

ICAO ESAF WACAF annual Environmental Workshop
and
EASA 3rd annual SAF workshop under the ICAO - EU ACT-SAF Assistance Project
Regional Workshop hosted by Rwanda

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Topic

The Case for SAF: Global Context and ICAO Vision: SAF as a key lever for aviation decarbonization



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CBR Sustainability Partners



Project Manager

Raphaela Spielberg is an experienced professional in the field of sustainable finance, with a strong track record in strategy development and the execution of impactful projects and climate technologies. Her expertise extends to thematic investment consulting and climate risk management, particularly in overseeing ESG-compliant initiatives while driving sustainable financial solutions.

She is experienced in assessing and developing business cases in the PtX field, analysing global climate challenges, executing the financial modelling and conducting deep-dive research of risk and sensitivity.

Consulting Focus @ CBR Sustainability Partners

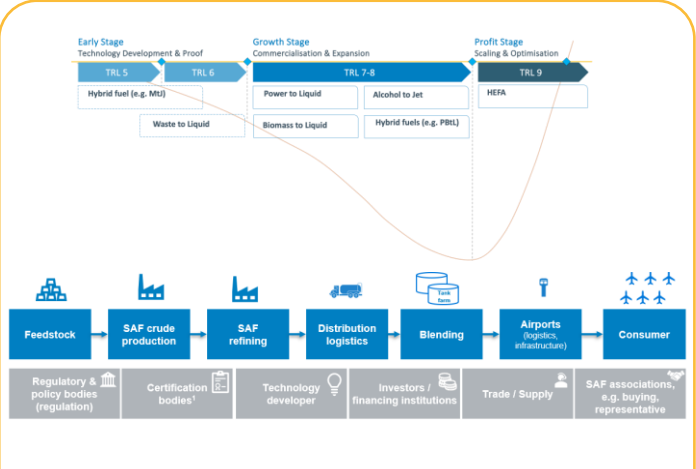
- Project management and business planning, e.g., application support for EU funding programs for the demonstration of innovative low-carbon technologies (EU Innovation Fund)
- Sustainability (CSR) and ESG concept development and implementation (strategy, roadmaps, reporting, labels)

Education

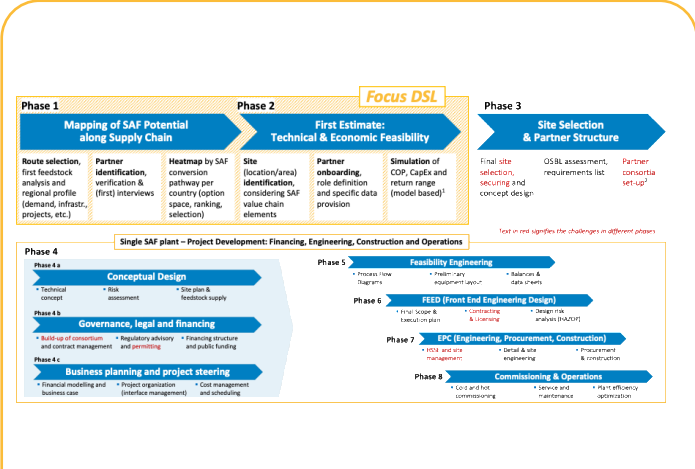
Sustainability & Climate Risk Professional, GARP

Master in Sustainable Finance, NOVA SBE, Lisbon

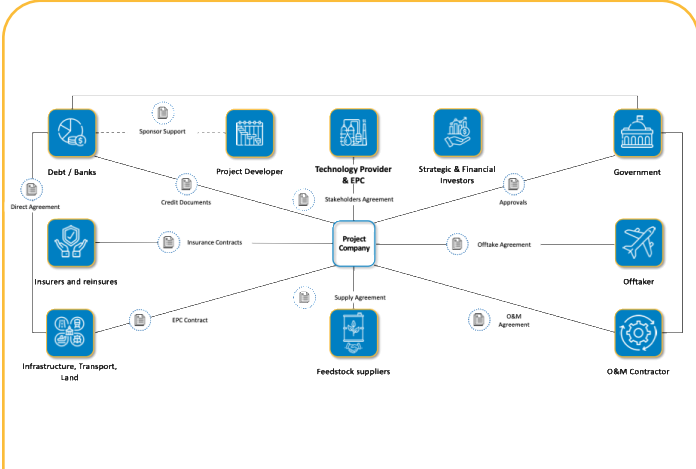
Guiding questions today



What are multi-dimensional bottlenecks of SAF supply chain? What is needed to bring SAF projects from growth stage to profit stage?



What are key challenges in SAF project management? What are the main complexities involved in developing FOAK projects?



Why strong stakeholder collaboration is required to foster in faster SAF deployment?

Direct Supply Lines are self-sustaining supply chains for sustainable aviation fuels, fundamental to boost sustainability in aviation

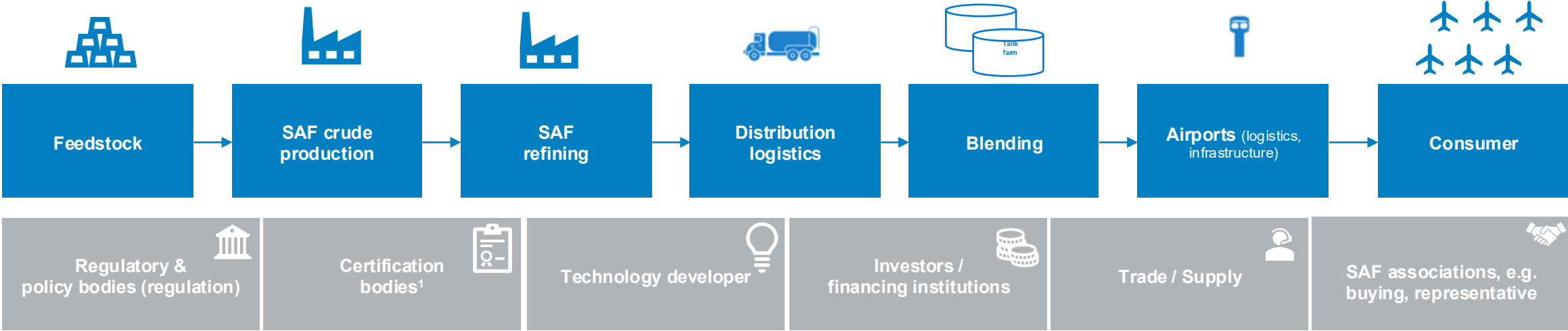
Steps and actors *along* the SAF value chain: New possibilities, new feeds, new players and partnerships

A **Direct Supply Line** (DSL) for SAF is a **self-sustaining network** of **regional supply chains**, consisting of a **local feedstock supplier**, a commercial fuel **production plant**, and long-term **offtake partners**.

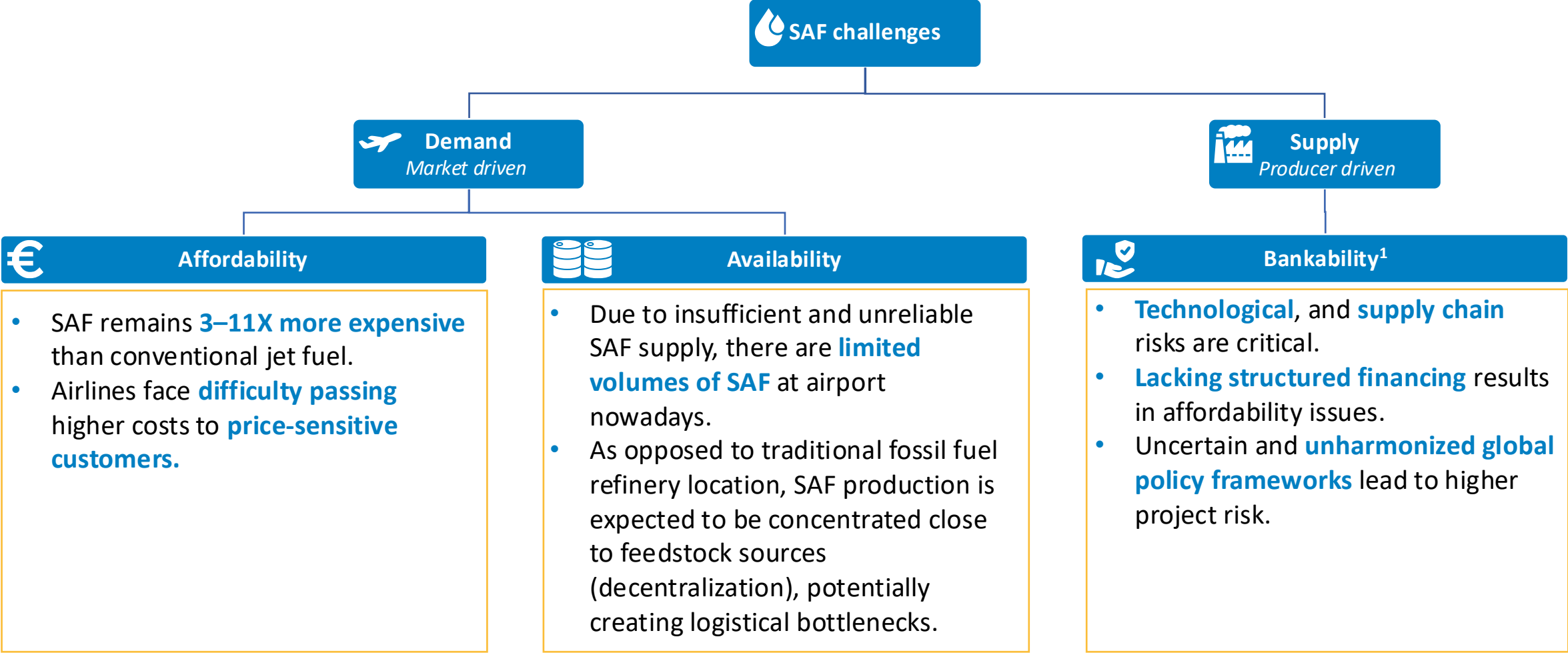
Stakeholders *around* the SAF value chain: Leveraging existing infrastructures and industry best practices

This is a complex system involving **multiple stakeholders**. While such a supply chain is **not yet fully established for SAF**, **similar frameworks exist in fossil aviation**, and much of this existing infrastructure can be leveraged for sustainable aviation.

In the SAF market ramp up phase, it is crucial for stakeholders to bring in their relevant capabilities, to carefully define risk sharing principles and ensure that the complexities of FOAK projects are addressed with the necessary relevance.

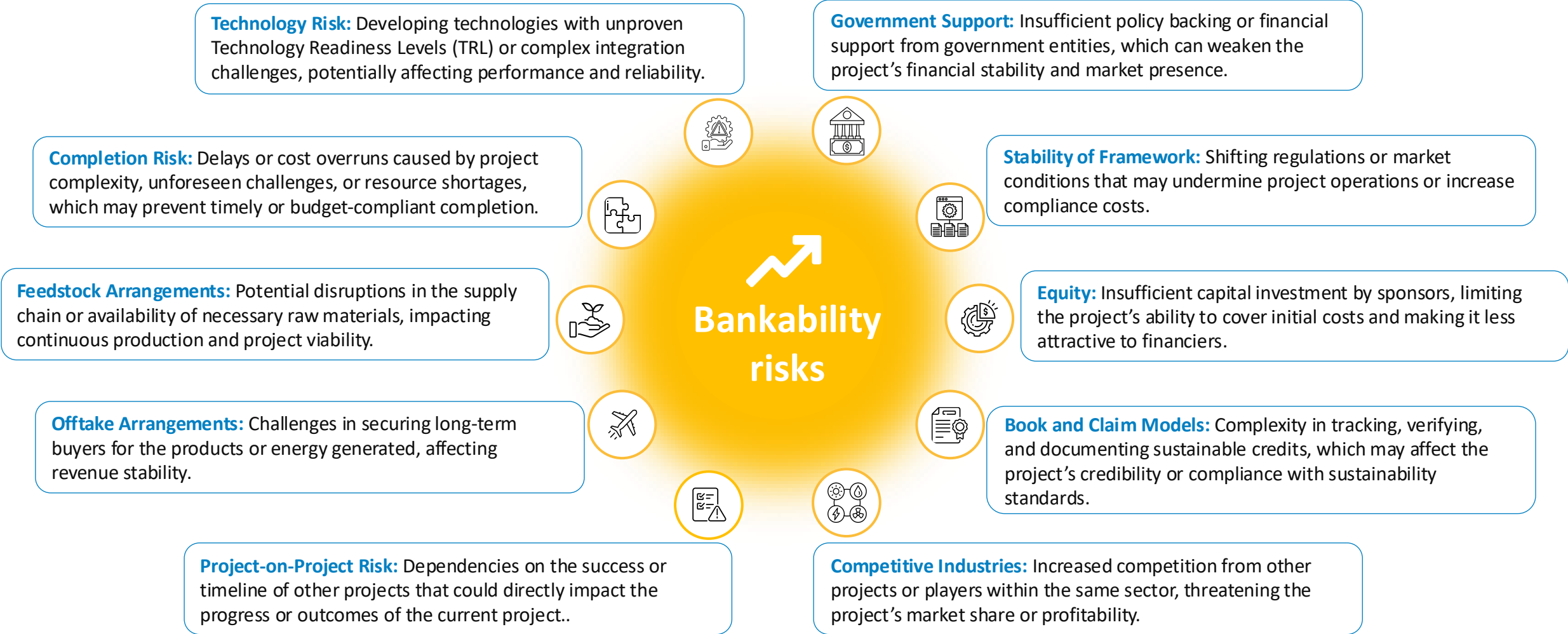


Both demand and supply side need to identify and address their challenges to enhance the bankability of SAF projects



Multi-faceted risks for bankability along SAF direct supply line need to be addressed to increase the comfort of financiers

Non-exhaustive





Feedstock related SAF value chain bottlenecks



Regulatory, market, infrastructure and technology constraints are key feedstock related bottlenecks of the SAF supply chain

Regulatory uncertainty

- **Lack of harmonized sustainability criteria** for feedstock eligibility across different regions of the world.
- **Shifts in policies structures** such as **changing incentives** may affect project viability.
- **Hinderance in feedstock eligibility** and certification **due to stricter sustainability standards.**

Competitive market

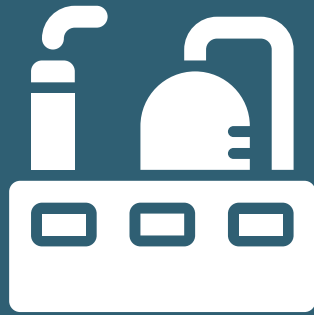
- **Inconsistency in accessibility of feedstocks** due to their demand for other applications.
- Growing **dependence on other compatible feedstocks.**
- **Risk of land use conflicts** and ILUC.

Demand and supply driver

- **Fluctuation in market** causes **feedstock cost instability** – affecting long term planning and investment certainty.
- **Inconsistency in feedstock production** hindering the stable supply.
- **Lack of supplier diversity** weakens negotiation leverage.

Infrastructure challenges

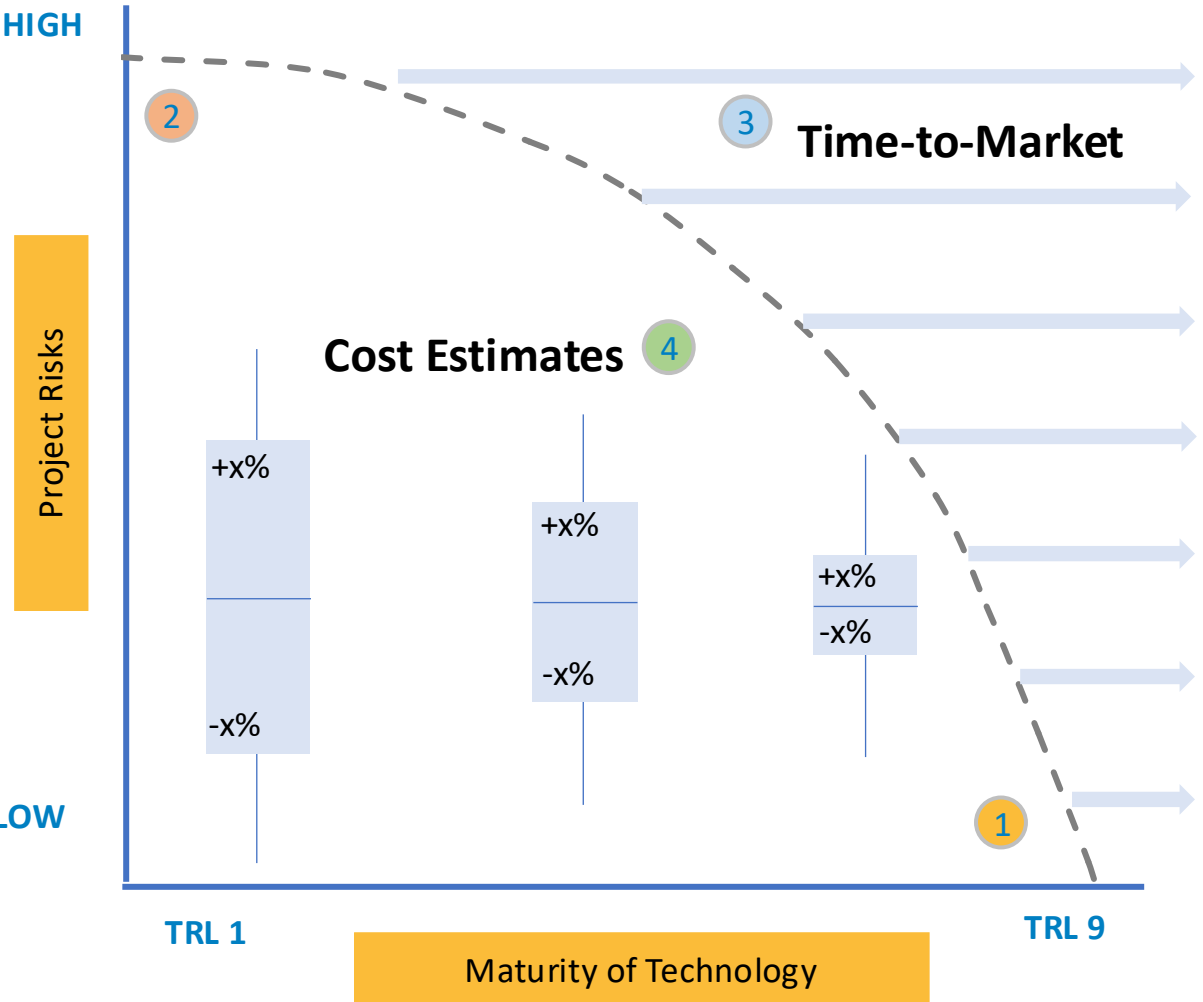
- **Discrepancies between feedstock activation** & innovation **and technology maturity** of feedstock treatment.
- **Unavailability of resilient infrastructure** for waste feedstock collection.
- **Lacking compatibility in** coprocessing **technologies,** lead to challenges to diversify the feedstocks diversity.



SAF production and technology readiness level



The SAF business case and resulting bankability challenges beyond sustainable, cost-efficient feedstock supplies and long-term offtake-agreements



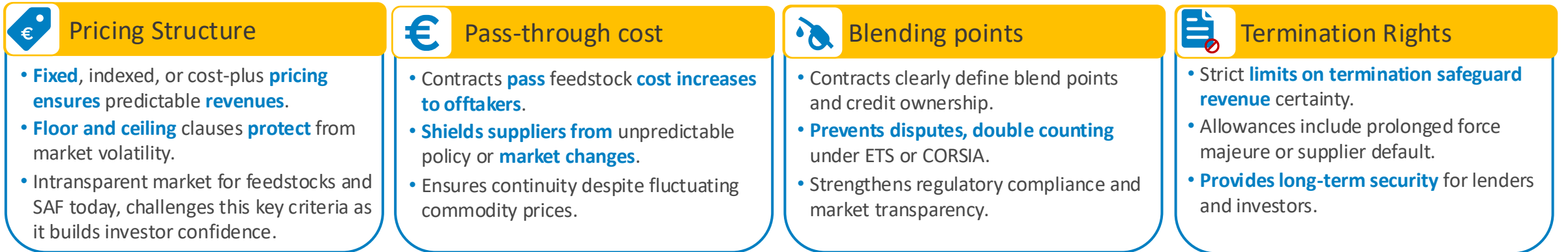
- 1 TRL Levels**
 - Majority of SAF projects are between the development and deployment phase with technology readiness levels (TRL) of 4-8/9
 - Even with higher TRLs for single technologies, combined full-system TRL is lower
- 2 Risk Profile**
 - Technology risks are still relatively high
 - Which SAF pathway and technological route will turn out as the most competitive?
 - What about risk of regulation changes for investment decisions larger than 20 years?
- 3 Time-to-Market**
 - How long does it take to see the first returns of new SAF project initiatives?
 - What is the impact of any delays during engineering, procurement, construction and commissioning phases?
- 4 Cost Estimates**
 - How precisely is it possible to assess financial investment needs and final SAF cost of production (COP) at different maturity levels and during engineering phases?



Offtake agreements and supply chain constraints



Committed off-take agreements are crucial elements to ensure future cash flows and bankability of projects



5 Long-Term Commitment

- Lenders require **10–20 year contracts** matching project financing timelines.
- Airlines often prefer shorter terms, creating bankability and funding risks.
- *e.g., Bayou Fuels secured 10-year offtake deals with IAG and Southwest Airlines.*

6 Volume Commitment

- **“Take-or-pay” terms guarantee payment** regardless of offtake fuel usage.
- Aggregating **multiple buyers** can be a strategy to **reduce** volume and default risk.
- *e.g., Phillips 66 signed a 5-year take-or-pay SAF deal with multiple buyers.*

7 Offtaker Creditworthiness

- Strong credit or **aggregated buyers reduce** payment and **default risks**.
- Consortia purchasing models improve bankability of large SAF projects.
- *e.g., Luxaviation and IdunnH2 signed a 15-year SAF agreement ensuring bankability.*

From farm to flight: SAF value chain has multidimensional bottlenecks to be addressed



Challenges of SAF supply chain

Feedstock availability & competition

The limited supply of sustainable feedstocks, coupled with competition from other industries, could **drive up prices and constraints sustainable production**.

Production scale up

Current SAF output falls far short of global aviation demand, with new refineries and **growing maturity of technologies** requiring longer lead times to commercialize.

Geographical concentration and supply

SAF production facilities are concentrated in feedstock dense regions, **necessitating robust** and well-connected **transportation and distribution network**.

Cost volatility

SAF cost is volatile due to interlinked factors such as feedstock availability, **limiting SAF uptake** despite its environmental benefits.

Infrastructure & logistics constraints

Limited airport blending, storage, and pipeline infrastructure complicates and **raises the cost of SAF distribution**.

Certification & quality Assurance

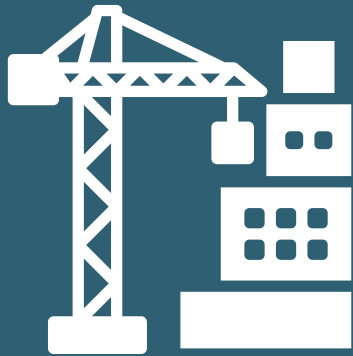
Strict ASTM and **regulatory requirements ensure safety but slow market adoption** and necessitate rigorous traceability.

Policy & incentive uncertainty

Inconsistent incentives and policy frameworks across countries questions the bankability and **discourages investor for long-term investment** in SAF projects.

Carbon accounting & sustainability verification

Robust tracking and lifecycle analysis are essential to prevent greenwashing and verify emissions reductions.



Project development challenges



Technology Transfer – “Unknown Unknowns”

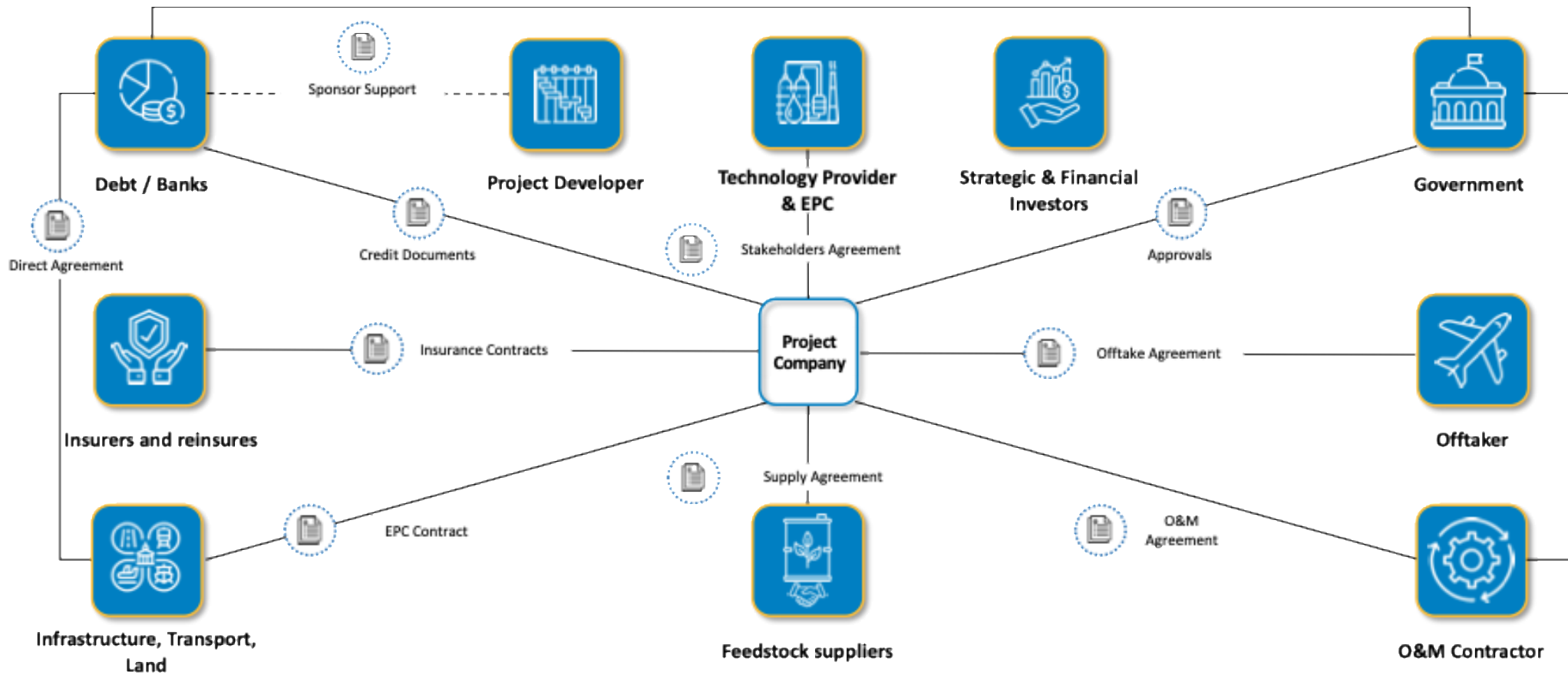
Mitigating risks and overcoming challenges in scaling innovations through representative demonstrations

- Despite knowing the **big picture** as well as details on **molecular level** implementation fails because of:
 - **tiny unexpected deviations** (“Unknown Unknowns”)
 - too much **trust in comparison with „similar“ systems and simulation.**
 - **lack of real data** in the industrial environment
 - **piloting effort is not honoured**, and benefit is underestimated
 - enterprises build too much on **experiences from incremental innovation**
- **Only demonstration on representative scale can minimize unknown unknowns.**
- Community and enterprises must be able to overcome paradigms and **create and implement scalable technologies** and processes.
- **Stopped projects** can **burn technology lastingly.**



SAF project development requires high multi-stakeholder collaboration

High inter-stakeholder dependency enhances transparency but also creates governance complexities, requiring robust consortia management and interface risk mitigation strategies.



Interface risk management would enhance the SAF project resilience

1

Guarantees & Risk Allocation

- Lack of standardized **offtake guarantees** to secure financing.
- Airlines often reluctant to sign **long-term take-or-pay contracts**.
- **Government guarantees or price floors** can help bridge risk.

2

Managing Parties

- **Complex ecosystem** involves airlines, fuel producers, feedstock suppliers, licensors, others.
- Airlines seek low costs, while investors seek returns.
- **Need for neutral conveners** or project integrators.

3

Intellectual Property (IP)

- Proprietary technology/**licensing fees raise costs**.
- IP disputes over process know-how between technology developers and operators.
- Balancing **knowledge sharing with competitive advantage**.

4

Certification & Standards

- SAF pathways must go through lengthy **ASTM / ICAO approvals**.
- **Lack of harmonization** across jurisdictions, causing duplication of effort.
- Periodic compliance audit is required.

5

Contractual Complexity

- SAF projects involve **multi-party contracts**: offtake, feedstock, licensing, EPC, O&M, finance.
- Delays or disputes in one contract ripple across the project.

6

Cross-Border & Regulatory Differences

- **Diverging mandates**, subsidies, and **sustainability criteria** across EU, US, Asia.
- **Creates uncertainty for global airlines** and fragmented markets.

7

Monitoring, Reporting & Verification (MRV)

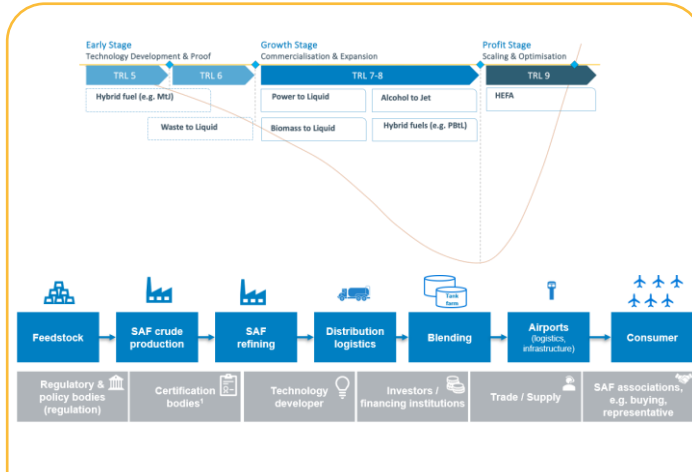
- Airlines and **financiers demand** robust **proof of GHG reductions**.
- MRV systems often lack interoperability, adding cost and complexity.

8

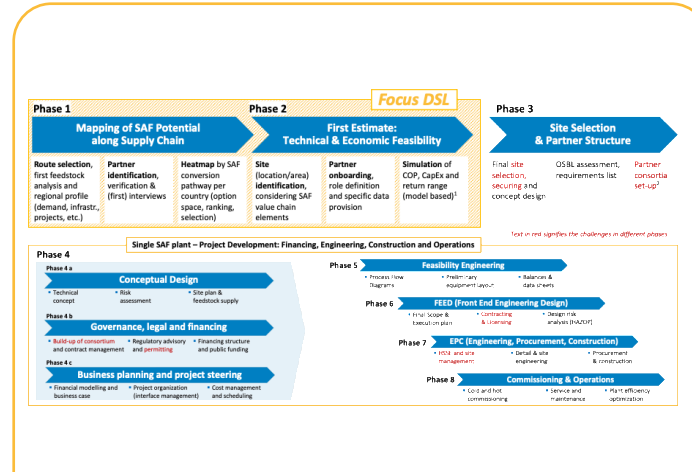
Infrastructure Integration

- SAF blending facilities, pipelines, and airport **fueling logistics often not ready**.
- Coordination needed between refiners, airports, and regulators.

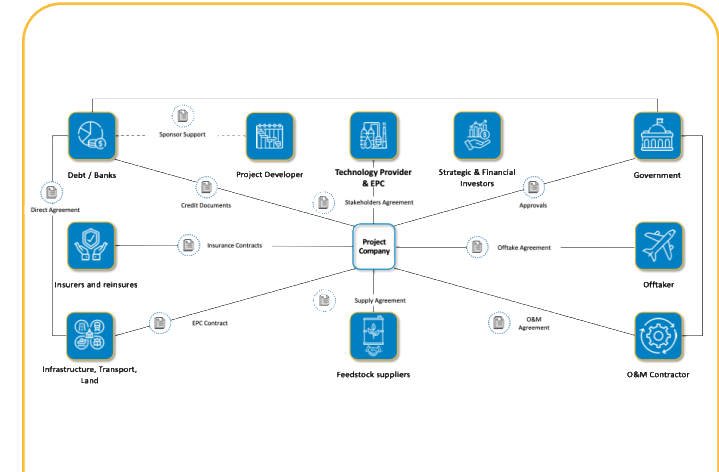
Key takeaways



Developing new technologies should advance beyond the ‘valley of death’ to achieve long term decarbonization goals.



SAF awareness could assist in mitigating project risks, resulting in avoiding financial losses and attracting investors.



Building a strong stakeholder consortia and proactive engagement facilitates mitigation of SAF project risks.

Thank you.

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