be mitigated to overcome bankability challenges.

Ramp-Up Stage Risks Affect Bankability



Ramp-Up Stage Risks

FOAK	NOAK
~8-36 Months	~1-3 Months

After mechanical completion, the **ramp-up and optimization of FOAK facilities to reach desired performance and full load hours may face further technical challenges and extended timelines**. Ramp-up typically spans ~8–36 months, during which process parameters must be continually recalibrated and adjusted to improve yields and utilities consumption.

Optimizing heat profiles, flow distribution, residence times, and conversion rates take time. During the ramp-up phase, yields and product quality may be lower due to incomplete conversion or fouling and utilities consumption may be higher.

- Heat integration and mass balance closure can differ from initial design models, where minor mismatches may create major operational ripple effects.
- Sensitive components, like catalysts and membranes, may show different performance and lifetimes under larger scale operations compared to demo scale operations.
- Supply chain fluctuations through feedstock variability, logistics scheduling, or utilities interruptions may present challenges not visible in short demo runs.
- Trial and error in development and refinement of standard operating procedures.

Bankability Challenge and Liquidity Bottleneck

The **ramp-up phase often consumes more funds and time than initially anticipated.** Challenges in this phase are typically underestimated as they are unpredictable and hard to account for, leading to **liquidity challenges and difficulties complying with financial covenants.**

- Additional costs from higher OPEX requirements during performance optimization, extra maintenance, spare parts, or expert interventions
- Revenue from initial product sales may be delayed or below expectation due to sub-spec quality or low facility efficiency and uptime during initial operations

Additional working capital and cash buffers are therefore typically required for another 12–24 months beyond mechanical completion for achieving reliable throughput, on-spec quality, and predictable operating cost. Public grants typically expire at the mechanical completion milestone, leaving project developers without support for funding an extended ramp-up phase.

The ramp-up phase could outlast the available capital and patience of shareholders. If investors or parent companies lack financial endurance, the plant may become stranded before technical proof is achieved.

Feedstock Supply & Offtake Risks Affect Bankability

Feedstock Supply & Offtake Certainty

Feedstock Supply Risks

Availability: Supply chains for biomass, plastic waste, and CO_2 feedstocks are in early development, therefore fragmented and not yet organized at industrial scale. Seasonal fluctuations in biomass availability may further compound supply uncertainty. This creates challenges for securing long-term and reliable volumes. Project on project risks may arise in cases where derivatives production facilities rely on commodity feedstock platforms, like methanol, which are complex conversion projects in themselves facing similar challenges.

Quality & Consistency: Variability in feedstock composition, moisture content, contaminants, and characteristics can cause technical issues during the conversion process, such as fouling and low yields.

Price Volatility: Competition for sustainable feedstocks is likely to grow in the future, creating scarcity-related uncertainty and volatility in feedstock pricing.

Counterparty Risk: Feedstock suppliers may be new, smaller players and therefore not yet have a strong track record or credit rating for accepting liabilities related to under-delivery.

Bankability Challenge

Uncertainty around the consistent availability of on-spec feedstock introduces risk for the project's ability to generate stable returns, especially for large-scale projects requiring high volumes of feedstock. The prospect of downtime or performance losses from feedstock supply challenges reduce lender confidence in the project's ability to meet repayment schedules.

Offtake Certainty Risks

Lack of Firm Offtake Commitments: Markets for sustainable commodity products are still emerging under upcoming regulatory targets. Offtakers, like airlines and fuel distributors, may signal interest but hesitate to commit to long-term take-or-pay contracts at sufficient scale due to future uncertainty in demand and product pricing. Products need to meet downstream product specifications of the offtaker, where early operation often shows deviations in composition and characteristics thereby limiting willingness of offtakers to initially commit to long-term agreements.

Price Risk: Uncertainty and volatility in merchant market for absorbing green premium. Price benchmarking in offtake contracts may still introduce volatility in offtake willingness to pay that does not align with production costs.

Counterparty Risk: Early offtakers may be smaller players or blenders with limited track record and balance sheets, which undermines the strength of offtake agreements.

Bankability Challenge

Markets for sustainable chemicals and fuels are still emerging. **Without contracted demand, lenders cannot rely on stable offtake volumes and remain exposed to volatile merchant prices**, leading to high revenue risk. Contracts with small offtakers offer limited credit protection, increasing default risk for lenders.

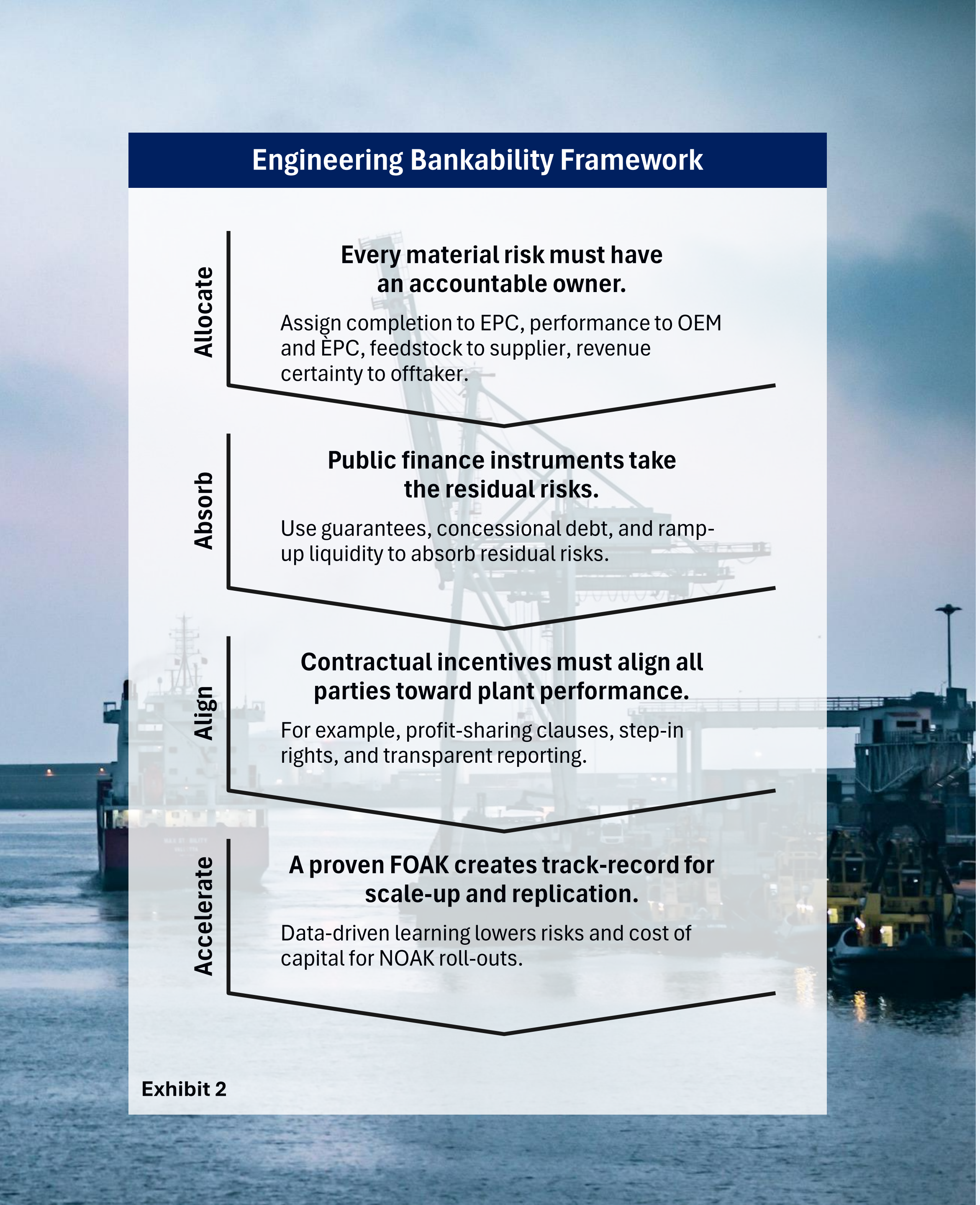


Exhibit 2

Systematic De-Risking Converts Uncertainties Into Structured Responsibility and Credible Cash Flows

"FOAK projects rarely fail based on technology, but because the market cannot structure their risks."

Bankability depends on predictable and credible repayment capacity. This can only be achieved through systematic and transparent risk allocation to the parties best positioned to manage each exposure. Developers, EPC contractors, OEMs, feedstock suppliers, offtakers, and lenders must each assume a defined share of responsibility through equity participation, completion and performance guarantees, or long-term commercial agreements.

Improving bankability for FOAK projects therefore requires:
i) **Layered de-risking structure** that integrates contractual, financial, and policy mechanisms to convert uncertainty into foreseeable cash flow streams.
ii) **Governance structure that allows lenders to intervene** within existing contract frameworks should the project not perform as planned.
iii) **Strong track record and credibility of counterparties** for securing lender confidence, particularly from the equity sponsor and project developer.
iv) **Public instruments**, including grants, guarantee schemes, and concessional loans to play a **complementary role** by closing residual risk gaps that market parties cannot feasibly absorb. The liabilities accompanied by providing guarantees are typically priced into contracts to offset excessive financial losses, which may lead to an increase in overall project costs. Public instruments reducing the need for performance guarantees and contracts can therefore also **contribute to lower project costs**.

FOAK projects become bankable when uncertainty is translated into structured responsibility, where every risk has an owner, every owner a contract, and every contract a price.

FOAK Projects Only Become Bankable When Feedstock, Conversion, and Offtake Risks Are Contractually Allocated and Mitigated

Feedstock Supply | Conversion Facility (Pre-Development, Construction, Ramp-Up, Operations) | Offtake

Feedstock Supply Risk Mitigation Requirements

Feedstock supply must be secured through **long-term feedstock supply agreements** (typically preferred for ~≥ 6 years), preferably aligned with offtake durations to ensure stable production volumes and therefore stable returns. Supply contracts should be secured with **creditworthy counterparties** to ensure supply continuity over the full loan horizon.

Key considerations:
- Diversified feedstock sourcing strategy and buffer storage.
- Certified quality and sustainability (e.g., ISCC).

Construction Risk Mitigation Requirements

Lenders require construction-stage risks to be clearly allocated through **contract structures and performance guarantees** to protect against cost, schedule, and technology performance shortfalls.

- **OEM equipment performance guarantee**: Guarantee that equipment operates as designed. Lenders may also seek equity stake from key OEM players for novel, unproven designs.
- **EPC lump-sum turnkey system performance guarantee**: Guarantee that facility is in ready to operate condition when all equipment is installed and connected. This may create substantial financial exposure for the EPC, where the liabilities the EPC are required to cover could exceed the margin the EPC can earn in the project. Technology insurance providers can also be approached, contingency-sharing models pursued, or policy-based support applied where possible to assist with fulfilling this role.
- **EPC or project sponsor completion guarantee**: Guarantee that construction is completed within agreed timeframe and cost overruns can be covered within contingency budget.

Key considerations:
- **Coverage of the performance guarantee package may be required to cover a significant portion of the loan value** of ~10-40% (varying case by case with technology, counterparties, and policy support). This could be structured as layered coverage combining EPC/OEM/project sponsor guarantees, insurance, and public guarantee instruments.
- FOAK projects require **higher contingency reserves** to accommodate for potential cost overruns.
- Lenders require **in-depth technical due diligence processes** to independently verify technology maturity, design integrity, pilot data, and performance assumptions.

Ramp-Up & Operations Risk Mitigation Requirements

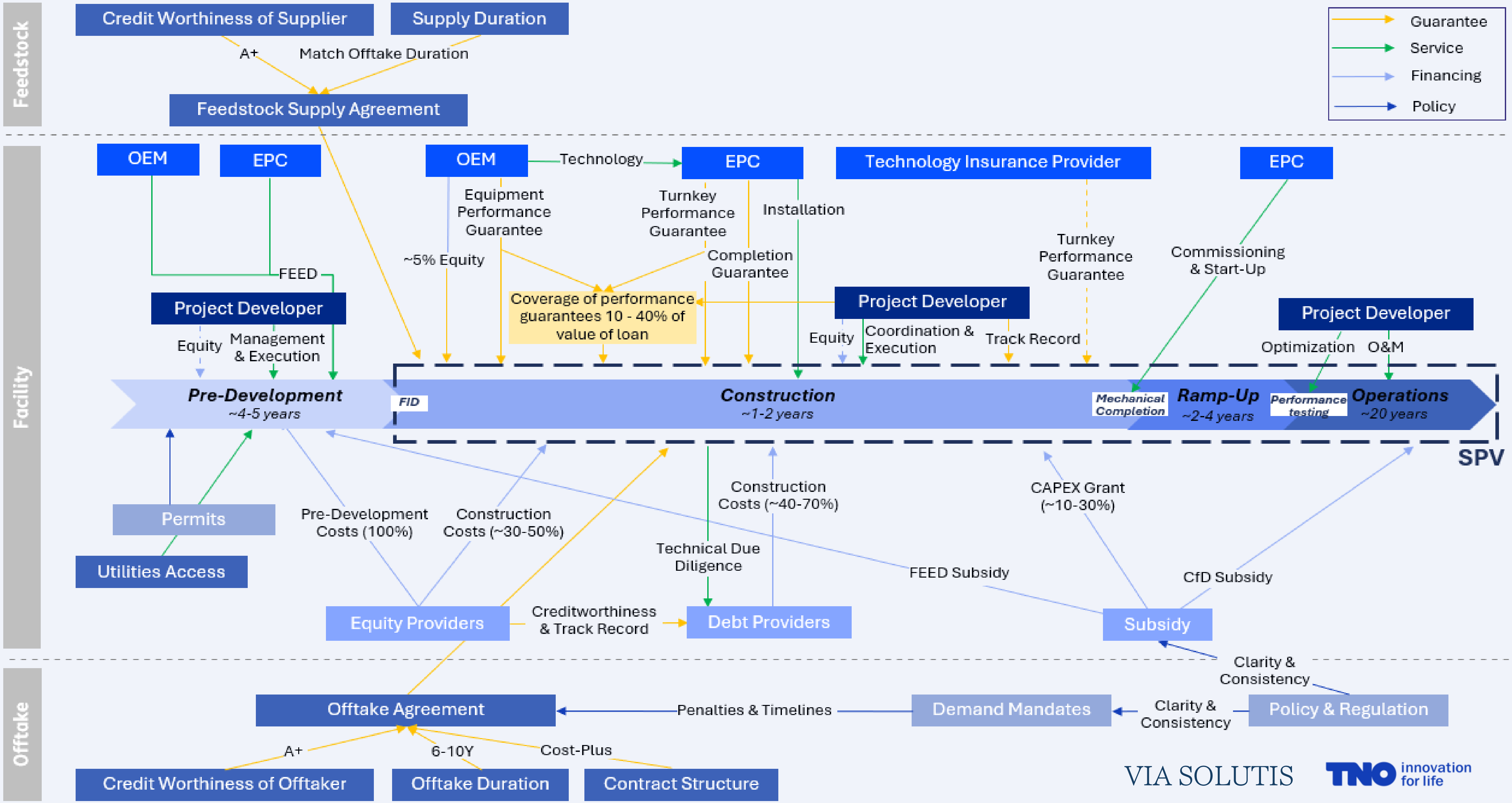
Plan for early ramp-up liquidity during FOAK project design: Acknowledge and plan for temporary impact on financial metrics by financing commissioning and optimization stage intentionally. **Model ramp-up phase cautiously**, aim to **secure dedicated ramp-up liquidity before FID**, **pursue milestone-based capital injections** from public or private parties in the form of equity, grants, or specialized loans to ensure financial stability.

Offtake Risk Mitigation Requirements

Offtake certainty must be secured through **long-term offtake agreements** (typically ≥ 6 years) to ensure predictable demand. Offtake contracts should be secured with **creditworthy counterparties** to ensure reliability of future cash flows.

Key considerations:
- **Full volume coverage**: Agreements should cover full output volume for products that do not yet have established commodity merchant markets. FOAK projects need at least one strong anchor offtaker.
- **Policy-anchored demand:** Agreements should be underpinned by demand mandates, which require consistent regulation and penalties with a clear time horizon to be effective.
- **Cost-plus structure:** Potential feedstock price fluctuations are passed-through to the offtaker to ensure stable margins and protect the predictability of cash flows.

Blueprint for Bankable FOAKs - Structuring Risk Across the Value Chain



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Public Capital Can Play a Key Role in De-Risking and Mobilizing Private Investments – Potential Government Support Mechanisms

Feedstock Supply | **Conversion Facility** (Pre-Development, Construction, Ramp-Up, Operations) | **Offtake**

Feedstock Supply

Feedstock supply aggregation led by a (public) intermediary that collects and organizes feedstock and provides feedstock supply agreements.

Enable risk allocation through government guarantees

Conversion Facility

Pre-Development

FEED subsidy for advanced technology projects to relieve pressure on equity requirements.

Construction

Substantial loan guarantee from government or export credit agencies (ECAs) for advanced technology projects (e.g. US Department of Energy Loan Programs Office – provides significant loan guarantees (in range of >$1billion per project) to derisk innovative clean energy projects, incl. biofuels, moving beyond demonstration phase[1][2]).

- Developers could pay a premium to have access to the loan guarantee fund to allow for the fund to be partially cost covering and potentially incentivise private investment.

Performance guarantee fund from government or public finance institutions for covering residual risk beyond EPC break-even point under lump-sum turnkey performance guarantee contracts.

- EPC provides required performance guarantees to the value of their expected margin on the project, and the performance guarantee fund covers remaining requirement from lender to allow for EPC to feasibly participate in risk allocation without facing excessive losses. Within the fund structure, EPC should remain responsible for the first loss position to ensure delivery.

Substantial CAPEX grants for advanced technology projects to reduce debt needs.

Public finance institutions acting as anchor investors or offering concessionary, subordinated loans to crowd in private finance.

State investment bank providing public equity and substantial concessionary funding support for FOAK advanced technology projects with larger capital requirements.

Ramp-Up & Operations

Milestone-based grants from government to provide operational cash flow during prolonged ramp-up period.

- Alternative format: Last resort loan from government or public finance institutions with flexible repayment schedule to provide cash flow support until project reaches optimized operations.

Offtake penalty support from government which covers penalties if initial production is delayed or off-spec.

Offtake

Government led **demand aggregation,** where government provides offtake agreements and takes on role of selling the product to the market.

Government-facilitated trading platform, where a public intermediary connects supply and demand and bridges the production cost and willingness to pay through CfD mechanism.

Reduce debt requirement through grants

[1] U.S. Department of Energy (2024). DOE Announces $1.67 Billion for Montana Renewables to Significantly Expand U.S. Sustainable Aviation Fuel Production.

[2] D. Tobin, U.S. Department of Energy (2010). DOE Loan Guarantee Program: Overview and Update.

Targeted Government Support & Public Capital Can Shape Bankable FOAK Projects to Unlock Europe's Industrial Transformation Stalemate

Europe has developed most of the next-generation technologies needed to defossilise its industries, but for some pathways technical and economic challenges remain. Success in invention must now be matched by success in large-scale replication. What is largely missing are effective mechanisms to accelerate deployment and mobilise financing for these technologies.

The **FOAK projects hold the key**: they must prove operational performance and build new value chains to turn national ambitions into tangible production capacity. **Most FOAK projects never leave the engineering stage** due to high-risk profiles and substantial investment requirements, thereby trapped between venture capital & growth equity and commercial debt. When government support is deployed to absorb risks beyond what market parties can cover, FOAK projects can move from being viewed as demonstrations to bankable assets, a critical shift for unlocking Europe's clean industrial transformation.

Public capital and government intervention are not substitutes for private investment, but catalysts that make it possible. Targeted guarantees, concessional loans, and performance-based grants are essential to bridge non-bankable exposures and attract commercial debt. When governments assume the residual risks of FOAK projects, they can unlock debt financing from private lenders. Every euro of public capital can mobilize around five to ten euros of private investment, turning policy ambition into investable infrastructure[1].

1. ***Bankability is engineered, not granted. It results from structured risk allocation, transparent governance, and credible contractual design.***
2. ***Public instruments must crowd in private capital, de-risking the early projects that validate technology and market performance.***
3. ***FOAK success creates data, confidence, and replicability, reducing the perceived risks for all subsequent projects and enabling full industrial rollout.***

[1] UBS (2024). The power to scale impact. A primer on blended finance.

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