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METALS-AS-A-SERVICE:
A STRATEGIC AND INVESTABLE CIRCULAR BUSINESS MODEL FOR THE WIND ENERGY INDUSTRY AND BEYOND

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Executive Summary

The metals system we rely on remains fundamentally linear, extraction-dependent, and structurally incapable of delivering the volumes required for the energy transition. The Metals-as-a-Service (MaaS) model directly addresses this constraint by reshaping how metals are owned, financed, circulated, and recovered.

At the center of MaaS lies a simple yet transformative shift. Metal is no longer sold as a one-off input but offered as a service by a dedicated Special Purpose Vehicle (SPV) that retains ownership throughout its lifecycle. Under this model, metal moves through manufacturing, deployment, operation, and end-of-life recovery without ever leaving the SPV's balance sheet. This enables long-term stewardship, incentivises recovery, and allows the metal to generate recurring value through multiple cycles of reuse. The SPV becomes the operational and financial backbone of the system, ring-fencing risks, maintaining the "Metals Bank", standardizing contracts, and enabling digital traceability, which, in turn, makes performance measurable and investor-ready.

The strategic value of MaaS is far-reaching. It reduces upfront capital expenditure (CAPEX) for project developers and original equipment manufacturers (OEMs) by converting metal procurement into predictable operational expenditure (OPEX). It strengthens supply security by unlocking both primary metal streams and high-quality secondary feedstock from the "urban mine," and it creates a new asset class by securitizing the metal-backed lease flows. MaaS also introduces a circularity business model that aligns incentives across the entire value chain, from metal producers to recyclers, and from project developers and OEMs to investors and policymakers.

Metal producers gain recurring revenues and long-term customer relationships; metal users reduce CAPEX burdens and improve cost predictability; recyclers gain guaranteed material flows; investors gain stable, inflation-hedged returns; and regulators gain visibility into material flows and carbon accounting. Crucially, MaaS generates a new class of investable assets: circular metals contracts that, by virtue of their traceability and managed lifecycle, produce predictable and securitizable income. This evolution transforms metal from a commodity into a financial asset, enabling long-term capital to enter the circular economy at scale.

In fact, the risks associated with MaaS, such as long asset lifecycles, counterparty default, recovery failure, or losses in material quality, are rendered manageable through a combination of financial infrastructure, operational design (including design for disassembly and verified recovery processes), and digital infrastructure (notably Digital Product Passports (DPPs) and blockchain-linked identification). These same tools enable real-time transparency for investors, turning what was once an opaque, untrackable system into one governed by verifiable data.

Ultimately, MaaS offers a route to scalable circularity while delivering bankability, cost competitiveness, and multi-cycle monetization.

The wind energy sector stands at a decisive moment: its long-term viability depends not only on expanding capacity, but on securing the metals that underpin the entire infrastructure of turbines, cables, substations, and towers. For this reason, our deep-dive analysis focuses on the wind industry. CCSI has prepared a companion report that provides the supporting quantitative economic analysis and illustrates the viability of the MaaS model in the wind industry.

An important clarification is warranted. This report uses the term "leasing" to describe the core transaction underpinning MaaS. Conceptually, however, the model is closer to "renting", as it is designed to maximise asset reuse across multiple users while actively managing degradation risk, analogous to rental models in the housing sector.

By contrast, leasing as commonly practiced in today's markets, in particular in the automotive sector, is not inherently circular, as it is typically structured around asset depreciation over time and does not seek to minimize primary production or maximise sequential reuse.

1. Why a new model is needed

Global metal resources are finite, while demand is rising sharply with the energy transition. Current estimates suggest that roughly 6.5 billion tonnes of end-of-use materials will be required to support this transition.[1] For key transition metals such as copper, nickel, lithium, cobalt, and silver, multiple forecasts indicate demand trajectories that approach, and in some scenarios exceed, estimated reserves (see Figure 1).

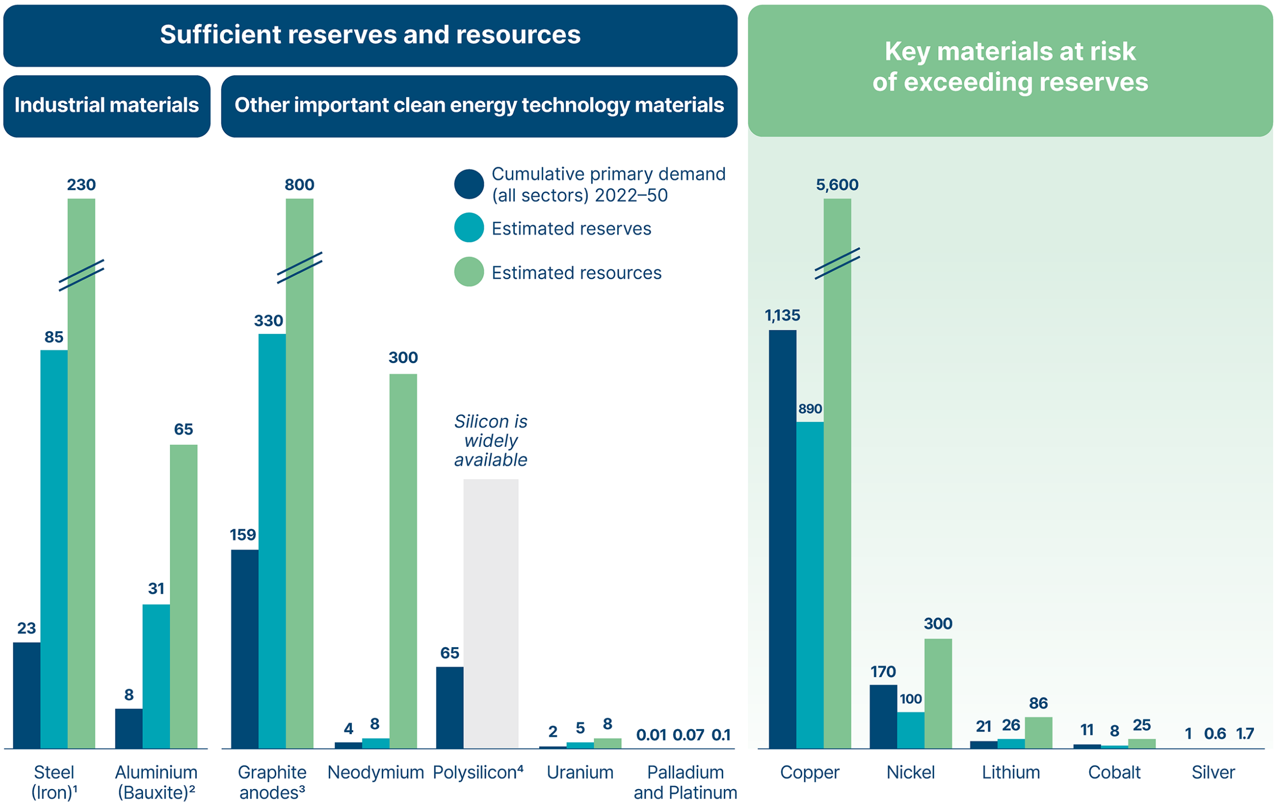


Figure 1. Cumulative primary demand 2022–50 from energy transition and other sectors compared to estimated reserves and resources.[2]

Even where reserves appear adequate on paper, time-to-supply is a binding constraint. Large mining projects typically take up to two decades to reach commercial production and are frequently delayed by planning and permitting processes. As a result, supply cannot adjust quickly to near-term shortages or price spikes. Supply security is further undermined by geopolitical chokepoints, including export controls and high concentration of production, which amplify the risk of disruptions.[3]

Declining ore grades compound these challenges. In copper, for example, producers have reported average grade declines of ~30% over recent decades,[4] implying greater material movement per unit of metal and, consequently, higher production costs, increased energy and water use, and larger waste streams.

In sum, the system faces a structural tension: we need substantially more metal, yet new primary supply is slow, costly, risk-prone, and declining in quality. This combination helps explain recurring price volatility and points to the necessity of business models that mobilize metal already in circulation (the so-called "urban mine"), maintain traceability and recoverability, and provide users with predictable access.

In the traditional linear model of metal ownership transfer, each player in the metal supply chain is segmented, with little influence over how metals are processed, collected, or recycled at end-of-life. Moreover, recycling alone, when introduced late in the chain, cannot deliver the scale of change required for the clean-energy transition. **The value chain fragmentation, combined with hurdles in recycling technology and the global logistics of metals, has hindered closed-loop recovery and risks stalling the energy transition due to material bottlenecks.** The result is continued dependence on primary production (entailing large-scale environmental degradation), high waste of durable materials, inefficient processes, and unnecessary carbon emissions. Achieving materially higher retention will require upstream product and process design oriented to recoverability, business-model shifts that reward lifecycle performance and reuse, and substantially stronger reverse-flow infrastructure to pull materials back into productive use.

Metals-as-a-Service (MaaS) is introduced as a model that seeks to change this by retaining ownership of metals with a single stakeholder and enabling integrated reverse logistics. Instead of selling metals once, MaaS envisions leasing them for their use by the downstream metal users (Original Equipment Manufacturers (OEMs), project developers, and operators), recovering them at end-of-life, and cycling them back into the value chain.

Aspect	MaaS	Circular economy
Ownership	SPV retains ownership	Wind farm developer/operator owns metals
Business model	Leasing / service-based turning metal stock into a long-life, income-producing asset where depreciation is hedged by multiple leases plus strong residual value	Product ownership with take-back or recycling loops, which doesn't create new cash flows beyond eventual scrap sale to a recycler
Financial impact	Lower CAPEX, predictable OPEX for the lessee	Higher CAPEX, potential residual value at end-of-life for the lessee
Incentives for sustainability	SPV incentivised to maximise metal lifespan and reuse	Metal users encouraged to design for recyclability
Material traceability	High, due to traceability via Digital Product Passports (DPP)	Moderate, depends on recycling standards
End-of-Life handling	Coordinated by SPV as part of the service	Managed by developer/operator or via recycling programmes
Circularity level	Strongly closed-loop (ownership maintained)	Closed-loop through recovery, but ownership shifts
Risk Allocation	SPV assumes material and recycling risk	Developer/operator assumes more responsibility for end-of-life management
Revenue model	Recurring service revenue for SPV	One-time sale for metal maker; possible secondary revenue from recycling
Best use case	Large-scale, long-life assets where materials are valuable and recoverable	A broader ecosystem approach to all components and materials

Table 1. **MaaS compared to metals, with traditional circular economy principles applied**

2. Introducing the MaaS concept and its key principles

MaaS is an innovative circular business model in which metal ownership remains with a single actor of the value chain (the "Asset Owner" (AO) –which can be any stakeholder in the mineral value chain or a third-party Special Purpose Vehicle created especially for this purpose) throughout its life without transfer. Only use rights (not legal title) are granted to the metal user ("the Lessee"), under a lease agreement that requires periodic leasing fee payments and a contractual obligation to return or enable recovery of the metal at end-of-use.

In practice, the AO procures metal that sits in a Metal Bank, which is essentially a metal inventory pool or stock, wholly owned by the AO and to be monetized over time. A metal user, acting as the Lessee, signs a lease agreement, and the AO allocates metal from the Metal Bank, but title never transfers. The lessee uses the metal in downstream applications or products and pays a periodic leasing fee. At end-of-use of the downstream application or product, a designated recycling partner collects the product, extracts the metal, and returns it to the AO's Metal Bank for the next cycle (see Figure 2 below). This keeps the owner financially motivated to work with the lessee on metal recoverability and recover the metal, and allows for monetization of multiple use cycles. Keeping ownership aligned incentivizes design for disassembly, recovery logistics, and financing that can genuinely compete with the traditional linear model.

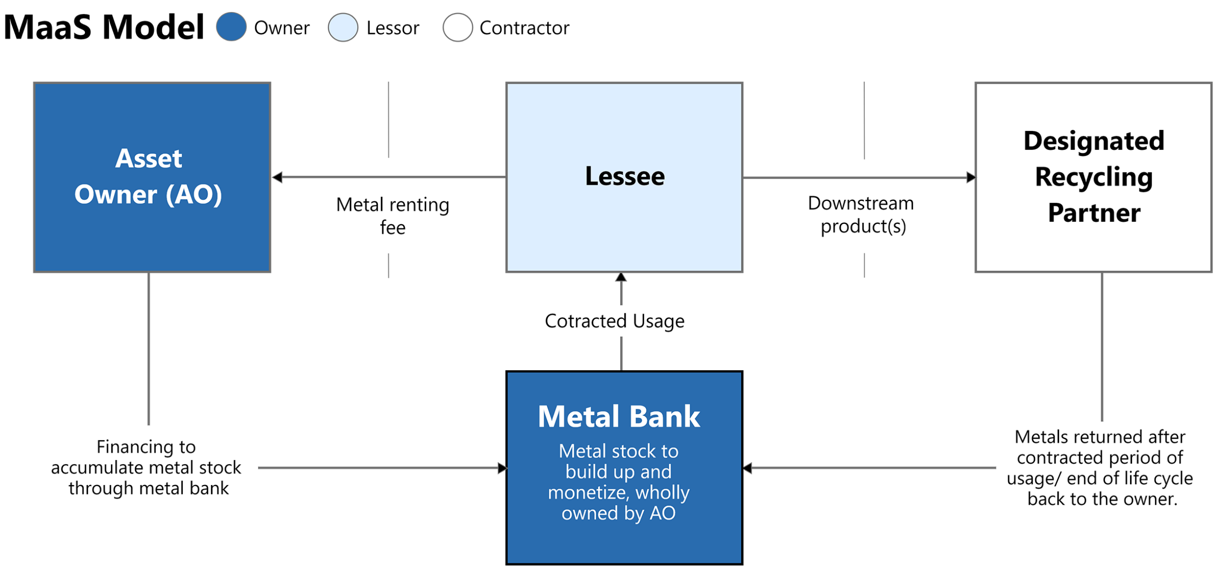


Figure 2. **Metals-as-a-Service Structure**

This model faces some immediately obvious challenges: metals often have very long lifecycles (steel in construction can last more than 50 years, copper in cables more than 30[5]), and fee-based lease agreements may appear less attractive than outright sales until cumulative revenues and recovered value catch up. Therefore, for MaaS to become a commercially investable model, it needs a backbone that is operationally and financially capable of tackling these challenges.

An important clarification is warranted. This report uses the term "leasing" to describe the core transaction underpinning MaaS. Conceptually, however, the arrangement is closer to "renting": its primary objective is to maximise asset reuse across multiple users while actively managing degradation risk, analogous to rental models in the housing sector.

By contrast, leasing as commonly practiced in today's markets, in particular in the automotive sector, is not inherently circular. Conventional leasing models are typically structured around asset depreciation over time and do not seek to minimize primary production or maximise sequential reuse.

3. Special Purpose Vehicle: the backbone that MaaS requires

A special purpose vehicle (the "SPV") is an independent legal entity established to separate a defined set of assets, liabilities, and risks from a parent company while facilitating investment and capital flows, including across borders. In practice, SPVs enable investors to access specific projects or markets via a dedicated investment structure that allows liabilities to be managed in a legally protected, tax-efficient manner. The central purpose of an SPV is therefore organizational and risk-related: by legally isolating particular risks, assets, or pools of funds, the parent company can pursue specific objectives without directly exposing its core operations to the full range of project contingencies and eventually reduce tax leakage and simplify cross-border transactions.[6] These features have made SPVs a well-established financing approach in sectors such as mining, energy, and infrastructure, where projects typically involve large capital requirements and long-lived assets.[7]

These attributes are directly relevant to MaaS. MaaS aims to provide metal access through an ownership-retention and leasing structure, which requires flexible, risk-proof financing arrangements. In particular, MaaS must address (i) cyclical metal prices, which can be managed through hedging instruments and structured risk allocation, and (ii) supply shortage risks, which can be addressed through procurement strategies and contractual design and iii) cost of carry (expense related to storing and insuring the metal as well as intangible benefits that come with owning the metal) incurred to help soften i) and ii) for the lessee. An SPV-based project finance structure can support MaaS by housing the investment and contracting framework for metal procurement and leasing, enabling the use of financial products to manage price risk, and providing a distinct vehicle through which investors can fund the Metal Bank (stock of metal). In this way, SPVs can translate the MaaS concept into an investable structure that protects the sponsor's core operations while enabling scalable participation by private capital.

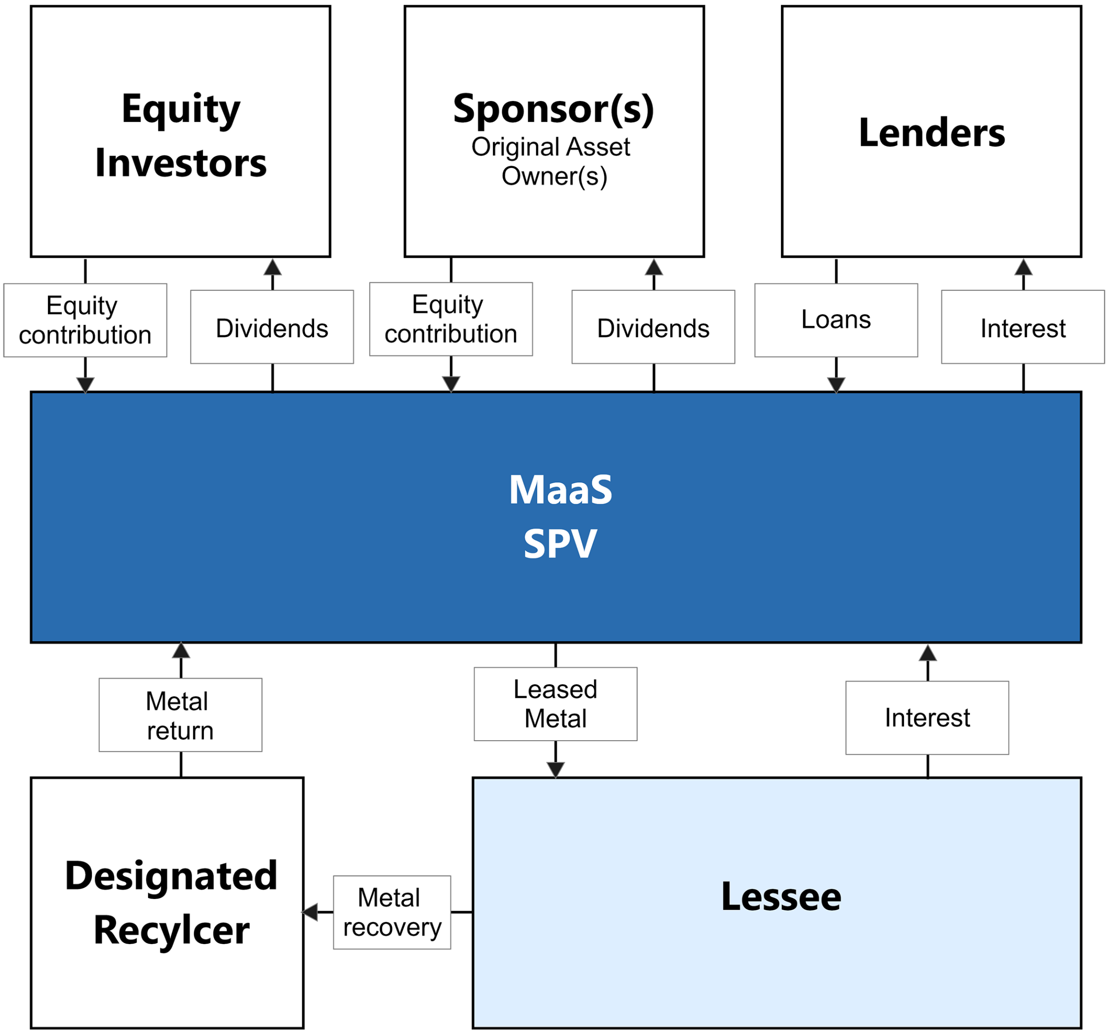


Figure 3. **MaaS Structure using an SPV**

As shown in Figure 3, the SPV serves as the backbone to execute the MaaS business model. The company(s) or entity(s) that create the SPV for purposes of operationalizing MaaS (the "Sponsor(s)") can be the original asset (metal) owners who either transfer the ownership of the metal to the SPV or allow the SPV to procure the metal by a separate transaction.

Unlike individual value chain participants, who are optimized for specific roles (processing, manufacturing, operations), the SPV's mandate is lifecycle integration. It is responsible for maintaining visibility and control over every state transition the metal undergoes, from initial extraction to recycling and subsequent reuse. Additionally, the SPV, as its own legal entity with contractual capacity, standardizes the MaaS contracting system by establishing norms on liability, inspection frequency, recovery conditions, and key performance indicators (KPIs). These standardized frameworks are critical to reducing administrative burden and creating a contract architecture that lenders and investors can trust. Relatedly, the SPV can enter into legal relationships with other companies to partner on the recovery, transport, and recycling of the metal, enabling the SPV to recover the metal from the Lessee and return it in a usable state. The SPV becomes the overarching mechanism for barriers that individual actors cannot solve alone, such as fragmentation of ownership, inconsistent recovery incentives, lack of standardized contracts, cross-chain risk asymmetries, financial opacity, and inconsistent maintenance behavior.

In this way, the metal's lifecycle will be optimized and made more efficient by leveraging the know-how of different actors across the metal value chain. To illustrate how this would work in a specific scenario, we will use the Wind Turbine value chain. In this context, the SPV sources primary metals from the Sponsor, other metal miners or producers, or secondary metals from recyclers. Then, the metals are leased to OEMs to manufacture wind technology components (e.g., towers, foundations, turbines), while ownership remains with the SPV. Wind farm operators will then use wind technology containing the leased metals, and the fee payments made by the Lessee will be based on usage, performance, or time. The SPV coordinates the recovery of metals with the wind developer, and recyclers process and return the metals to the SPV for an additional cycle of leasing to new wind farm assets or assets in other industries, thereby creating a circular flow. Alternatively, the SPV only leases to the wind developer, with the OEM only subject to a service contract with the wind developer.

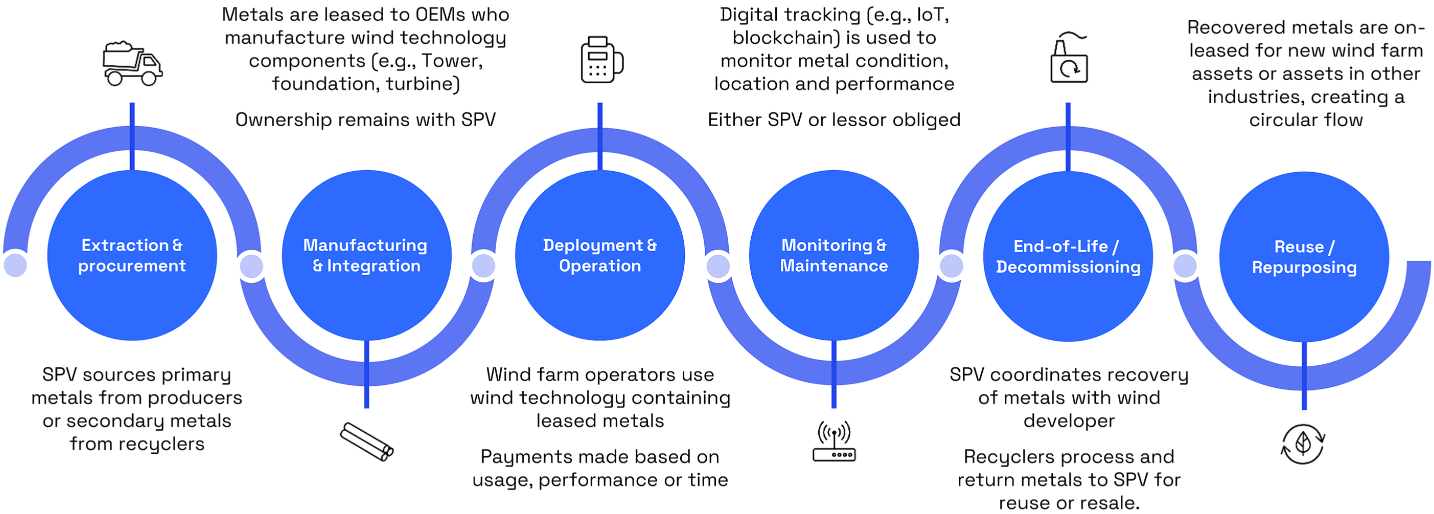


Figure 4. Operationalizing MaaS using an SPV in Wind Value Chains

Retaining ownership means the SPV has a vested interest in recovery, quality preservation, and reduction of material loss. In doing so, it effectively internalizes what have historically been externalities. The MaaS model acknowledges that circularity cannot rely on voluntary goodwill or fragmented market incentives: it must be built into the financial and commercial architecture of the metals system.

See Annex I for a more detailed visualization of the shifts in metal state, processing activities, and business activities involved in an SPV structure for MaaS.

4. Ensuring the Financial Viability: An Overview

The successful adoption of MaaS frameworks depends on their economic and financial viability and ensuring that this business model financially outperforms the linear model.

Unlike a linear and traditional sale of metals, the lessor cannot liquidate the asset during the lease agreement, creating several financial challenges. Under MaaS, the metal remains illiquid, tying up capital; metal price volatility exposes the lessor to market risk; and building the Metal Bank for MaaS requires significant upfront financing. Interest-rate fluctuations further affect the cost of capital.

For MaaS to become a viable alternative to traditional metal sales, it must demonstrate that it can create sustainable value for all stakeholders while managing risks and providing liquidity (Annex II reflects risks borne by each stakeholder and associated mitigation strategies). This analysis explores the financial structures and underlying conditions or pillars that need to converge in order to make MaaS viable, focusing on fungibility, stock accumulation, and innovative financing models managed by the SPV.

A. Fungibility within defined quality bounds

MaaS models benefit from treating metals as economically substitutable or “fungible” within defined quality bands, rather than as unique assets tied to a specific installation. In practice, this means it is not necessary to receive the exact same piece of metal that was initially delivered, as long as an equivalent amount of metal of the contractually defined quality is recovered. This enables residual value to be pooled, contracts to be standardized, and liquidity to improve through shorter contract durations, provided that recovery, testing, and reprocessing pathways are clearly specified.

Fungibility can also support earlier decommissioning by the lessee, preserving higher-value reuse options in demanding environments and reducing risks related to contamination, fatigue, or corrosion. Earlier recovery could also be a preferred option, allowing for later technology adoption rather than locking in capital in less efficient ones. Earlier recovery is easier for battery metals with short service lives. In the context of long-term assets tied to PPAs, where construction steel is embedded, such as in a wind turbine, it is only likely to work when a single grade of steel is used across multiple projects operated by the lessee, enabling the lessee to juggle multiple commitments.

More broadly, metals whose material properties and market structures allow a substantial share of economic value to be retained across multiple use and recovery cycles — when supported by appropriate asset design and recovery pathways and facilitated by economic substitutability/ fungibility within defined quality bands — are well suited to MaaS models, whose core objective is to keep material value in circulation. By contrast, materials with low recyclability and high degradation are not well suited for MaaS.

For fungibility to actually be of service to the MaaS business model, **traceability mechanisms** should be put in place to track the contractual quantity and quality of the metal throughout the MaaS contract life and at the time of metal recovery. Digital Product Passports (DPPs),[I] enabled through blockchain and IoT tagging, elevate MaaS by providing a live, immutable, and centrally accessible log of metal condition, location, and compliance. OEMs, logistics specialists, and project developers update the passport through controlled permissions, creating an auditable trail of performance and handling. Investors can use these digital insights to evaluate collateral performance in real time, guaranteeing the quantity and quality of the recovered metal, and supporting securitization and potentially lowering the cost of capital. However, full-scale traceability systems may not be necessary in early MaaS deployments, which are likely to occur within relatively closed, relationship-based ecosystems where counterparties are known and the metal's processing, use conditions, and end-of-life pathway are defined contractually and operationally—allowing provenance and quality to be managed through MaaS contracts without the added cost and complexity of advanced digital traceability tools.

B. Stock accumulation

Stock accumulation and subsequent monetization are critical to the model's viability. To leverage fungibility, it is crucial to differentiate the flows and stocks for the circular analysis. In a linear economy, selling metal once captures only a single cycle of value. Leasing, on the other hand, initially looks less attractive from the lessor's perspective because the payment fee appears to be just a fraction of the selling price. However, leasing revenues can be reinvested to acquire more metal (stock); receivables can help raise more debt, and then a book of multiple contracts can be further securitized through SPVs, just like asset-backed securities, with the proceeds financing stock growth. This creates a self-reinforcing cycle: more stock enables more contracts, which generate more cash flow, which funds further growth in metal stock. When a material is durable and retains or even increases its value across multiple cycles, the stock itself becomes a strategic asset. In this way, MaaS becomes not just a circular economy model but also a financial solution.

Crucially, the stock-based MaaS model serves as a hedge against both price volatility and the risk of limited near-term physical availability of metal. By holding inventory on its balance sheet (that is, hedged by derivatives), the MaaS provider (AO) absorbs short-term market dislocations that would otherwise be borne by industrial users (Lessee). At the peak of the commodity cycle, or in economically significant episodes of backwardation, when the marginal value of immediate physical access exceeds that of future delivery, often reflecting tight inventories or supply disruptions, leasing fees can adjust to tighter market conditions while still insulating the lessee from extreme price and supply risk. In effect, MaaS reallocates and monetizes the metal's ***convenience yield*****:** the value of assured access to physical metal precisely when market access is most constrained.

I "Digital product passports" is used in this report in a functional sense to describe a digital record for tracking metal quantity, specifications, and condition over the contract lifecycle to support fungibility and recovery. It does not refer to the specific EU regulations such as Digital Battery Passport or other emerging regulatory passport frameworks that are designed to capture broader ESG and due-diligence disclosures.

C. Innovative financing models to transform over time

The key to viability is reducing the "variable yield" — the gap between upfront sale proceeds and leasing returns. To close this gap, there is a need for capital inflows through capital raising. It will first start with the following options: leveraging the credit rating of the SPV sponsors, their equity contributions, the assignment of mining revenue streams when the miner is the sponsor, and the assignment of first MaaS receivables. It can then evolve towards realizing that MaaS contracts behave like bonds: lease fees resemble coupons, and recovered metal resembles principal repayment. This bond-like structure makes MaaS contracts tradable financial assets rather than consumables. A portfolio of these assets will then be securitized, turning illiquid assets into liquid assets appealing to a variety of investors.

The following sections take a deep dive into the three conditions (fungibility within defined quality bands, stock accumulation, and innovative financing models). outlined above. CCSI has prepared a companion report that provides the supporting quantitative economic analysis and illustrates the viability of the MaaS model in the wind industry.

5. Building MaaS Contracts

What makes MaaS operational is a MaaS Contract: an agreement that governs liability, how payments are calculated, and how performance is measured. Table 2 sets out proposed MaaS Contract clauses that, together, would be the building blocks to implement MaaS.

Example clause title	What it covers
Payment Terms & Fee Structure	How the developer pays (availability fee, usage fee, performance bonus), formulae, currency, timing, and invoice rules.
Service Levels and KPIs	Quantitative performance targets (availability %, corrosion rate, recyclability rate) and what happens if they are missed.
Ownership & Title Retention	The organisation(s) that make up the SPV with details of their role and responsibilities.
Inspection & Monitoring	Rights and obligations for inspections, data access, sensor monitoring, or third-party audits.
Decommissioning & Recovery	What happens at end-of-life: material recovery rights, scrap-value credit, recycling standards.
Mobilisation Deposit Clause	The rules for the upfront deposit or lease fee payment, including refund or forfeiture conditions.
Performance Bonus Clause	When and how bonuses are triggered (e.g., corrosion rate below threshold, recyclability ≥95%).
Force Majeure & Termination	Conditions allowing either party to suspend or terminate the agreement.
Liability & Insurance	Damage caps, warranties, and insurance coverage requirements.

Table 2. **Proposed MaaS Contract Clauses**

6. Valuing MaaS Contracts

At its core, a MaaS contract is like an interest-bearing gold deposit (currently being used through government-backed programs in India[8] and Turkey[9]): periodic payments plus the return of the underlying asset. Its value can be estimated using fixed-income valuation methods, adjusted to MaaS.

A. Key drivers of value or MaaS yield[II]

The key drivers are:

- **Lease/rate payments** (like coupons) are made of: risk-free rate, and a credit spread consisting of an inflation premium, default risk premium, liquidity premium, and maturity premium.
- **Recovered metal value** at maturity.
- **Recovery rate assumptions** (not all metal may be recoverable or recovered at the same quality).
- **Spot price projections** at maturity. It is not possible to accurately estimate the spot price of the leased metal at the MaaS contract's expiration, but projections based on analyst research can provide a variable range to use.

However, like bonds, MaaS contracts are sensitive to changes in interest rates. Duration measures the sensitivity of a contract's value to rate movements, while convexity captures the non-linear relationship between value and rates.

For investors, this means:

- Contracts should be hedged against interest rate movements (with plain vanilla swaps, for instance)
- Pricing models should incorporate convexity adjustments to improve accuracy.
- Risk should be actively managed, making MaaS securities more attractive.[III]

Moreover, MaaS contracts, as they mature, become less risky for the commercial relationship with the lessee, recovery processes, and risk management methods being all established; it means that their yield (specifically the credit spread) will decrease/ compress over time because the premia (on default, inflation, liquidity, and maturity) will be less justified.

II The relationship between the key drivers of MaaS yield can be articulated in the form of an equation, MaaS Present Value = [(N $\sum_t$ = 1 P(T)) + (Q x R x S_T) / (1 + r)^t where N $\sum_t$ = 1 P(T) represents the sum of all interest payments N number of periods, from time t = 1 to time T - the end of life/ contract maturity. Q - Quantity of metal leased, R - a variable for the recovery rate, S_T - the spot price of the metal at time T, and r - the discount rate. Q, R, and S_T are multiplied together to get the total value of the metal recovered.

III The more active management is needed, the more the transaction costs increase and asset management fees increase due to the specialized nature of risk management. However, MaaS delivered superior risk adjusted returns, as shown in the companion report.

B. The issue of the collateral

When a MaaS contract is created, metal is leased in exchange for collateral to protect the lessor (SPV) if the lessee cannot service the MaaS contract. All collateral is held by a third-party trust to eliminate counterparty risk (further explained in the companion report and Annex II), with safekeeping fees split equally. Collateral types vary by liquidity and industry acceptance.

1. Receivables

- Common in project finance.
- For MaaS in wind, a floating PPA can serve as collateral, giving the lessor rights to utility payments in the event of default on debt service.
- PPAs carry lower counterparty risk due to their legal enforceability, but should be combined with another form of collateral to fully cover that risk.

2. Real Assets

a. Direct Real Assets

- Physical project assets, including equipment made from MaaS-supplied metal.
- In default, the lessor (SPV) can recover metal by taking control of these assets.
- The challenge is that the depreciation reduces the collateral value, so the physical assets should be paired with receivables when a MaaS contract is originated.

b. Indirect Real Assets

- Assets unrelated to the MaaS project (real estate, land, infrastructure, etc.).
- The absence of a direct connection between the asset pledged and the end product created under a MaaS contract will not incentivize circularity unless the indirect asset is of a similar nature (e.g., another onshore wind farm using the same metal grade).
- The operational complexity makes this option unattractive.

c. Insurance Requirement

- Physical-asset collateral must be covered by property & casualty insurance.
- Force majeure coverage depends on policy terms and premium capacity.
- All insurance costs are borne by the project SPV (e.g., wind developer).

The figure below illustrates a collateral scenario using a combination of receivables and insured physical assets. The numbers correspond to the models described in the companion report that contains the quantitative economic analysis.

MaaS Collateral Structure

A scenario for structuring collateral for MaaS enabled onshore wind

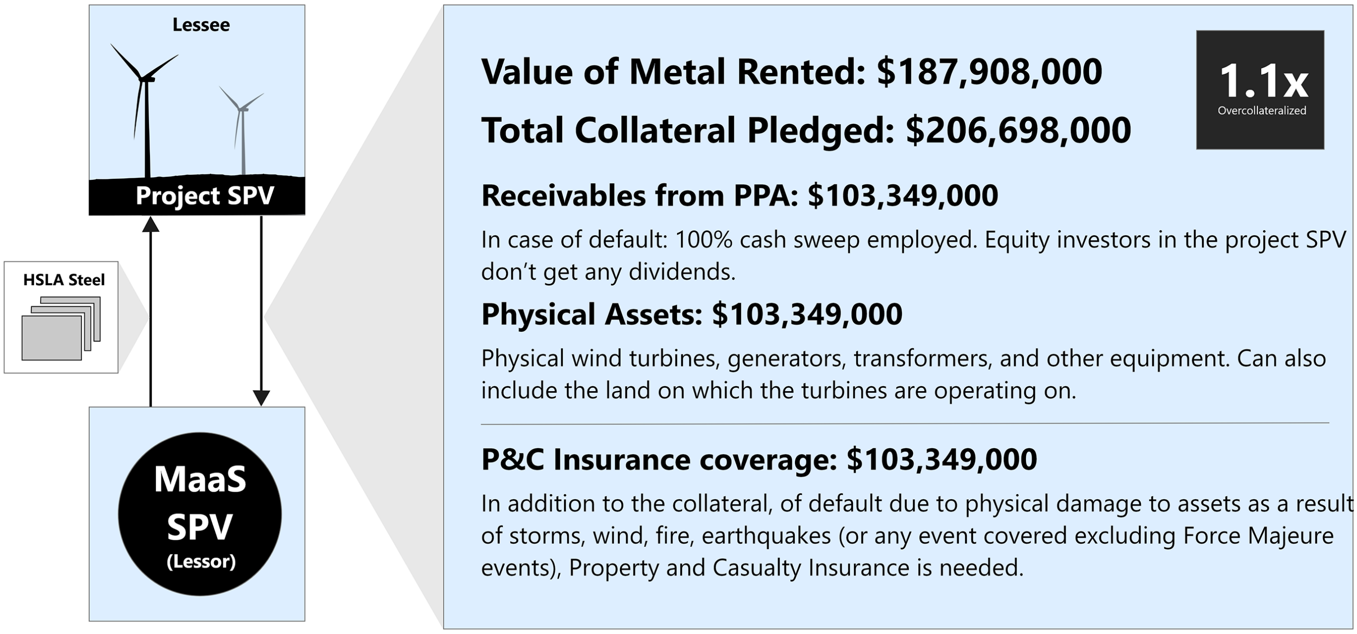


Figure 5. Mass Collateral Structure

3. Guarantees

- A third party guarantees debt service and metal return obligations.
- Only financially strong entities with proven track records qualify and can include project sponsors, parent companies, export credit agencies, offtakers (minimum purchase guarantees), equity investors,

4. Other less common options

Cash and cash equivalents are the most liquid form of collateral, including instruments like interest-bearing certificates of deposit. Hard-currency cash is preferred over soft-currency cash due to higher FX risk. For MaaS, full cash collateral only works if metal fungibility is accepted under the contract, since in a default where the lessor cannot recover the physical metal, the cash would need to be used to repurchase metal on the spot market or, less ideally, to acquire the project's physical assets—an option that complicates operations and weakens circularity. Publicly traded stocks and bonds as assets on the lessee's balance sheet can also be pledged, but the stock price volatility and the bond issuer default risk require significant overcollateralization (even higher for stocks). In the case of stocks, the lessee will retain voting and dividend rights.

7. Building the Metals Bank

At the core of the MaaS business model sits the concept of a Metals Bank, a centralized pool of owned metal inventory that supports the leasing system.

The concept of the Metals Bank is to monetize a stock of metal for the benefit of the entire value chain. A Metals Bank provides a predictable source of supply, generates recurring revenue for the AOs (as a specific stakeholder or an SPV), and provides tradable exposure to circular metals.

A. The concept of Variable Yield

The accumulation of stock is necessary to realize this concept. However, the difference in revenues realized from the sale of metal and from the leasing fees can be significant for the AO. ‘Variable yield’ represents this difference.

The smaller the Variable Yield is, the more comparable the MaaS/stock model return is to the linear/flow model. This is expressed through the following formula:

Variable yield (V) = 100% – $\text{MaaS}_{\text{yield}}$

The 100% represents the proceeds from selling the commodity immediately at (t=0). The **$\text{MaaS}_{\text{yield}}$** is the interest gained from leasing.

MaaS Variable Yield Curve

Variable yield is a term coined to quantify the marginal revenue differences that need to be reduced in order for MaaS to become lucrative for metal owners.

A per unit decrease in the variable yield would lead to a marginal per unit increase in metal stock, as renting (stocking) metal becomes more financially lucrative than selling metal ownership.

The Variable Yield Curve can be represented by the following formula:

$$M = 100 \cdot e^{(-kV)}$$

Where: M = % of metal stock accumulated
k = elasticity co-efficient; determines how quickly asset owners shift to leasing as yield decreases
V = variable yield (%)

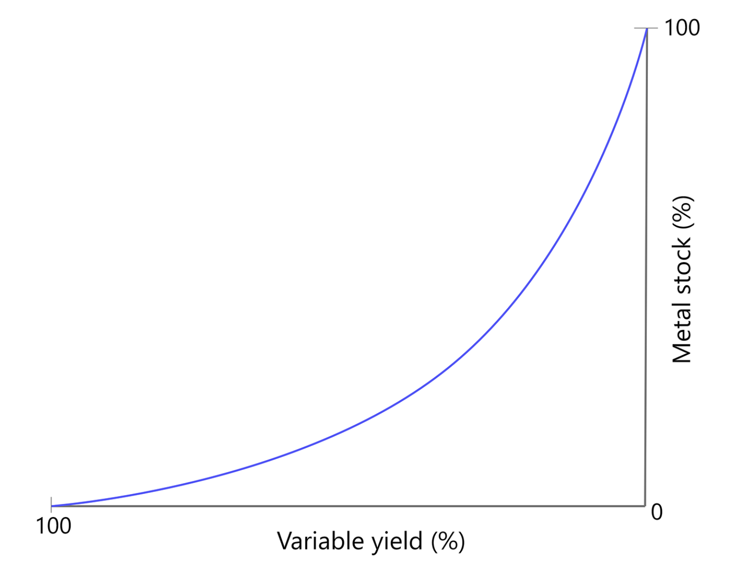


Figure 6. MaaS Variable Yield Curve

A decrease in the variable yield will lead to a marginal incentive to accumulate metal stock for leasing, but each AO has its “elasticity”, which means that each AO reacts differently to variable yield reduction depending on:

1. Type of metal
2. Cost of Capital
3. Lessee’s credit-bearing capacity
4. Debt terms
5. Metal prices
6. Contextual factors (inflation, interest rates, etc.)

This means that the lower the leasing risk (determined by the above factors) relative to outright selling, the flatter/**linear (less convex)** the relationship becomes—meaning AOs are more easily incentivized to accumulate stock and lease. In other words, as the variable yield (i.e., the return gap between the leasing and selling business models) gets smaller, it becomes more attractive for an AO to hold metal and lease it out rather than just sell it. But different AOs won’t respond the same way. The practical takeaway is: the lower the leasing risk relative to simply selling, the more stable and predictable leasing looks. In that case, the relationship becomes less “curved”, showing that even a small improvement in economics is enough to motivate the AO to accumulate stock and lease it, because leasing is no longer a high-risk bet compared to an outright sale.

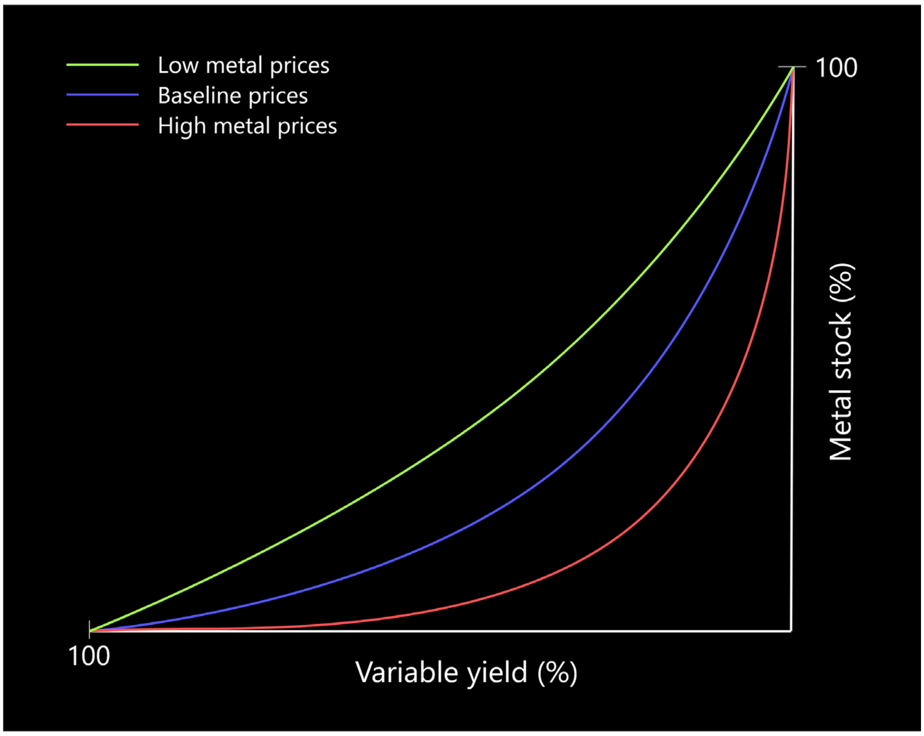


Figure 7. **MaaS Variable Yield Curve Across Metal Prices**

When metal prices are low, falling yields of the linear business model encourage stockpiling. At high prices, the effect weakens. The choice between the two business models depends, in large part, on whether the lessee values the secured supply enough to justify higher leasing fees. In periods of backwardation, when spot prices exceed forward prices, often signaling short-term supply constraints and elevated near-term market stress, the choice between procurement options requires even closer scrutiny due to increased price risk. Elasticity in this environment tends to flatten, since the AO can pass more of the convenience yield (the intangible benefit of holding physical metal during tight markets) onto the lessee through higher fees.

Across commodity cycles, reducing the variable yield will entail increasing the number of MaaS takers and leasing contracts so that they can have an equivalent amount of cash inflow for a given period of time. To achieve this, the AOs have to build up sufficient stock and raise capital to get there. Schematically: If the leasing interest is 10% of the selling price, they have to have 10X stock of metals, resulting in a Variable Yield = 0.

B. Market entry points to build up the Metal Bank

There are three market entry points in the metal value chain where the MaaS AO could take on metal ownership, enabling the build-up of a Metal Bank (Table 3).

Metal Bank entry points	Description	MaaS cycle
Asset-Centric	Primary metal is supplied to project developers or OEMs who manufacture a product that is provided to a customer.	AO maintains ownership of metal during manufacture, product use, re-use, and recycling.
Product-Centric[IV]	Ownership of the metal is tied to the product in use or available for reuse	AO purchases the metal contained within the product, creating or adding to a metal bank. Products continue in use under an assignment (sale) of a MaaS contract.
Recovery-Centric	Ownership of the metal is taken during the metal recovery phase at the end of the product's life	AO purchases waste metal and has it reprocessed into secondary metal. Creating, or adding to, a metal bank. Key consideration: secondary metal already in the urban stock was not originally designed for MaaS, so the added costs and risks of acquiring this type of metal should be taken into account.

Table 3. **AO ownership entry points for the Metal Bank**

Each market entry point corresponds to the form the metal takes in the Metals Bank.

- Asset-Centric entry plays to the strengths of miners, metals producers, and traders who already provide primary metals to the market. Through this entry point, they take on metal ownership and retain it through all stages of the circular metal value chain (i.e., first use, product refurbishment & reuse, recycling).
- Product-Centric and recovery-centric entry enables new entrants to 'buy-in' to MaaS and build up a Metal Bank under the considerations above. Buyers could be miners, metals producers, or traders wishing to expand their existing Metal Bank, or alternatively, new market entrants such as recycling businesses, large OEMs, or entirely new investment-backed market disruptors who recognise attractive commercial opportunities.

In Table 4, we share 10 examples of how Asset-Centric, Product-Centric, or Recovery-Centric models might arise.

IV Our research showed that business models based upon this form of entry point are being used by companies in the wind industry to mitigate steeply rising maintenance and service charges. Therefore, this is presented as a potential entry point in an illustrative way. However, the economic analysis presented in the companion report does not include an economic viability analysis for a product-centric entry point, and therefore, its financial viability would need to be analyzed further on a case-by-case basis. Anticipated estimations of residual values and decommissioning timeline should support the business case for this entry point.

MaaS Model Type	Asset model	Some applications	Short description
Asset - Centric	Long-term leasing of metal for large infrastructure or large product sets	Infrastructure-as-a-Metal Bank	Large-scale infrastructure projects (e.g., building, road, railway, chemical) where primary metal is leased for use in assets and then recovered at end-of-life.
		Renewable Asset Circular Leasing	Renewable energy assets (e.g., wind, solar PV, heat pump) where the primary metal is leased with recovery rights. Rights might include the take-back of equivalent-quality materials recovered during asset decommissioning (i.e., metal fungibility).
		Mobility Metal Pools	Vehicle manufacturers lease primary metal for vehicle construction, with a return obligation to the metal owner.
		Utility-Linked Metal Leading	Primary metal for utility infrastructure (grid, power generation) is leased with recovery at end-of-life.
Product - Centric	Long-term leasing of component products	Component-as-a-Service	Specific components (e.g., wind turbine gearboxes) are leased with a lease tied to product-level material volume.
		Battery-Metals-Stewardship	Specific MaaS leases focused on battery metals with second life and metals stewardship obligations.
		Remanufacturing-as-a-Service	MaaS providers lease metals with built-in remanufacturing cycles for components (e.g., turbine gears).
Recovery - Centric	End-of-life product reprocessed into metal for on-leasing	Urban Mining Models	Recover metals from urban demolition and recycling, then lease them for new uses.
		Industrial Symbiosis Metal Networks	Metals are shared across co-located industries via leasing networks, enabling reuse and recovery between firms.
		Community-Based Models	Local communities lease metals for shared infrastructure (e.g., microgrids) and exercise collective recovery rights.

Table 4. **Type Examples of MaaS Model**

8. Pathway towards MaaS: observations from the wind sector

MaaS is not a single leap but a progressive restructuring of business models, metal ownership, financing, operations, and circularity. Throughout our investigation, we have observed that sectors and industries are evolving towards MaaS through successive waves of incremental capability tweaks. Evolution has been driven primarily by a commercial interest in reducing CAPEX or OPEX costs and by identifying opportunities to develop new services that offer cost reductions, thereby leveraging circularity to improve the bottom line.

Observed shifts in the wind industry from linear toward circular metal use include new business models that valorize circularity, improvements in metal recycling technology, the reuse of recycled metals in operational applications, increased use of refurbished equipment, and the adoption of digital traceability.

These changes reveal that MaaS is part of a broader shift toward monetizing lifecycle performance rather than single-use material extraction. This section covers these enabling conditions in the wind industry and how to pilot MaaS under these favorable conditions.

A. Market conditions favoring circularity are in place in the Wind sector for MaaS to emerge

Commercially driven circularity is starting to occur via reuse, refurbishment, or recycling

Market conditions in the wind sector are starting to favor reuse, refurbishment, and recycling. Reclaimed materials, such as surplus steel pipe, which is repurposed into subsea cable ducts, can achieve required industrial performance standards while delivering around 20% cost savings and significantly lower embodied emissions.[10] Vestas' breakthrough in chemically disassembling turbine blades signals how end-of-life materials once considered unrecoverable can now be reintegrated into the manufacturing cycle.[11] These examples demonstrate that virgin metal inputs are not always demanded, and that sustainable alternatives exist today.

New business models are today fueled by repurposing, refurbishing, or reusing

There is a growing body of evidence showing that technological and material innovation in the wind sector must be paired with circular business models to deliver system-level improvement in sustainable business performance.[12] The substantial cost of support and maintenance contracts for wind assets—particularly for smaller operators—and the long lead times for essential replacement components have spurred growth in a servicing ecosystem that offers refurbishment products at lower prices than new products and delivered on shorter lead times. Businesses, such as Cleveland Steel and Tubes[13] are adapting their business models to capture this new market opportunity.

Key to a switch from nascent circularity practices to MaaS business models will be processing and technology development that ensure materials and products are reliably returned in a form suitable for efficient redeployment or recycling across multiple lifecycles. MaaS depends on consistent, contractually guaranteed recoverability, which keeps metals in a controlled loop. This enables the SPV to model future material value and treat metal inventories as long-term assets.

Integrate digital traceability to make metals measurable and fungible

As metals begin to circulate at higher levels of quality, traceability becomes a necessity (see Section 4A). Operational risk becomes investable only when it becomes measurable, and this requires digital infrastructure, specifically, unique tagging, digital product passports (DPPs), internet of things (IoT) tracking, and blockchain-based audit trails.

The wind sector is already demonstrating the feasibility of such approaches, using digital traceability for blade recycling and copper supply chains. MaaS builds on these practices by requiring full lifecycle visibility, transparent condition reporting, and verifiable metal recovery.

Digital traceability, including digital twins and asset-tracking technology, is now widely used across the sector, enabling operators to monitor real-world turbine behaviour and optimize maintenance. Vattenfall's fleet-wide system integrates real-time sensor data from each physical turbine to support proactive maintenance and anomaly detection.[14] Fathom IoT-enabled digital twin platform collects live asset and structural data to improve operational decision-making and reduce O&M costs – important to a sector where operations and maintenance costs account for around 30% of the lifetime.[15] Structural digital twins developed by Acteon and 2H Engineering provide component-level insight, tracking stresses, fatigue, and loads across foundations, towers, generators, and cables.[16] Technology improvements to track asset location, operational history, and combine condition monitoring, manufacturing, and production data are on the horizon.

B. Piloting MaaS

Getting started with MaaS for the first time involves several clear stages, as outlined in Figure 8 below.

MaaS Stages of Implementation

How MaaS can be implemented at different stages.

1. Finding a Lessee

The first step is to find a lessee.

Who can be a lessee?

Either one of the sponsors of the MaaS SPV or a developer-operator. If the developer-operator has an EPC contract, it will be less risky for the MaaS SPV to implement MaaS as there will be added certainty that the metal is being used to underlie a revenue model.

2. Evaluating needs

The conditions of the MaaS contract can vary depending on the lessee and their specific needs.

Knowing what metal, what quality, quantity, composition (in case metal is an alloy), origin, etc. should be understood.

3. Due Diligence

Based on the Lessee's needs, the lead sponsor needs to conduct due diligence into the lessee (and/or the lessee sponsor group).

Looking at previous 5-10 year audited financial statements, credit ratings, liquidity ratios, governance structure, management team, revenue drivers (like a PPA agreement for wind for instance), operational abilities for safeguarding the metal and/or any material topic should be taken into account.

4. Contract signing

Terms of the agreement, interest rate, expectations, timelines of metal delivery, etc. are negotiated.

Once a resolution is reached, The (to-be) lead sponsor of the SPV enters into a MaaS contract with the lessee.

5. SPV formation

The lead sponsor either forms an SPV on their own, or involves other stakeholders to be a part (like the lessee).

Including multiple sponsors (eg: recycler, financier) can help de-risk the pilot SPV, since each brings distinct expertise or advantages that strengthen the operation. Depending on the jurisdiction, the structure may differ from a LLC, LLP C-Corp, S-Corp, etc.

6. Capital Raise

The SPV raises capital, and will most likely do so through equity dilution.

When the sponsor group is formed, it can be strategic to involve parties who are capable of either funding the capital raise, or have access to capital with the lowest cost.

7. Procurement

Methods of procurement:

a. Direct - if producers are part of the stakeholder group, an offtake agreement can be set up between the SPV and the producer.

b. Indirect - metal can be bought from a commodity exchange at spot rates or through derivatives.

8. Delivery

Metal is delivered to the lessee. Geographically, it would be beneficial if the lessee and the lessor are present in the same country.

In case this is not possible, a longer lead time should be accounted for by both parties for MaaS to remain a competitive alternative

9. Tracking

Over time, the lessor mandates the lessee to provide quarterly disclosures on the state of the metal, along with audited financial and liquidity data of the lessee.

Tracing technologies can be mobilized for monitoring metal used.

This information is monitored over time to reduce risks and ensure successful recovery at EoL.

10. Firefighting

In case of unexpected events causing either the lessee to miss a payment, or loose metal entirely, the SPV can employ firefighting measures such as restructuring the loan, liquidating the collateral pool, or taking operational control of the lessee, all depending on the situation.

11. Re-Investing

The SPV can choose to re-invest interest income to engage new potential lessees and to procure metal to suit their needs.

The SPV can also pledge the receivables from the MaaS contract as collateral to raise more capital to further build stock.

12. End of Contract

Either at the end of the contract, or the end of life of the metal (whichever comes first), the metal is tested for quality and purity.

If the state of the metal is radically different than it was at origination, a penalty may be incurred by the lessee.

13. Recycling

The end product containing the metal is shipped off to a designated recycling partner as outlined in the contract (and which can be part of the SPV sponsors).

Coverage of transportation and recycling costs is specific in the contract. Once recycled, the metal will be ready to be rented once again, either to the same lessee or to a new entity.

14. Securitization

The SPV can choose to re-invest interest income to engage new potential lessees and to procure metal to suit their needs.

The SPV can also pledge the receivables from the MaaS contract as collateral to raise more capital to further build stock.

15. Going Public

After a few years of successful operations and track record, the MaaS SPV can change structures to an MLP (Master Limited Partnership) or an Exchange Traded Fund under a Trust, both of which will enable it to go public through an IPO (initial public offering) and introduce liquidity for all investors

Figure 8. **MaaS Piloting Step-by-Step Pathway**

Given the specificities of different metals, their uses across multiple sectors, and their potential end-of-life paths, it is not possible to create a detailed, step-by-step guide for all metals and their outcomes. This sub-section provides a high-level framework for introducing MaaS when market conditions suggest growing interest in circularity. Below, we talk to several business model attributes that impact commerciality.

Contract fee structure

Interest has been noted in hybrid fee structures which combine fixed, variable, and contingent elements to align risk, performance, and circular value creation. Five complementary payment types were explored individually or in combination, depending on asset criticality and project risk profile.

- **Availability service payments (predictable):** Fixed periodic payments are made in return for guaranteed availability and functional performance of the metal asset. These payments provide revenue certainty and are well-suited to load-bearing structural components where reliability is paramount.
- **Performance-linked payments (contingent):** Bonuses or penalties are applied based on measured performance against agreed KPIs. These mechanisms incentivise durability, corrosion control, and structural integrity over time.
- **Upfront or Capital-related payments:** Initial payments may cover mobilization, lease deposits, or financing costs to reduce early-stage risk for metal suppliers.
- **Terminal or Recovery payments:** At decommissioning, revenues are generated through material recovery, reuse, or revenue sharing. This ensures residual value is retained within the Metals Bank.

BOX 1. EXAMPLE SERVICE PAYMENT: STRUCTURAL AVAILABILITY SERVICE PAYMENT

Service provided: Load-bearing structural integrity for towers and foundations, ensuring usable capacity throughout the service life.

Payment form: Fixed periodic fees (e.g., quarterly or annually).

Payment Formula: Fee = Base Rate ($/MW/year) × Rated Capacity (MW) × Availability Factor. The rated capacity is the average uptime of the asset, e.g., 90-95% for an offshore wind turbine.

KPIs and Monitoring: Annual structural inspections, continuous or periodic sensor data (e.g., tilt, vibration), and corrosion rate thresholds.

Risk Allocation: The SPV retains ownership and long-term risk. A wind farm developer/ operator could claim service level agreement (SLA) penalties if KPIs are breached.

Contract signing and SPV formation

Forming an SPV to manage MaaS is the least risky option as it permits the new business to create appropriate commercial and contractual structures and avoids later legal issues around liability, lender documentation, and the need for contract assignment or novation.[V] However, insights from stakeholders, particularly those with strong metal asset bases such as traders or miners, indicated interest in first piloting MaaS directly through MaaS contracts

V A novation is an agreement made between two contracting parties to allow for the substitution of a new party for an existing one.

before forming an SPV. This may be a prudent approach for businesses with strong balance sheets and substantial commercial trading competencies (e.g., complex contract structuring capabilities, strong partnering skills, prioritizing lessee identification, negotiating a term sheet), which can be used to match the trading capabilities of SPVs without incurring the costs and rigidity of establishing such an entity.

Both approaches are viable provided the contracting plan explicitly accounts for how the MaaS agreement will be executed by, or transferred into, the SPV once long-term commercial viability is confirmed.

As noted in Figure 8 above, robust lessee due diligence is essential not only for counter-party selection but also for determining the level of traceability tools needed, since operating within a well-understood, relationship-based ecosystem with clear visibility into how metal will be processed, used, and recovered can reduce more costly and operationally complex digital traceability systems.

Capital raise

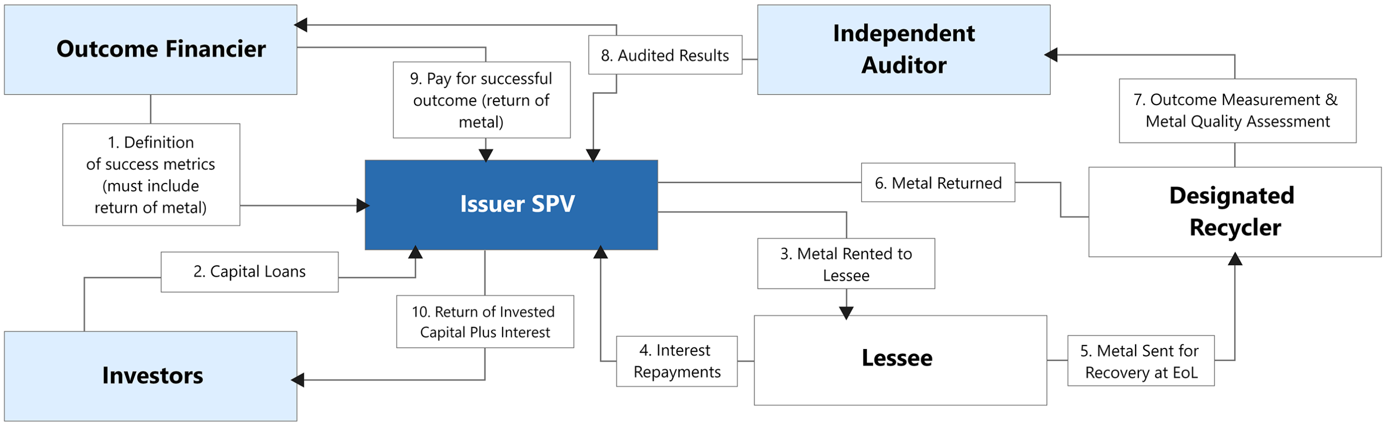
An SPV would simplify capital-raising by separating the project from the sponsor's balance sheet and operational risks, whilst allowing the sponsor to retain ownership and, in some cases, accrue tax advantages. Equity investors for the SPV could be limited to one investor or a mix of government, miner, metal producer, recycler, OEM, and/or customer (e.g., wind developer). The lead sponsor would likely assume operational control of the SPV, possibly with a partnership team comprising partner representatives. Early SPV revenues would be recycled to strengthen the balance sheet.

Debt financing is plausible for sponsors with significant financial strength, but probably difficult at an early stage for an SPV set up as an independent early-stage start-up without strong financial backers, as lenders are likely to demand high pricing until the model is proven, making terms heavily dependent on the sponsor's credibility. In these circumstances, venture debt could provide short-term bridge financing but is generally too expensive to serve as core funding.

An alternative approach to debt raising is outcome-based financing (see Figure 9) that links returns to environmental performance, such as lower coupons when metals are successfully recovered, which could attract impact investors while offering an upside narrative to mainstream investors.

MaaS Environmental Impact Bond

A financial instrument to drive measurable circular impact for the MaaS framework through the strategic capitalization of social value.



As an alternative to traditional financial instruments involving debt and equity, more newer and innovative approaches through the launch of an outcome based financing model that capitalizes on social value could be a potential financing mechanism for MaaS.

An Outcome financier, who really cares about circularity (like Closed Loop Partners) could pay for the successful completion of a MaaS loop. This would be great for a pilot and may even incentivize the concept to take off.

As the successful retrieval of the metal rented is core to MaaS, making it an inseparable part of the financing mechanism through an EIB could be a strategic way to ensure the loop is closed at the end of life or MaaS contract.

Figure 9. Environmental Impact Bond in the context of MaaS

Because capital raising can be slow, strong existing relationships with financiers can significantly accelerate the process and help meet contractual timelines.

First procurement for building the Metal Bank

There are two potential pathways to building an initial stock in the metals banks.

For a SPV sponsored by **a miner, metal producer, or recycler** in an asset-centric MaaS model, one option is to rely on an offtake agreement aligned with the metal leased to the end user. In practice, offtake agreements are usually signed well before production begins, which makes them poorly suited to the short timelines required to launch a MaaS pilot.. A more practical solution is to deploy a small fraction of its annual metal ore or product inventory to the Metal Bank. This would be a relatively low-cost, low-risk approach for such a sponsor. It might also remove from inventory products that lack immediate sale, reducing storage and transport costs. Transferring idle stock into MaaS both frees up tied-up capital and strengthens the economic case for participation. **For traders,** the advantage is different as moving assets to a SPV Metal Bank allows existing inventories or short-dated supply positions to be converted into higher-margin, longer-tenor contracts, replacing low-yield or speculative holding strategies while preserving optionality through hedging rather than physical sale.

Alternatively, using the capital raised by the SPV, metal can be procured at spot prices directly from a commodity exchange like the London Metal Exchange,[17] Shanghai Metals Market,[18] or Multi Commodity Exchange.[19] Alternatively, metal can be procured at a price desired by the lead sponsor through a commodity derivatives exchange such as the Chicago Mercantile Exchange.[20]

Reinvesting for growth

Reinvesting income and recovering physical assets to reenter the Metal Bank for on-leasing is very important, but it is unlikely to be enough to grow the stock efficiently at scale. Rapidly, the SPV would work to monetize leasing income and MaaS contracts: the SPV aggregates leasing fees, refinances both receivables and MaaS contracts with financiers, and passes through payments, transforming these obligations into tradable financial assets (see Figure 10 below).

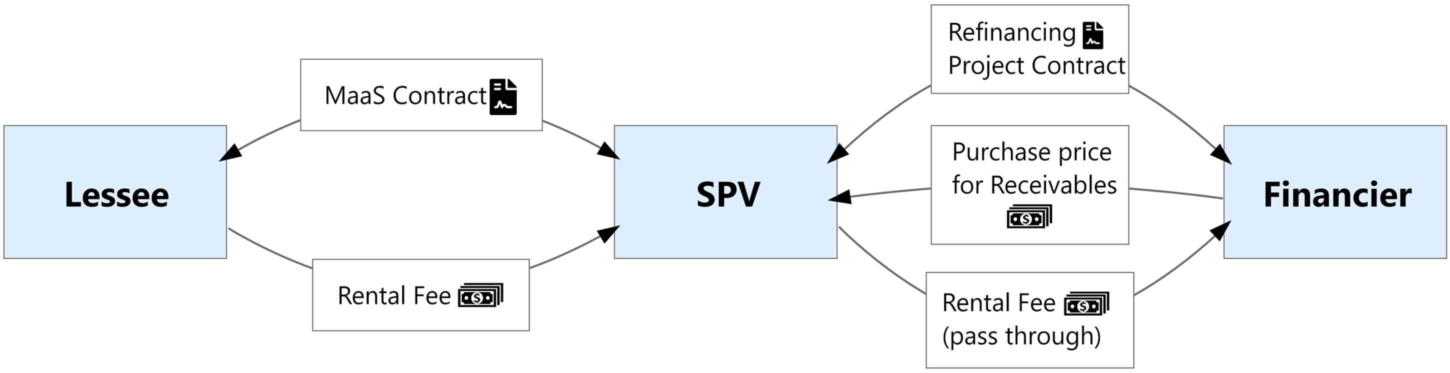


Figure 10. **MaaS Contracts and Receivable Monetization**

Returning the metal to the Metal Bank

Metal will be recovered by the AO or the lessee (depending on the contract terms) at the end of the contract when the MaaS term expires. If the contract ends while the metal is still usable, the parties may choose to renew it, requiring fresh negotiations on terms, covenants, interest rates, etc. At contract end, third-party metallurgical inspection of the product and/or metal will be required. The contract should specify an acceptable range of degradation to support predictable recovery. If the metal's condition falls outside this range, the lessee may be liable to a financial penalty to cover additional recycling costs; if they cannot pay, the amount is deducted from their collateral.

Post-use metal degradation encompasses **in-service deterioration mechanisms** (such as corrosion, oxidation, and fatigue) and **end-of-life metallurgical degradation**, including impurity accumulation and alloy dilution during recycling, which collectively reduce material quality and recoverability.[21] As the extent of degradation and recyclability vary across types of metals, as shown in Table 5, MaaS contracts should be designed with tiered quality degradation clauses, together with clauses on how to use and transform the metal (e.g., specifying what alloys and combinations with scraps should be avoided) and to accommodate product design for recovery and acceptable recycling method.

	Steel[22]	Copper[23]	Aluminum[24]
In-service degradation	Subject to corrosion, but it can be reversible in the remelting process	Does not degrade much due to a stable surface layer (patina)	Does not degrade much as it is protected by a stable aluminum-oxide (Al_2O_3) layer
End-of-life metallurgical degradation	Tramp (unwanted alloying) elements (Cu, Sn, Ni) can cause quality loss due to mixed post-consumer scraps during the recycling process	Does not degrade, but scrap from complex products (e.g., cables) needs special separation	Alloy mixing after use likely affects quality
Primary quality constraint	Tramp elements cannot be removed economically once dissolved	Effective separation and liberation of copper from complex waste	Alloy contamination (Mg, Si, Cu)
Dominant re-refining method	Thermal melting + composition adjustment	Smelting and electrolytic refining	Thermal remelting + composition adjustment
Ability to remove impurities	*Low* for specific alloys (Cu, Sn, etc.)	*Very high* - with proper sorting, smelting and electrolysis can purge many impurities into slag	*Medium* - oxides can be removed; alloying contaminants often persist
Typical post-refining purity	Often downgraded	99.99% purity	Alloy-specific — good but may be downgraded relative to virgin alloys

Table 5. Degradation potential across steel, aluminum, and copper

Securitization of MaaS Through SPVs

Once a portfolio of multiple MaaS contracts is in place, the claim to all future receivables can be securitized. Securitization converts MaaS contracts into financial securities, distributing risk to investors while creating liquidity for sponsors, which, as mentioned in prior sections, can easily be achieved by the SPV (see Section 9 for more details on securitization).

BOX 2. CASE STUDY

The Hornsea 1 Offshore Wind project in the UK raised nearly £2 billion through an SPV, securitizing future electricity sales. MaaS can follow a similar model, securitizing future lease payments and recovered metal.[25]

9. Scaling MaaS: Financing MaaS with Bonds

A. Securitisation enables the issuance of Asset-Backed Securities (ABS)

SPVs can issue **Asset-Backed Securities (ABS)**, pooling securitized MaaS contracts as collateral. ABS structures provide flexibility and risk diversification.

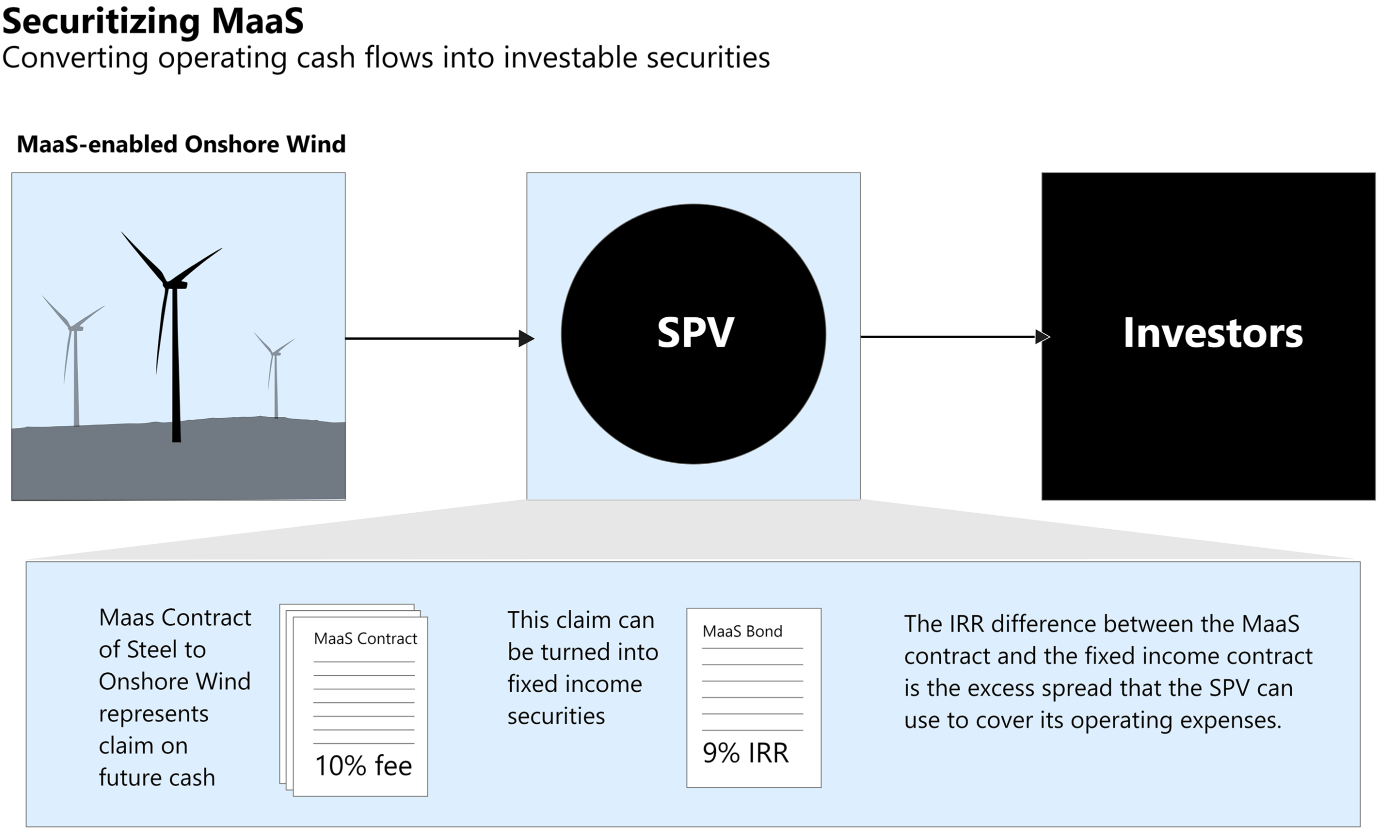


Figure 11. MaaS Securitization

Key Features

- **Credit tranching**: Senior tranches get paid first, junior tranches absorb losses first, in exchange of higher returns. Allows the SPV to diversify its debt sources and optimize its Weighted Average Cost of Capital.
- **Excess spread**: Difference between lease income and bond coupon, used for expenses or reinvestment.
- **Overcollateralization**: Pledging more assets than debt raised, boosting investor confidence - generally a requirement for non-recourse senior debt.
- **Embedded Options:** A call option embedded into the bonds gives the issuer (the SPV) the right to redeem the bonds early from investors. This grants financial flexibility to the SPV from a decrease in interest rates and allows refinancing to access cheaper debt. However, it increases the initial cost of capital because investors face the risk that the bond will be called before its maturity date.

Features of Securitization
Overcollateralization and Tranching are risk management tools for investors

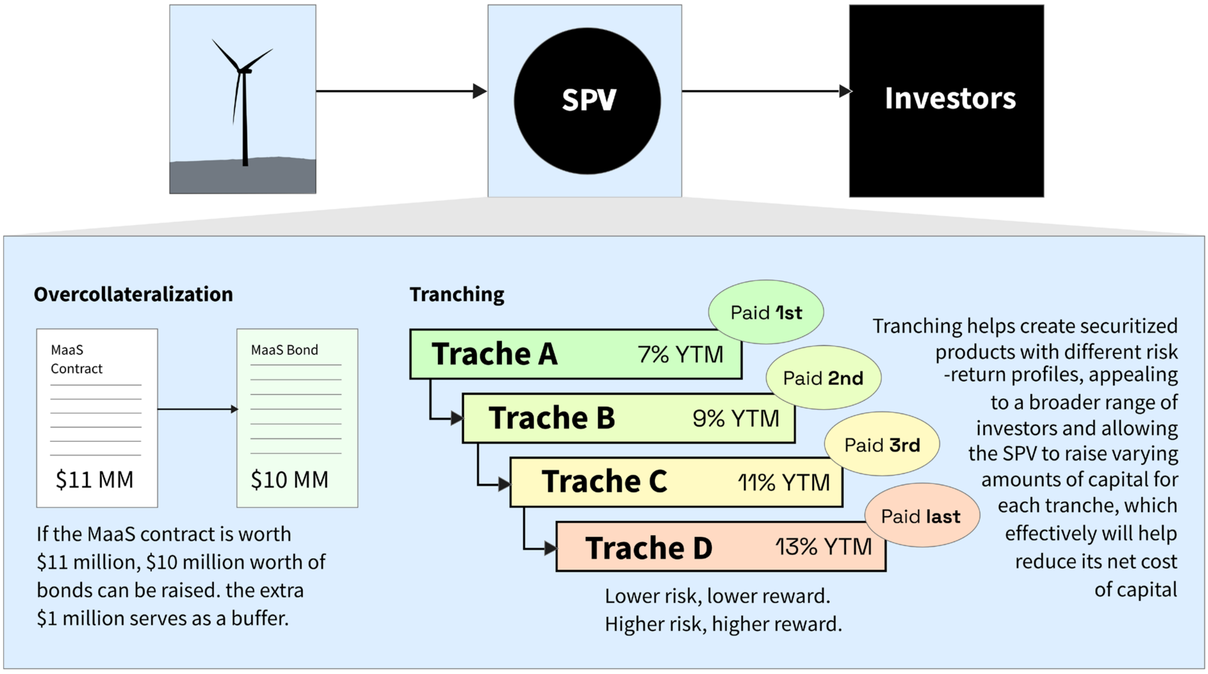


Figure 12. Features of Securitization

This ABS structure allows pension funds, insurers, and other fixed-income investors to participate in MaaS financing.

While the discussion focuses on an SPV structure, the same ABS approach can be used by any MaaS participant. The main differences in how the contracts perform depend on the credit quality and track record of both the lessor (stakeholder) and the lessee (underlying counterparty).

Interestingly, Trafigura has recently set up an SPV to monetize its commodity inventory through an ABS issuance. This brings Trafigura closer to the transformation needed to embrace MaaS.

BOX 3. CASE STUDIES

Trafigura, one of the world's largest commodity traders, has launched a new securitization vehicle, Trafigura Commodities Financing (TCF), to unlock additional liquidity by leveraging its crude oil and refined metal inventories. The Singapore-based special purpose vehicle raised $470 million by selling senior variable funding notes to a group of banks, including Natixis, Bank of Tokyo-Mitsubishi UFJ, and Westpac.

The funds, along with a subordinated loan from Trafigura, will be used to purchase inventories from Trafigura, which will then repurchase them later at a predetermined date, and is a structure similar to a repurchase agreement (repo). This setup allows the company to systematically issue notes collateralized by physical commodities and, eventually, seek term financing in the asset-backed securities market. The arrangement includes safeguards, such as third-party verification and physical inspection, to address risks such as theft, fraud, and liquidity issues that have plagued commodity repo markets in recent years.

This marks a strategic shift for Trafigura from securitising receivables (money owed) to securitising inventories, expanding its toolkit for commodity trade financing.[26]

Other examples in the industry show that securitization is an effective and widely used tool for unlocking liquidity.[27]

One such example is the use of Collateralized Debt Obligations (CDOs)[VI], which are a type of ABS structure that can help unlock debt financing through tranching and retain an excess spread (see Figure 20 in Annex III).

B. Covered bonds as an alternative

Beyond ABS, MaaS SPVs can adopt other financing structures, such as Covered Bonds:

- Issued by banks, backed by MaaS contracts.
- Lower cost of capital but higher risk for banks, since contracts remain on their balance sheets.
- Typically safer but less flexible than ABS.
- Unitranche, and almost always senior secured debt with recourse.

For the detailed mechanics of structuring a Covered Bond for MaaS, see figure 19 in Annex III.

VI Forms of CDOs were responsible for the 2008 financial crisis, but were employed on a completely different asset class. Since then regulations have become strict and have required CDO structures to become less complex. To protect investors from default, the collateral is subject to a series of tests that include coverage of payment obligations to CDO investors by cashflows from the collateral as well as credit enhancement through overcollateralization, tranching, and excess spread.

10. MaaS as a Journey: Evolution of SPV Structures

The SPV structure will evolve along the MaaS journey, from pilot to growth stage.

A. Limited Liability Companies (LLCs)

- **Purpose**: Early-stage MaaS financing with either **equity-only capital or minimal debt in its structure**.
  - **Mechanics**:
    - Funded by venture capital, sponsor groups, and/or commodity-focused hedge funds
    - Minimal debt component → higher WACC but lower financial risk.
    - Convex reduction of variable yield (aligned with MaaS-only focus) - as explained in Section 7A
  - **Strengths**: Flexible, low setup costs, simplified governance, VC alignment, lower financial leverage risk due to a higher proportion of equity in the capital mix
  - **Weaknesses**: Illiquidity, limited investor base, no track record, higher cost of capital, and the highest asset management fees among all structures.
  - **Best for**: Proof-of-concept MaaS ventures (0–3 years).

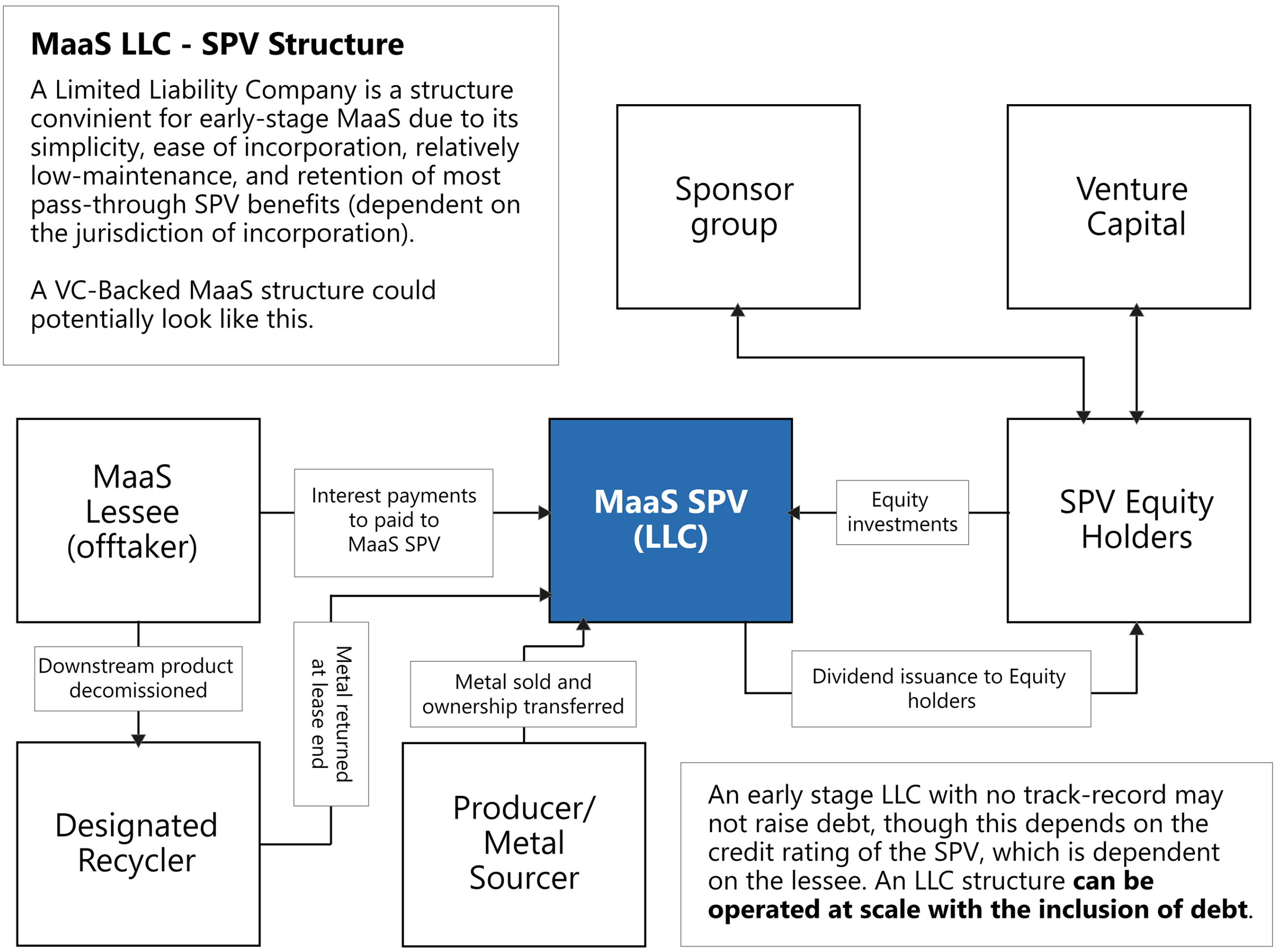


Figure 13. **MaaS LLC SPV Structure**

B. Master Limited Partnerships (MLPs)

- **Purpose**: Hybrid structure combining the **tax benefits of private entities** with the **liquidity of public trading**.
- **Mechanics**:
  - General Partners (GPs) manage operations; Limited Partners (LPs) provide capital.
  - Uses **American-style waterfall** (each MaaS contract treated separately, cash realized immediately).
  - GP compensated via management fee + carried interest (with hurdle rates).
  - Allows LP-specific provisions (side letters, co-investment rights).
- **Strengths**: Liquidity, GP-LP alignment, flexible structuring.
- **Weaknesses**: GP concentration risk (a single decision-maker rather than multiple bodies voting), limited diversification of management expertise, and higher asset management fees than the CIT model.
- **Best for**: Growth-stage MaaS projects needing institutional capital and scalability (3-5 years).

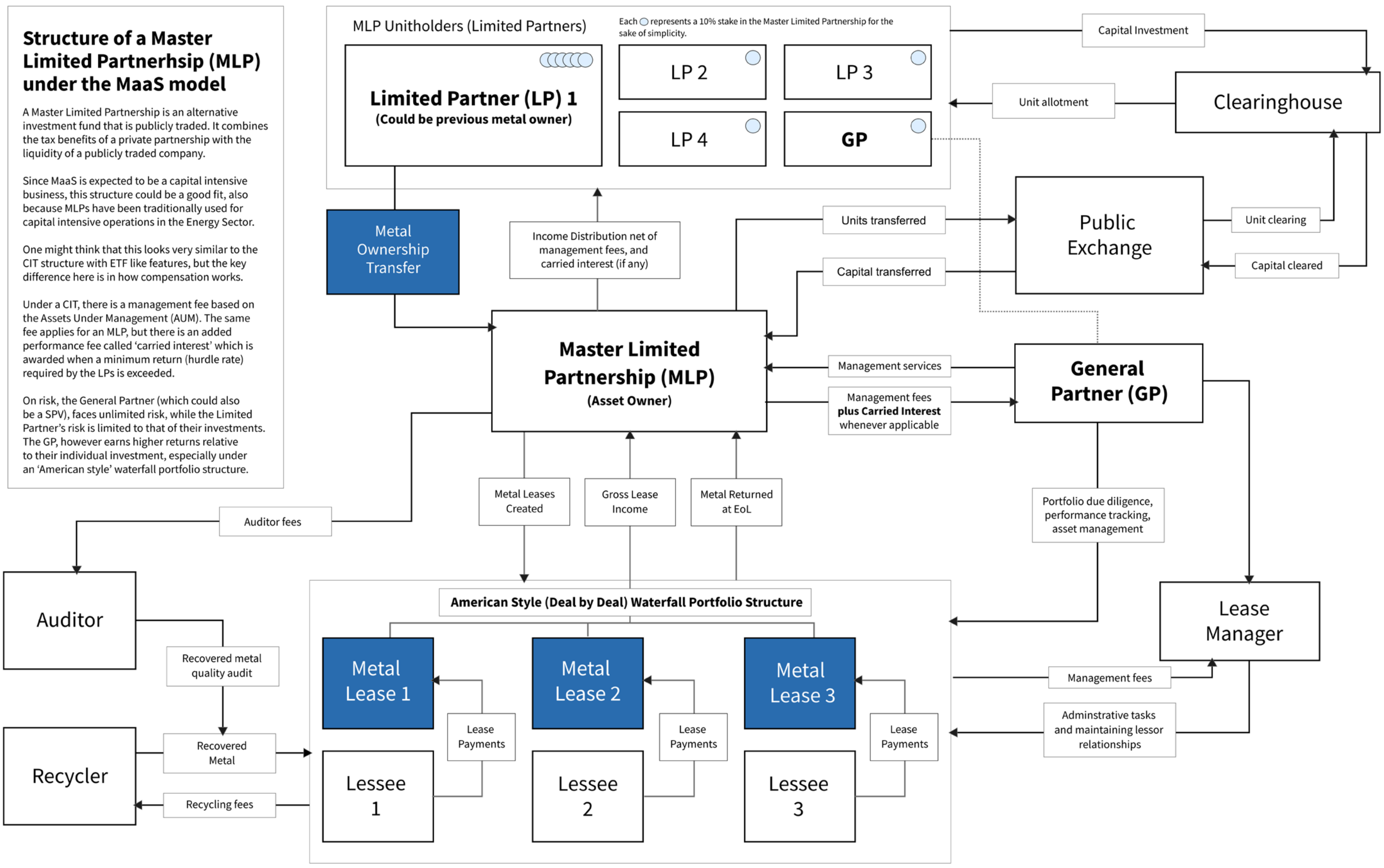


Figure 14. MaaS MLP SPV Structure

C. Commodity Investment Trusts (CITs)

- **Purpose**: Raise capital by issuing publicly traded shares against a portfolio of securitized MaaS contracts (ETF-like).
- **Mechanics**:
  - Metal owners transfer assets to the trust in exchange for shares.
  - MaaS contracts generate revenue; net income is distributed as dividends.
  - Treated as a pass-through entity (avoids double taxation).
- **Strengths**: High liquidity, broad investor base, sophisticated risk management, lowest asset management fees, and potential for global expansion through depository receipts as explained below in sub-section D.
- **Weaknesses**: High setup costs, concentration risk, and requires a mature track record.
- **Best for**: Mature MaaS markets with diversified portfolios (5+ years).

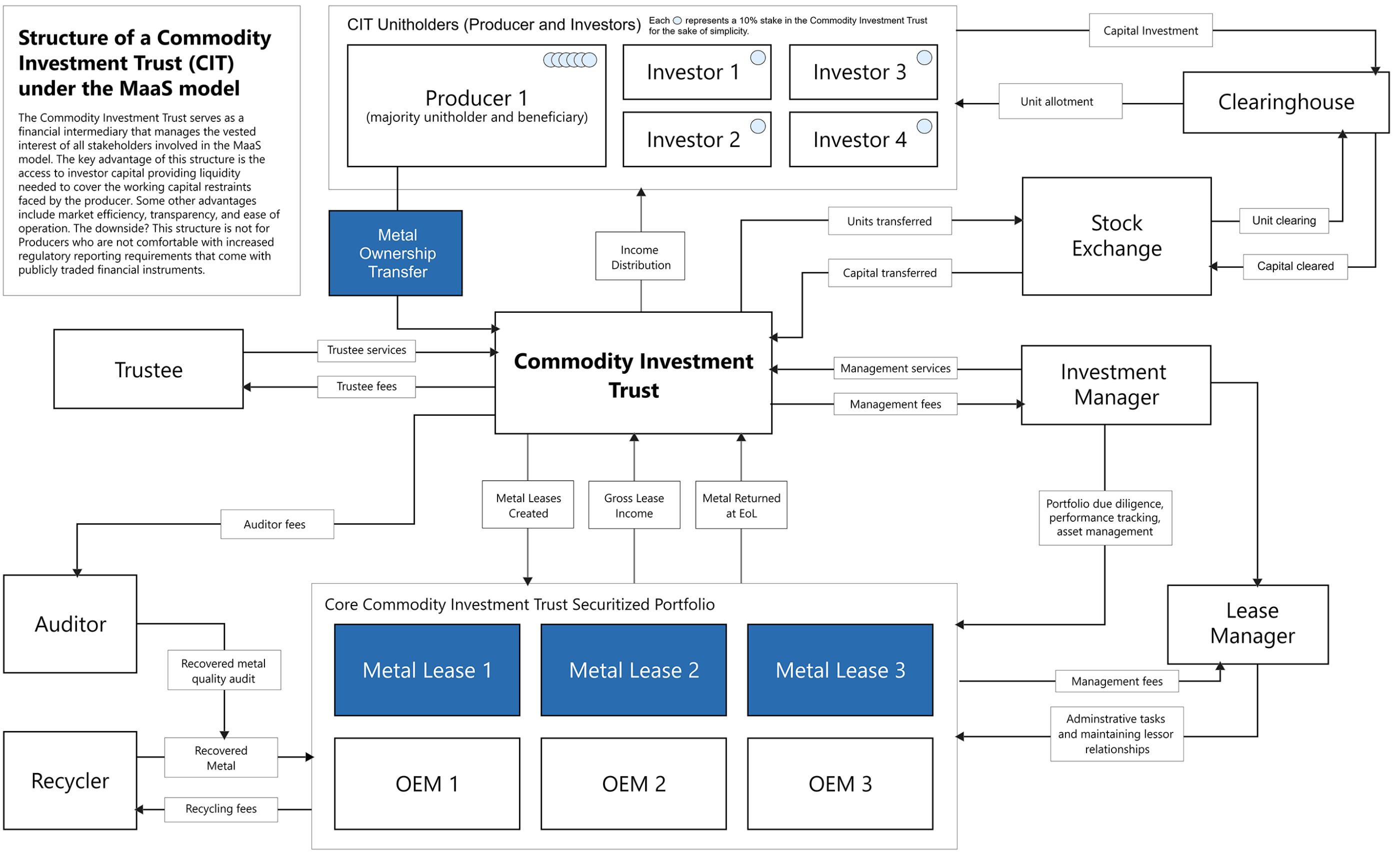


Figure 15. **MaaS CIT SPV Structure**

D. Globalization of the Financing Through Depository Receipts

To attract international investors, MaaS SPVs can issue **Depository Receipts**:

- **American Depository Receipts (ADRs)** for U.S. investors.
- **Global Depository Receipts (GDRs)** for broader markets.

These instruments expand the investor base, improve liquidity, and integrate MaaS into global capital markets.

11. Scaling MaaS: Evolving commercially

Once the SPV is fully capitalized and the model is more proven in the market, both financing the stock and procuring the metal for it will become easier. The sale of MaaS contracts can also be considered: funds earned from a profitable exit from a MaaS contract held by the SPV can be reinvested for stock accumulation. In addition, **the MaaS business model can expand or be combined with other as-a-service business models that are directly connected to MaaS.**

Name	Business model
Metal-as-a-Service	Processed metal is on-leased to project developers or OEMs, and then the client, with ownership remaining with the SPV
Product-as-a-Service	Metal contained within a product is on-leased to the client, with ownership remaining with the SPV
Component-as-Service	Equipment components (e.g., wind towers) are on-leased to the client with ownership remaining with the SPV
Recovery-as-a-Service	Metal is recovered from recycled products or components and is leased to the client, with ownership remaining with the SPV
Shared-as-a-Service	Pooled products or component offerings are pooled for use across multiple clients.
Function-as-a-Service	Clients request a metal-solution to a specific performance requirement from the SPV offering.

Table 6. **MaaS Business Model Concepts**

These business models, combined with the value chain entry points mentioned in Section 7B, represent an illustration of the opportunity space for expanding servitization in metals.

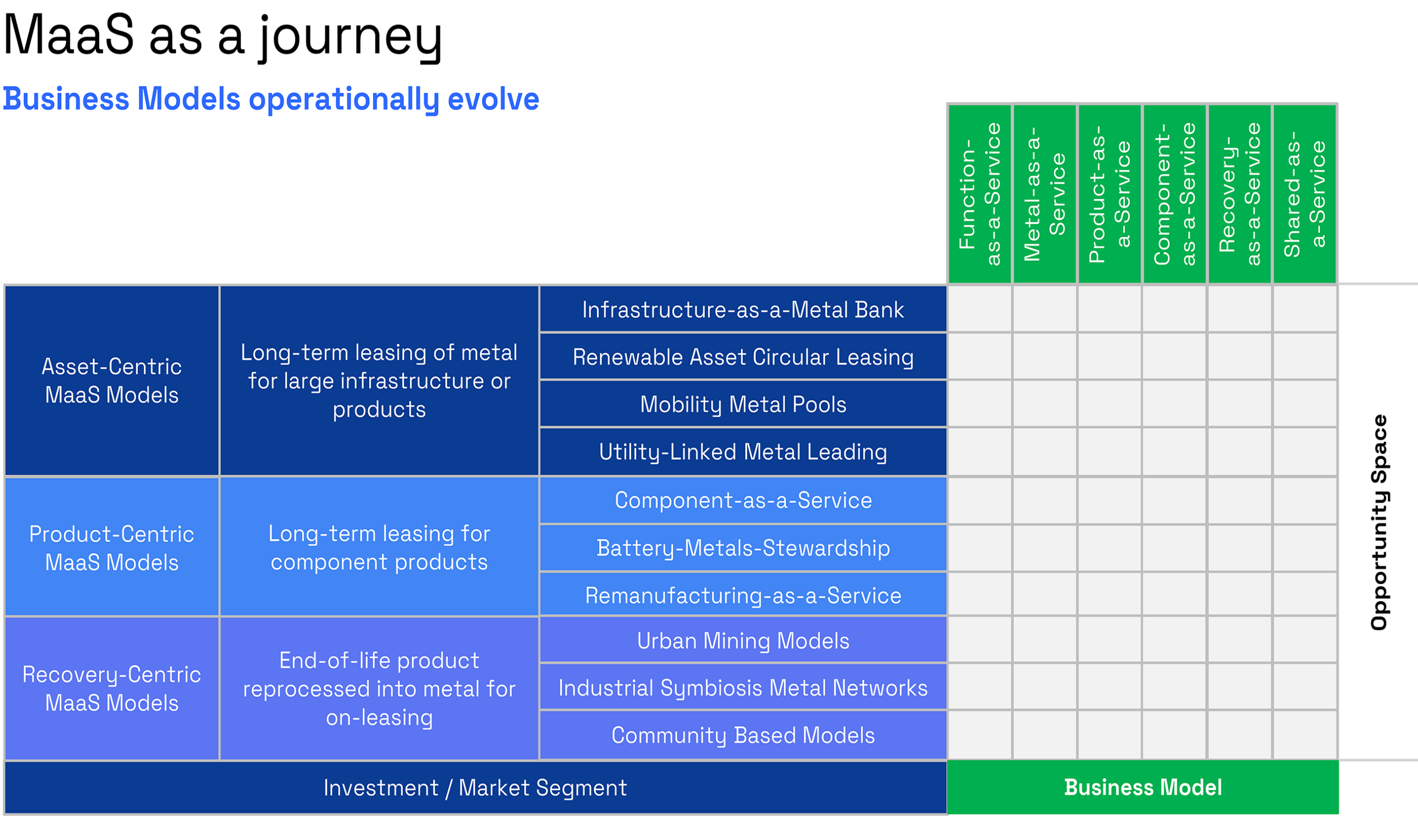


Figure 16. **Opportunity universe anchored on MaaS**

12. Stakeholder Benefits of MaaS

Metals-as-a-Service delivers value not through a single improvement, but by realigning incentives, cash flows, and risk across the entire wind value chain.

1. Lower upfront capital and more predictable costs

MaaS reduces upfront CAPEX by replacing metal purchases with service-based payments. This improves cash flow predictability for project developers and OEMs while reducing exposure to commodity price volatility.

2. Improved supply security and system resilience

By retaining ownership and enforcing recovery, MaaS keeps metals in circulation rather than losing them at end-of-life. The Metals Bank aggregates primary and secondary supply, reducing reliance on constrained extraction markets and improving long-term material availability.

3. Aligned incentives for circularity

SPV ownership ensures that the party with the strongest incentive to preserve material value controls the lifecycle. Circularity, recovery, and quality retention become economically embedded rather than voluntary or regulatory add-ons.

4. Clearer risk allocation and transparency

MaaS consolidates material, operational, and recovery risk within the SPV, simplifying liability and improving bankability. Digital traceability makes these risks measurable, auditable, and financeable.

5. Stable, long-term revenue streams

Leasing, performance-linked payments, and recurring revenues convert metals from one-off sales into recurring income-generating assets. These predictable cash flows support reinvestment and system scaling through the Metals Bank.

6. Creation of a new investable asset class

By combining ownership, standardized contracts, and verified data, MaaS enables circular metals to be securitized. This unlocks institutional capital and connects long-term finance directly to material stewardship.

7. Regulatory and strategic advantage

MaaS improves visibility over material flows, recovery rates, and embodied carbon, supporting credible reporting and future regulation. Strategically, it positions a metal-intensive industry like the wind industry as a leader in scalable industrial circularity.

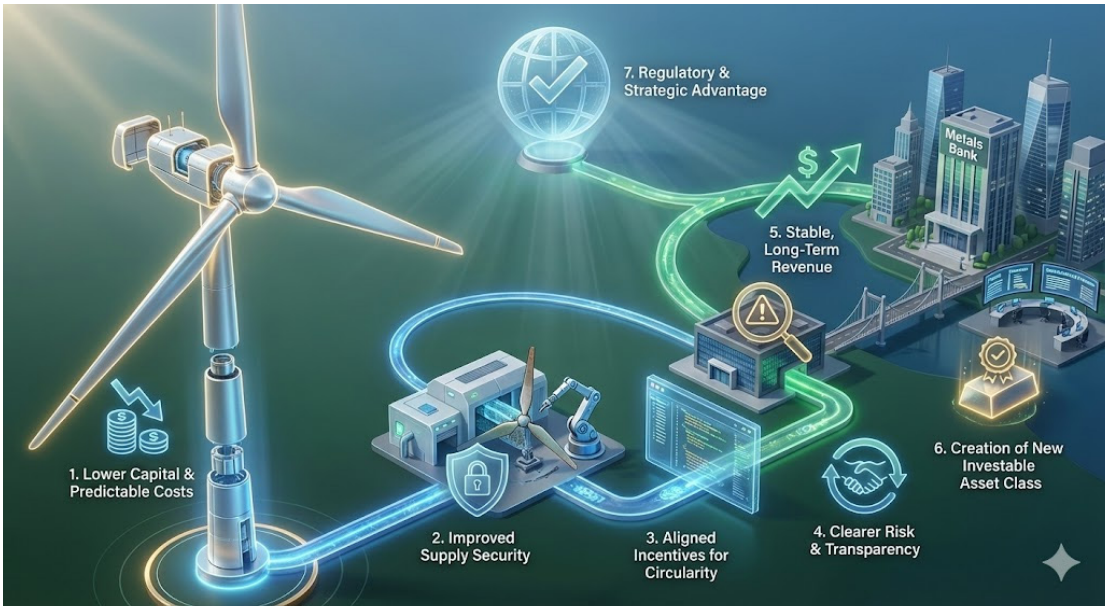


Figure 17. **Illustration showing the stakeholder benefits of MaaS enabled onshore Wind**[28]

13. Conclusion

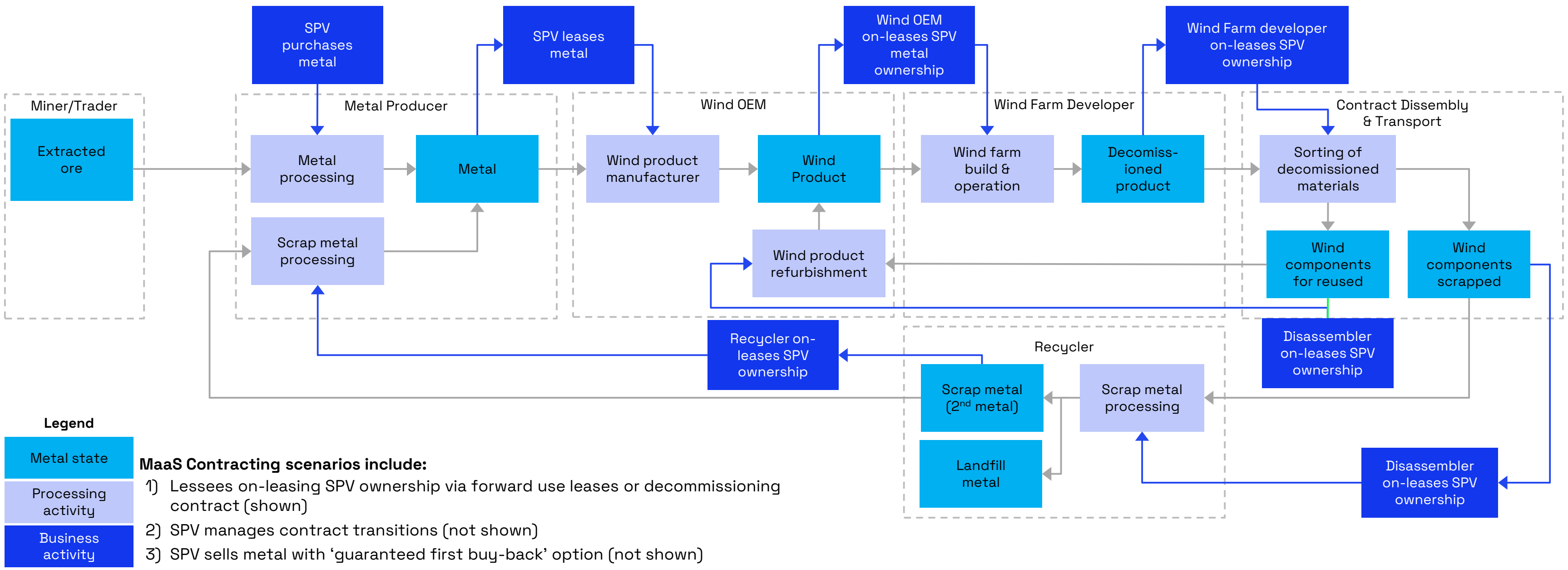
The MaaS model represents a profound redesign of how the wind industry acquires, manages, and values the metals essential to its infrastructure. By placing a dedicated SPV at the centre of a closed-loop system, MaaS ensures that metals retain their value across multiple lifecycles, that risks are made transparent through digital traceability, and that financial structures evolve to reward circularity rather than undermine it.

This is a model in which supply security improves as the system grows, in which operational efficiency and financial bankability reinforce each other, and in which sustainability becomes not a compliance obligation but a driver of economic value. MaaS offers the wind sector a route to expand responsibly, competitively, and resiliently, while unlocking a new asset class that merges industrial stewardship with long-term financial performance.

Ultimately, the message is unmistakable: **circularity becomes an engine of value when metal stays owned, stays visible, and stays in play. MaaS makes this system real, investable, and ready for scale.**

ANNEX I - Shifts in metal state, processing activities, and business activities in a MaaS model for the wind value chain

The MaaS business model begins with the SPV acquiring metal, either primary or secondary, and adding it to the Metals Bank, an inventory of metal held specifically for leasing. The SPV pays processors to refine this metal into standardized, market-ready forms, which are then allocated to wind project developers. OEMs, under usage contracts, transform this leased metal into components used in productive assets (e.g., turbines, towers, foundations, in the wind industry), while keeping the SPV's ownership intact. These components are then on-leased to developers or operators, who pay periodic fees over the asset's operational lifetime. At end-of-life, developers trigger the decommissioning process, and the SPV assumes responsibility for coordinating reclaim, refurbishment, or recycling. The SPV may on-lease the metal components directly for use in similar assets or send them to recyclers for scrapping, who produce secondary raw material of equivalent specification. This metal is 'returned' to the Metals Bank for deployment in new projects. Another scenario that would simplify the contractual approach is for the SPV to deal only with the wind developer, not the OEM.



Sources: Carbon Trust/CCSI analysis. Modelling approach taken from Engelmann, A., Zeeuw van der Laan, A., Aid, G., Nybom, L., Aurisicchio, M. (2021) 'Developing the Material-Service System Concept: A Case Study of Steel Industrial Drums', in Proceedings of the International Conference on Engineering Design (ICED21), Gothenburg, Sweden, 16-20 August 2021. DOI:10.1017/pds.2021.122.

Figure 18. The SPV as the operational backbone

This model allows the SPV to manage metal as a long-term asset with multiple value-creation cycles. The **emphasis on equivalent weight and quality, rather than physically identical material**, makes the model practical for real industrial flows while maintaining circular integrity. Moreover, the SPV's oversight ensures that metal does not leak out of the system into untraceable downstream applications, preserving future value.

ANNEX II - Identification of risks by stakeholder and Mitigation Strategies

Total risk = systematic risk + unsystematic risk. Unsystematic risk is usually managed, not measured like systematic and total risk, because financial theory assumes it could and should be either diversified away or managed contractually when systematic risk can't be transferred, diversified away, and should be managed differently and in a more sophisticated way.

Stakeholder	Risk Type	Specific Risk	MaaS-specific Risk Mitigation Strategy	
Metal Asset Owner	Systematic	Metal Price Volatility	• Implement dynamic pricing mechanisms with commodity price floors/ceilings • Diversify metal portfolio across different commodity cycles	• Use financial hedging instruments (futures, options) • Negotiate pass-through clauses for extreme price movements on the basis of the convenience yield
	Systematic	Interest Rate Risk	• Use fixed-rate financing for long-term assets • Implement interest rate swaps and caps	• Match lease duration with financing terms • Build interest rate escalation clauses into long-term leases
	Systematic	Inflation Risk	• Include inflation adjustment mechanisms in lease agreements	• Use real asset backing as a natural inflation hedge
	Unsystematic	Credit Risk (Lessee)	• Implement robust credit screening and monitoring • Require security deposits and guarantees • Use credit insurance products	• Diversify lessee portfolio across industries and geographies • Implement early warning systems for financial distress
	Unsystematic	Residual Value Risk	• Invest in advanced metal tracking and condition monitoring • Implement strict quality standards and inspection protocols • Use predictive analytics for residual value estimation	• Require lessee compliance with usage guidelines • Partner with certified recyclers for value recovery assurance
	Unsystematic	Asset Recovery Risk	• Implement blockchain-based asset tracking systems • Use IoT sensors for real-time location monitoring • Establish legal frameworks with clear recovery rights	• Pre-negotiate with certified recycling partners • Require asset location disclosure and access rights • Consider developing regional recovery hubs
	Systematic	Environmental Regulation	• Stay current with regulatory developments • Design compliance into lease agreements	• Partner with certified environmental service providers • Maintain regulatory compliance reserves
	Systematic	Trade Policy Risk	• Diversify geographically across trade zones • Monitor trade policy developments actively	• Build flexibility into supply chain arrangements • Use political risk insurance where appropriate
	Unsystematic	Obsolescence Risk	• Focus on metals with broad industrial applications • Implement technology roadmap monitoring	• Build upgrade and substitution rights into leases • Maintain relationships with metal processors and recyclers for recycling options

Stakeholder	Risk Type	Specific Risk	MaaS-specific Risk Mitigation Strategy	
Metal Lessee	Systematic	Metal Price Volatility	• Lease metal using MaaS to avoid exposure to fluctuating metal prices.	
	Systematic	Economic Downturn	• Build flexible lease terms with volume adjustments • Negotiate payment deferrals and restructuring options	• Maintain adequate working capital reserves • Diversify revenue streams and customer base
	Unsystematic	Operational Cash Flow	• Align lease payment schedules with revenue cycles • Negotiate seasonal payment adjustments	• Maintain credit facilities for working capital • Use revenue-based lease structures where possible (tracking the recurrent revenue cash flows of the lessee)
	Unsystematic	Supply Disruption	• Build buffer inventory (metal stock) within lease agreements (leasing more than required as a cautionary buffer) • Establish backup supply arrangements	• Implement supply chain traceability systems • Negotiate service level guarantees with Asset Owners
	Unsystematic	Quality Risk	• Establish clear quality specifications in lease agreements • Implement incoming quality inspection protocols	• Negotiate quality guarantees and replacement rights • Use certified suppliers and quality management systems
	Systematic	Product Liability	• Clarify liability allocation in lease agreements • Use comprehensive product liability insurance	• Implement quality assurance and documentation systems • Negotiate indemnification clauses where appropriate
	Unsystematic	New Process Integration Risk	• Conduct thorough technical due diligence • Implement phased integration approaches	• Invest in process flexibility and adaptability • Maintain close technical collaboration with suppliers
Financier	Systematic	Metal Price Volatility	• Use sophisticated commodity risk models • Implement dynamic loan-to-value ratios	• Require additional collateral for high-risk metals • Use commodity-linked interest rates
	Systematic	Interest Rate Risk	• Use asset-liability matching strategies • Implement interest rate risk management tools	• Build rate sensitivity into loan pricing • Maintain diversified funding sources
	Unsystematic	Counterparty Credit Risk	• Implement enhanced due diligence for MaaS models • Use specialized MaaS risk assessment frameworks	• Require operational performance covenants • Monitor real-time asset utilization and performance
	Unsystematic	Asset Recovery Risk	• Require asset tracking and monitoring systems • Pre-arrange relationships with metal recyclers	• Use asset recovery specialists and legal frameworks • Maintain asset recovery insurance coverage
	Systematic	Basel III/IV Requirements	• Maintain strong capital ratios above regulatory minimums • Use regulatory capital optimization strategies	• Monitor regulatory developments and impact • Engage with regulators on MaaS-specific issues
	Unsystematic	Due Diligence Risk	• Develop MaaS-specific risk assessment expertise • Use specialized advisors and consultants	• Implement comprehensive due diligence checklists • Build industry knowledge and benchmarking capabilities

Table 7. **Stakeholder-specific risk and mitigation strategies**

ANNEX III - Covered Bonds and ABS Structures

Financing MaaS contracts using Covered Bonds

Covered bonds are securities issued by Banks that are 'covered' by a 'pool' of collateral. In the case of MaaS, the SPV would partner with a bank to issue Covered bonds to investors by securitizing and collaterizing MaaS contracts.

The ownership of the metal remains with the SPV, who is responsible for the creation and management of all MaaS leases.

Covered bonds typically incur lower transaction costs but pose greater risk for the bank since MaaS leases will remain on the bank's balance sheets, which is why banks will need to actively manage collateral by removing non-performing leases and replacing them with cashflowing leases.

In the context of MaaS, this model comes with one of the lowest costs of capital and allows a MaaS SPV to inherit the credit rating of the bank which can be beneficial in the scaling stages of MaaS.

At Maturity, a balloon payment will be expected of the principal. To avoid working capital issues for the SPV the tenor for the Covered Bond should match the duration of the MaaS lease (including timelines for successful recovery of metal).

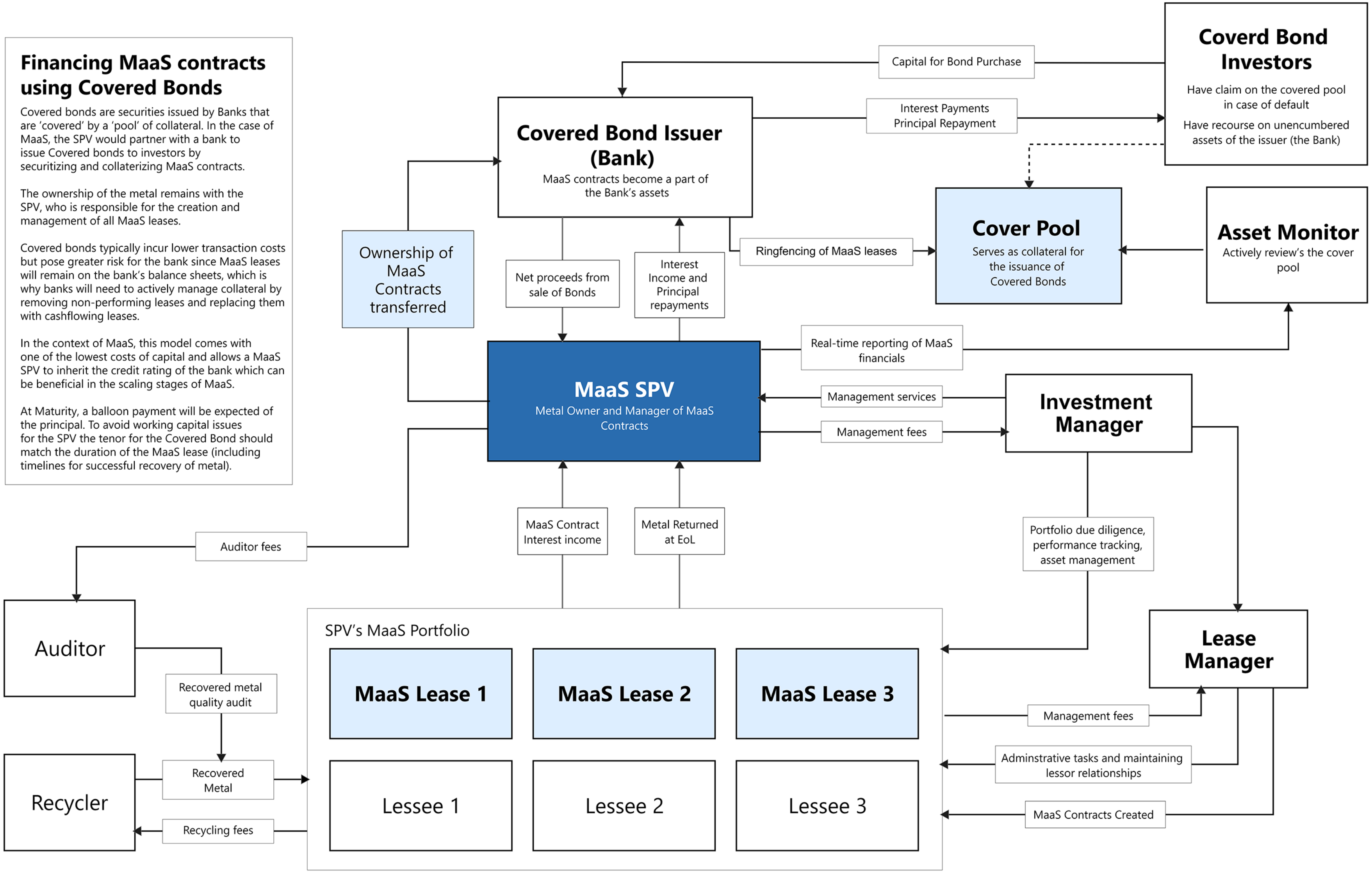


Figure 19. Structuring MaaS contracts using Covered Bonds

In the covered bonds model, an SPV partners with a bank to issue securities collateralized by a pool of MaaS contracts, with the bank bearing significant credit risk because the leases remain on its balance sheet, and investors can claim the bank's other assets in case of default. At the same time, covered bonds offer low cost of capital as the SPV inherits the credit rating from the bank.

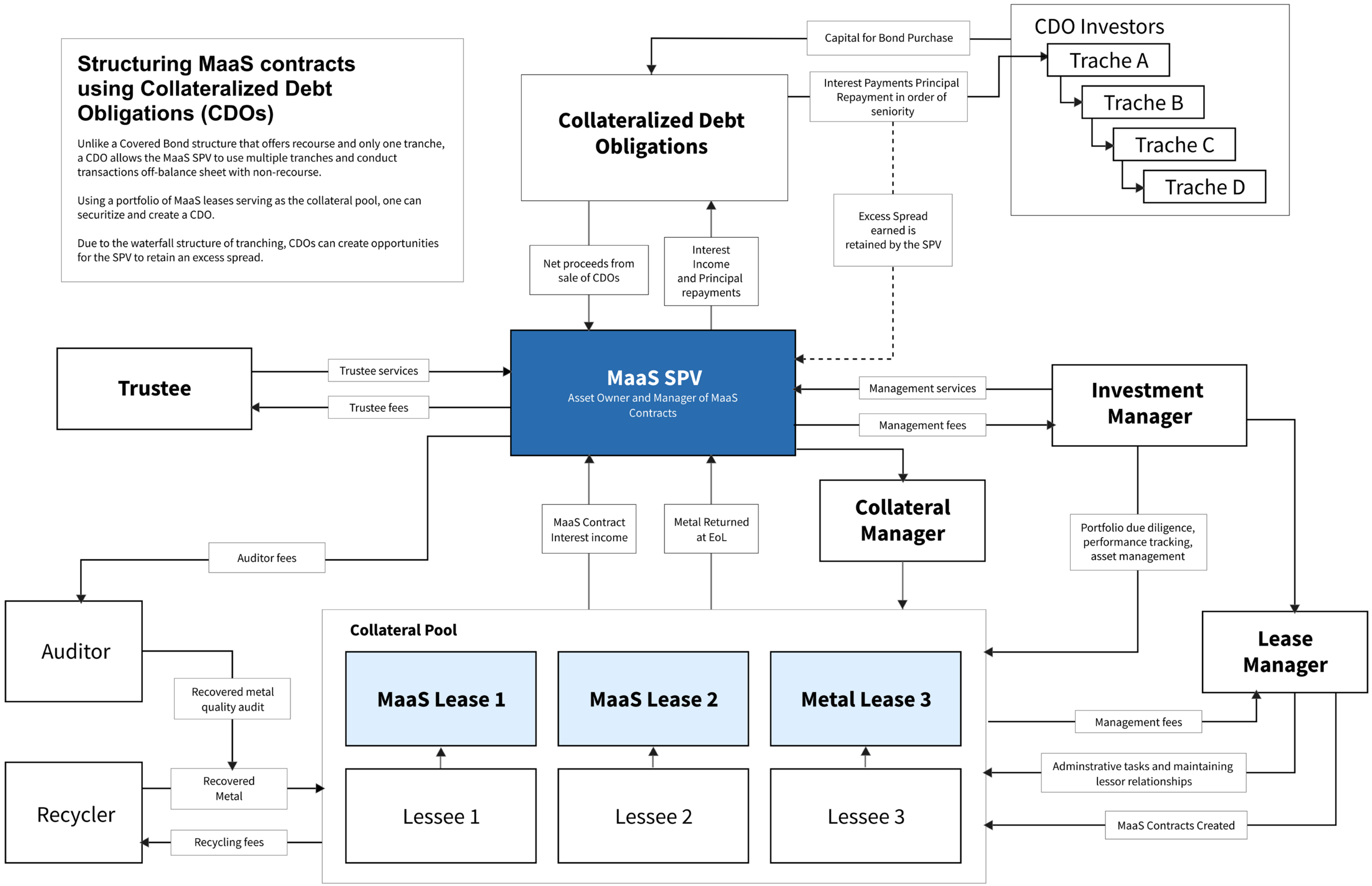


Figure 20. Structuring MaaS SPV contracts using Collateralized Debt Obligations (CDOs)

Unlike a Covered Bond, a CDO uses multiple tranches, operates off-balance sheet, and is non-recourse. If an MaaS SPV issues debt backed by MaaS leases, it creates a CDO. The tranche waterfall lets a CDO generate excess spread. The SPV can structure debt so that the average interest paid is lower than the interest earned from MaaS lessees.

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