

SPARC White Paper

SPARC lets lower-emission generators fulfill defined delivery bands inside existing coal PPAs, shifting production one MWh at a time while the underlying contracts remain in force.

SPARC Labs

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Draft for Stakeholder Consultation (Not for Citation or Distribution) This document is a working draft for structured engagement with stakeholders across the power, finance, and regulatory sectors. It presents a concept under active development and does not represent a final position on any element of the proposed mechanism. All definitions, formulas, institutional roles, regulatory pathways, and economic parameters described herein are indicative and subject to revision based on feedback received. Nothing in this document constitutes a commitment, proposal, or offer by any party. Readers are invited to engage critically with the content and to treat all aspects as open for discussion.

I. Executive summary

Southeast Asia's power sector faces a dual challenge: rapid demand growth and the need to decarbonize grids dominated by coal. A key barrier to introducing new renewable energy (RE) capacity is the prevalence of long-term coal power purchase agreements (PPAs) that guarantee offtake for coal-fired power plants (CFPPs). These contracts lock in both capacity and energy entitlements (MW and MWh) from legacy generators. In several markets, this has resulted in high reserve margins and contracted generation volumes that exceed short-term system needs. For example, the Philippines' grid in 2025 generated roughly 100,000 GWh with over 75% from fossil fuels, and Thailand's reserve margin exceeds 40%. Under these conditions, adding low-cost solar or wind capacity does not automatically reduce coal output. Coal plants hold legally granted rights to supply and be paid for contracted volumes, and consumers remain obligated to pay for those even when cheaper renewable energy is available.

In effect, many grids are legally and contractually full: the production slots are allocated through long-term PPAs. Simply adding new renewable capacity to this structure creates overlapping contractual obligations rather than displacing existing ones. The current market architecture, therefore, lacks a mechanism to reallocate contractual production rights within existing PPAs. A new approach is required that operates within these contracts and enables a gradual redirection of energy production to low-carbon generators, without waiting for PPAs to expire or undertaking costly full plant buyouts.

The structural rigidity of dispatch is reinforced by financial rigidity. Much of the regional coal fleet is relatively young and still recovering invested capital through contracted cash flows. These plants were financed on the expectation of long-term PPA-backed revenue streams. Accelerated retirement, therefore, implies either stranded capital or large-scale compensation through public or concessional finance. This slow capital turnover cycle blocks rapid reallocation of investment toward renewable and storage assets. Any transition mechanism must therefore address not only dispatch constraints, but also the preservation and orderly recycling of contractual cash flows. A viable solution must enable capital recovery for legacy assets while redirecting future energy performance toward lower-carbon technologies.

KEY POINT

With this paper, we introduce **SPARC**, short for **Supply of Power And a Right to emit Carbon**, as a market-based mechanism for reallocating contracted coal generation to lower-emission delivery without terminating the underlying PPA

SPARC works through registered **SPARC streams**. A SPARC stream is a defined delivery band inside an existing coal PPA that an approved delivery party agrees to fulfill. It carries the rights and obligations of that band: the right to supply power, the right to get paid, and the embedded right to emit carbon dioxide, along with the corresponding availability and delivery obligations. These rights were previously inseparable from the PPA itself. SPARC makes them transferable.

A SPARC is created when one eligible MWh is delivered under a SPARC stream and evidenced through the required metering and attribute systems. Production shifts from coal to lower-emission generators at the level of the delivered MWh, while the original PPA remains intact. Where the delivering generator produces lower emissions than allowed, the unused portion is issued as an **ARC, an Avoided Right to emit Carbon**.

Rather than relying on broad mandates or retirement deals focused only on capacity, SPARC offers a dispatch-focused, economically grounded approach tied to the contractual reality of existing PPAs. It identifies specific bands in coal PPAs that can be replaced by cleaner and lower-cost generation and creates a market instrument to manage that substitution. SPARC supports a gradual phase-down of coal rather than an all-or-nothing retirement. It shifts production from high to low-carbon sources one MWh at a time, avoiding the large capital requirements, delays, and political resistance associated with full plant retirements. Because emissions depend on actual generation rather than installed capacity, this mechanism directly reduces verified emissions.

SPARC provides a dispatch-focused mechanism grounded in the contractual reality of existing PPAs. It converts monolithic generation rights into tradable SPARC streams, each reflecting the contractual value of the underlying agreement, including both energy and allocated capacity components. SPARC streams can be transferred to generators able to fulfill the obligation with lower emissions while preserving the economic position of incumbent right holders.

The mechanism enables a gradual phase-down of coal without binary retirements or full PPA buyouts. As contractual MWh are delivered by lower-carbon generators, fossil load factors decline while capacity availability and fixed-cost recovery remain intact. Emissions fall because verified delivery shifts, consistent with the principle that climate impact follows generated MWh rather than installed capacity.

KEY POINT

Crucially, SPARC distinguishes between energy (MWh) and capacity (MW), focusing on dispatch shifts rather than capacity buy-outs.

This allows coal-fired power plants to remain available for grid stability while their annual load factor is progressively reduced toward minimum stable load levels through market-based trading, until the point at which the complete shutdown of the least efficient plant becomes economically feasible. By aligning the incentives of fossil incumbents, renewable entrants, and regulators, SPARC provides a commercially realistic pathway toward national climate targets without compromising energy affordability or grid reliability.

KEY POINT

Importantly, the mechanism is designed to operate without increasing customer costs. The economic headroom stems from the fact that renewable generation is often cheaper than the fossil fuel it replaces.

Additional value can be realized through monetized carbon benefits and, where applicable, grid-related benefits from improved injection points or reduced congestion. Together, these value streams enable emission reductions while keeping overall system costs neutral or lower, aligning economic and environmental objectives.

SPARC is designed for immediate implementation under sovereign control and within the framework of existing contractual rights and granted operating licenses. It is intended to use established energy-attribute tracking infrastructure and registry governance principles, potentially through an I-TRACK product code. SPARC aligns with recognized market principles while remaining directly applicable to Southeast Asian regulatory contexts. The

mechanism is particularly suited to jurisdictions where meeting enhanced climate targets, such as increasing the share of renewable generation, requires near-term displacement of large volumes of coal-fired generation.

2. The structural problem SPARC addresses

2.1 Structural barrier in existing power markets

Progress in decarbonizing the power sectors of Southeast Asia and other emerging economies remains critically slow despite the plummeting leveled costs of solar, wind, and storage technologies. The fundamental barrier is not technological or financial, but contractual. Many Southeast Asian power systems sit in a combined condition that slows decarbonization even when renewable energy costs fall: electricity demand growth remains strong, fossil fleets remain relatively young, and contractual structures often protect fossil dispatch through long-term PPAs with minimum offtake and revenue guarantees.

The vast majority of coal-fired generation is protected by long-term PPAs or Power Supply Agreements (PSAs, for the purpose of clarity we stick to the term PPA) that grant fossil generators guaranteed offtake for twenty to twenty-five years. In markets such as Thailand and the Philippines, these agreements have resulted in high reserve margins – often exceeding 40% – where the system is already oversupplied with contracted fossil production rights.

These PPAs result in a "contractually saturated" grid. Even in markets with existing renewable energy (RE) priority dispatch policies, such as the Philippines, the system remains effectively occupied by long-term fossil obligations. This creates a "lock-in" effect where new, cleaner generation is often not permitted more because the grid's legal and physical capacity is already claimed by the existing coal fleet. Under current structures, adding more RE capacity without a mechanism to directly reduce fossil dispatch merely increases the total cost to consumers, who must pay for new green energy while still fulfilling the availability and offtake guarantees of the idle fossil fleet.

2.2 Slow capital recycling rates

In addition to dispatch rigidity, the transition is constrained by slow capital recycling within the existing generation fleet. A significant share of coal-fired power plants in Southeast Asia was commissioned in the past fifteen years and remains within its contracted capital recovery period. These assets were financed on the basis of long-term PPAs that provide predictable cash flows to service debt and deliver expected returns to equity.

Under these conditions, early retirement is not merely a technical decision. It implies either writing down unrecovered capital or mobilizing substantial external funding to compensate investors for the loss of contracted revenue streams. Both pathways are capital intensive and politically sensitive. As a result, asset owners, lenders, and host governments have strong incentives to preserve existing cash flows until contractual terms expire.

This dynamic creates a structural mismatch. Renewable energy and storage costs have declined rapidly, yet capital remains locked in fossil assets that were financed under different cost assumptions. The transition challenge is therefore not only about replacing higher-carbon generation with lower-carbon alternatives. It is about enabling an orderly reallocation of contractual cash flows from brown assets to green assets without triggering financial loss or destabilizing balance sheets.

Absent a mechanism that operates within existing contractual frameworks, the system remains stuck between two extremes: continued fossil dispatch to preserve capital recovery, or large-scale buyouts that require external subsidies. A scalable transition pathway must address this slow capital turnover directly and allow value to shift at the margin rather than through binary closure events.

2.3 Dispatch constraint and contractual rigidity

Climate policy often focuses on installed capacity (MW), yet emissions are exclusively a function of dispatched energy (MWh). Existing regulatory frameworks lack a mechanism to reallocate marginal dispatch in real time based on carbon intensity. In a typical single-buyer or bilateral market, dispatch is dictated by the merit order, but in systems dominated by "must-run" or "take-or-pay" coal contracts, the merit order is effectively frozen by contractual obligations.

Even when RE is theoretically cheaper, it often lacks the legal mechanism to acquire the "production slots" held by fossil generators. This rigidity prevents the power system from benefiting from the "sustainable abundance" of renewables – where marginal production costs are effectively zero. The system currently lacks a granular instrument to shift production rights, leaving the grid stuck in a binary state between full coal operation and full (and expensive) coal retirement.

2.4 Limits of binary early retirement models

Current models for early coal phase-out, such as the Energy Transition Mechanism (ETM) or various transition credit pilots, generally require a full buy-out of the PPA to enable early closure. These binary models face several challenges:

CHALLENGE	IMPACT ON TRANSITION
Capital Intensity	Requires massive upfront liquidity to pay the Net Present Value (NPV) of remaining PPA cash flows.
Complexity	Preparation timelines are typically 3–5 years, involving complex restructuring of debt and equity across multiple stakeholders.
Political Economy	Creates a concentrated "loser" in the CFPP operator, leading to lobbying against transition. Binary closure also raises immediate energy security fears.
Leakage Risk	If a plant is shuttered entirely, there is no inherent guarantee that the generation won't be replaced by other, potentially less efficient, fossil reserve capacity on the grid.
Sunk cost	The purchaser of the PPA under an ETM transaction is "throwing away" a granted right, thus absorbing the full cost of doing so, increasing the cost of transition and reducing the scalability of this mechanism as the full cost of this purchase needs to be transferred to carbon credit buyers, pricing them out of the market.

2.5 Policy conflict

Governments in emerging markets are trapped in a policy conflict. They must meet rising electricity demand driven by industrialization and population growth while simultaneously adhering to their Nationally Determined Contributions (NDCs) under the Paris Agreement. Grid congestion and brown-out risks are ever-present, making regulators hesitant to remove any baseload capacity.

The conclusion is evident: the current power system architecture lacks a mechanism to decarbonize the baseload incrementally. There is no contractual flexibility to shift dispatch at the margin, and there is no instrument that facilitates a graceful, profitable phase-down of coal assets. SPARC is designed to resolve this trajectory conflict by providing a market-based bridge between today's fossil-heavy reality and a carbon-neutral future.

3. What is SPARC

3.1 SPARC streams and SPARCs

SPARC is built around two distinct layers: the SPARC stream and the SPARC.

A **SPARC stream** is the registered basket of rights and obligations attached to a defined delivery band inside an existing coal PPA. It carries the right to supply power under that band, the right to receive the associated payment, and the embedded right to emit carbon dioxide per MWh delivered, along with the corresponding availability, delivery, and capacity obligations where applicable. The SPARC stream is the forward object: it exists once the coal operator and the approved delivery party have agreed the terms and the stream has been recognized by the relevant regulator, system operator, or registry process. The rights it carries were previously inseparable from the coal PPA. SPARC makes them transferable.

A **SPARC** is the MWh-level record created when one eligible MWh is delivered under a registered SPARC stream and evidenced through the required metering and attribute systems. SPARCs arise from energy delivery. One produced MWh creates one SPARC. The number of SPARCs that exist under a stream at any point is therefore determined entirely by actual dispatch, metering, and verification.

The lifecycle is direct: the SPARC stream is registered, eligible MWh are delivered, SPARCs are created, eligible renewable-energy evidence is linked where the delivery is renewable, and ARCs are issued where the embedded emission right is unused.

3.2 The Avoided Right to emit Carbon (ARC)

An ARC is the unused emission right from a SPARC.

Each SPARC carries an embedded emission right expressed in tCO₂/MWh. Its legal or contractual character arises from an approved PPA-linked, regulatory, ETS, or host-country basis. Its quantity is established separately through an approved plant-specific emission factor or plant-specific legal allocation for the originating coal plant. When a SPARC is created from eligible delivery, the registry compares that embedded emission right against the verified emissions of the delivered MWh. Where verified emissions are lower, the difference is issued as an ARC.

The ARC does not rely on a modeled counterfactual. The embedded emission right exists in the registered SPARC stream before any delivery occurs, established by the originating plant's approved emission factor and recognized through the SPARC product code and the applicable host-country framework. When a SPARC is created from lower-emission delivery, the unused portion of that right is recorded as an ARC. The ARC is the registry evidence of an emission right that was held and not used.

3.3 Three records, three claims

A complete SPARC transaction involves three linked records or instruments. Each evidences a different fact about the same underlying event. They are linked but carry separate claims.

The **SPARC** records that the delivered MWh fulfilled a registered delivery band inside an existing coal PPA. It links the MWh to the originating contract, the delivery party, the payment right, and the embedded emission right. The SPARC does not itself establish the generation source. Where the delivery is renewable, that attribute is evidenced separately through an eligible REC or equivalent energy-attribute certificate.

The **Renewable Energy Certificate (REC) or equivalent energy-attribute certificate** evidences that the delivered MWh was generated from a qualifying renewable source. Under SPARC, eligible REC or equivalent evidence is linked to each SPARC created from renewable delivery. It confirms the renewable attribute of that MWh but says nothing about the contractual context of the delivery or the emission right attached to it.

The **ARC** records the unused emission right from that SPARC. It is issued when the verified emissions of the delivered MWh are lower than the embedded emission right carried by the SPARC. The ARC documents a specific quantity of emission right that was held under an existing contract, operating license, ETS allocation, or host-country-recognized framework and was not exercised.

Each record supports a different claim. The single SPARC claimant registered for the delivered MWh may rely on the SPARC as evidence that the MWh fulfilled the identified coal-backed stream. The SPARC is not held in an account, transferred, or redeemed. A party holding the eligible REC or equivalent certificate may claim the renewable attribute of the MWh according to the rules of that certificate system. A party holding the ARC may claim the unused emission right. A party claiming renewable coal-band substitution must be the registered SPARC claimant and control the relevant renewable-energy evidence. Making broader claims requires control of the relevant linked records or instruments. This claim discipline prevents double counting across energy attribute, contractual delivery, and emission-right accounting.

3.4 Core design features

From monolithic contract to defined delivery bands

A long-term PPA is structurally rigid. It assigns the entire contracted generation or capacity obligation to a single plant for the full duration of the contract. There is no mechanism within a conventional PPA to reallocate a portion of that obligation to a different generator, to adjust it seasonally, or to let another producer fulfill part of it. The contract is treated as a single indivisible block.

SPARC disaggregates it. By registering defined delivery bands inside the existing PPA as SPARC streams, the mechanism converts a monolithic contract into a set of defined, separately assignable streams of rights and obligations. Each stream carries its own delivery band, payment right, and embedded emission right. Each may be assigned to a different approved delivery party. The underlying PPA remains intact; what changes is that its performance can now be fulfilled by more than one generator, across more than one stream, without renegotiating the contract itself.

This is the foundational flexibility SPARC introduces. The coal operator does not need to sell the plant or surrender the PPA to enable a transition. It defines a band, registers a stream, and assigns fulfillment of that band to a renewable operator. The rest of the PPA continues unchanged.

Dispatch shifts through delivery, not retirement

When a renewable operator fulfills a SPARC stream, it can offer or schedule eligible MWh at its own delivery cost under the applicable market rules. In systems where dispatch reflects marginal cost, renewable delivery is likely to clear ahead of coal generation with positive fuel cost. In other market structures, the same effect is achieved through the approved scheduling, nomination, or settlement process for the registered stream. Dispatch shifts at the margin without shutting down plants or restructuring entire PPAs. Production reallocates one MWh at a time.

The SPARC stream carries the full contract value

The SPARC stream embodies the contractual revenue associated with the defined delivery band, including both energy payment and any capacity-linked component allocated to the stream. That value is shared between the

coal operator and the delivery party according to the stream agreement. The coal operator avoids costs and reduces selected risks; where the delivery party assumes the matching firm obligation, released capacity or availability value may support the delivery payment. The delivery party receives payment for fulfilling the band and bears the defined performance obligations. Fixed-cost recovery remains with the coal operator unless the stream genuinely avoids a corresponding cost or the delivery party assumes a matching obligation that allows capacity or availability value to be released.

Capacity remains intact

SPARC does not transfer ownership of MW capacity. It reallocates fulfillment of a defined delivery band, including capacity-related obligations where these are part of the stream. It does not reduce nameplate capacity, alter reserve margin calculations, or change availability obligations. Plants remain in the system and continue to provide capacity under the regulatory framework. What changes is the annual load factor. As SPARC streams are established and fulfilled, coal plants produce fewer MWh while remaining available. This preserves reliability while allowing gradual production decline.

Contribution margin discipline

A coal operator will assign fulfillment of a SPARC stream when the expected retained value under the stream agreement is at least equal to the value of self-fulfillment, after accounting for avoided fuel cost, retained margin, risk relief, and any released capacity or availability value. A renewable operator will fulfill a stream when delivery payment, allocated ARC value, and recognized grid value are sufficient to cover its cost of delivery and risk. Price discovery therefore reallocates production rights toward lower-cost or lower-carbon generators. The mechanism targets the short-run production decision embedded in each MWh, not the long-run ownership of MW capacity.

By focusing on energy rather than capacity, SPARC changes what is produced before it changes what is owned. Emissions fall because production shifts, not because capacity is forcibly retired.

4. Operational mechanics and dispatch logic

The mechanics described in this section reflect the current design hypothesis for SPARC. They remain subject to refinement through stakeholder consultation, regulatory review, and testing against real market structures.

4.1 Power market principles relevant to SPARC

A few power-market principles are useful to refresh before turning to the operational mechanics of SPARC.

Electricity is produced in real time and must be matched continuously with demand. Physical delivery is therefore coordinated through dispatch, scheduling, nomination, or another system-approved process, depending on the market design. The transmission system operator, system operator, or market operator determines which resources are accepted for delivery into the grid in each interval, either directly through centralized dispatch or indirectly through market and grid rules. Power producers have a clear commercial interest in being available and producing as much as their contracts, plant conditions, and market position allow. Actual MWh delivered to the grid, however, are determined by the applicable dispatch and settlement process and confirmed through metering.

PPAs define the commercial framework under which generation is made available, delivered, and paid. In an energy-only PPA, payment is mainly tied to MWh delivered. In a capacity-plus-energy PPA, the generator may receive a capacity payment for making MW available and an energy payment for MWh delivered. These structures differ in settlement form, but both combine commercial rights with performance obligations.

This operating logic defines the basic SPARC structure. The SPARC stream is the forward object: a registered delivery band inside an existing coal PPA. The SPARC is the MWh-level record created when eligible electricity is delivered under that stream. The parties agree in advance which band the approved delivery party will fulfill; actual SPARCs arise from delivery, metering, and evidence.

4.2 SPARC stream agreement

The commercial starting point is the SPARC stream agreement between the coal operator and the renewable operator or other approved delivery party. The parties define the band that the delivery party will fulfill and the economic rules that apply when eligible MWh are delivered under that band.

The SPARC stream may take any structure the parties agree, subject to approval by the relevant regulator, system operator, or registry process. It may be expressed as a fixed MW band over a daily delivery window, a seasonal block, a dispatch-linked block, or another defined performance band. In the main case, the coal-fired power plant operator remains the contractual counterparty to the utility, regulator, and system operator, while the approved delivery party fulfills the agreed stream (alternative models are discussed in Section 4.10).

The SPARC stream agreement specifies:

- the delivery band and term;
- the availability, scheduling, and performance obligations of the delivery party;
- the treatment of non-delivery, imbalance, replacement power, and penalties;
- the payment-sharing mechanism between the coal operator and the delivery party;
- the embedded emission right per MWh;
- the allocation of ARC value;
- the consequences of transfer, default, or replacement of the delivery party.

Under the preferred bilateral subcontracting model, the coal operator continues to receive the PPA payments from the offtaker or market operator. It then pays the delivery party according to the SPARC stream agreement. The delivery party is compensated for fulfilling the agreed band, while the coal operator retains the agreed share of the PPA value and avoids fuel, variable operating cost, and selected performance risks for the MWh it no longer produces.

The agreement may express payment as a capacity-linked service fee, a per-MWh delivery fee, a revenue-sharing formula, or a combination of these elements. In all cases, the commercial logic is anchored in the value of the agreed stream and the MWh actually delivered under it.

The SPARC stream agreement is then submitted for the applicable regulatory, system-operator, or registry recognition. Once recognized, the agreed stream becomes a registered SPARC stream under the SPARC framework.

MECHANISM NOTE

SPARC stream

A SPARC stream is the registered basket of rights and obligations attached to a defined delivery band inside an existing coal PPA. It includes the right to supply power under the band, the right to receive the associated payment, and the embedded right to emit carbon. It also carries the corresponding obligations, including availability, scheduling, delivery, replacement-power, and capacity obligations where these are part of the underlying PPA or the SPARC stream agreement. Individual SPARCs are created only when eligible MWh are delivered under the stream and evidenced through the required metering and attribute systems.

4.3 Conversion and registration

The conversion phase establishes the legal, operational, and registry foundation for the agreed SPARC stream without altering the physical characteristics of the generation asset or terminating the underlying PPA.

Regulatory authorization

The operational lifecycle proceeds through regulatory recognition of the SPARC stream. The regulator, system operator, or equivalent authority confirms that the agreed band within the existing PPA may be fulfilled by an approved substitute generator under the SPARC framework.

This authorization defines:

- the originating PPA and eligible coal unit;
- the MW band and delivery window;
- the term of the SPARC stream;
- the approved delivery party;
- the dispatch, scheduling, or nomination rules applicable to the stream;
- the metering and evidence requirements;
- the embedded emission right per MWh;
- the rules for ARC issuance and allocation.

The regulator confirms that the SPARC stream does not terminate or invalidate the original PPA. The conversion restructures the method through which a defined part of the PPA is fulfilled. The coal-fired power plant operator remains the formal PPA counterparty, while the approved delivery party assumes the operational obligation for the registered stream according to the SPARC stream agreement.

Registry registration

Upon authorization, the SPARC stream is recorded in the SPARC registry. The registry records the stream parameters, the parties, the originating PPA, the approved delivery band, the embedded emission right, and the evidence required for SPARC and ARC creation.

A SPARC is created when one eligible MWh is delivered under the registered stream and evidenced through the required metering and attribute systems. The number of SPARCs created under a stream is therefore determined by actual dispatch, delivery, and verification.

This structure keeps the registry aligned with power-system operation. The PPA defines the contractual framework, the SPARC stream defines the delivery band, and metered delivery creates the MWh-level SPARC record.

Preservation of economic integrity

Conversion preserves the total contract value associated with the relevant PPA band while enabling operational flexibility.

- The underlying PPA remains legally intact.
- The coal-fired power plant operator remains the grid-facing contractual party.
- The renewable operator or other approved delivery party fulfills the registered SPARC stream.
- The parties share the value attached to the stream according to their commercial agreement.
- The embedded emission right is tracked for each MWh delivered under the stream.

The plant continues to exist as a contracted asset within the system. What changes is the method through which part of the contracted energy performance is fulfilled. The coal operator can preserve its contractual position and retain a negotiated share of value, while the delivery party receives compensation for delivering the agreed band and may receive ARC value according to the stream agreement.

This structure enables gradual reallocation of production without full contract termination, debt restructuring, or upfront plant retirement. It creates flexibility at the level of delivered MWh while maintaining contractual and regulatory stability at the level of the PPA.

4.4 Dispatch and delivery

Dispatch remains under the authority of the grid or system operator. SPARC does not override dispatch rules, reliability requirements, or system security constraints.

The approved delivery party is positioned to deliver under the registered SPARC stream. Depending on the market design, delivery may occur through bidding, scheduling, dispatch instruction, bilateral nomination, or another approved mechanism. The SPARC framework defines how eligible delivery is recorded once it occurs.

When the approved delivery party delivers one eligible MWh under the registered stream, one SPARC is created in the registry.

A SPARC records:

- one metered MWh delivered under a registered SPARC stream;
- the originating coal PPA and delivery band;
- the delivery party and delivery interval;
- the payment right associated with that MWh under the stream agreement;
- the embedded emission right associated with the originating coal PPA.

The SPARC is created as a completed MWh record. Delivery and SPARC creation occur in the same operational event. No separate pre-dispatch issuance or later redemption step is required for the MWh-level SPARC.

4.5 Evidence of renewable delivery

Where the SPARC stream is fulfilled by renewable generation, the delivered MWh must be evidenced through metering and an accepted REC or equivalent energy-attribute certificate.

The initial Product Code version 0.2.1 supports renewable delivery only. Other lower-emission sources remain outside the base Product until a later Product Code revision defines their source, emissions, and claim requirements.

The REC or equivalent certificate evidences the renewable MWh. The SPARC records that this renewable MWh fulfilled a registered delivery band inside an existing coal PPA. The two records are linked but carry different attributes.

The REC or equivalent certificate confirms the renewable generation attribute of the MWh.

The SPARC confirms the contractual origin of the MWh-level delivery under the coal PPA stream.

The SPARC product code defines how eligible REC or equivalent evidence is linked, tagged, retired, cancelled, or otherwise referenced when used as evidence for SPARC creation. This claim discipline prevents the same renewable MWh from supporting inconsistent claims in different markets. A party may claim the renewable attribute according to the rules of the relevant certificate system. A party may claim the unused emission right according to SPARC and ARC rules. Claims over both attributes require control of the instruments required for both claims.

4.6 Carbon outcome: ARC

An ARC is the unused emission right from a SPARC.

Each SPARC carries an embedded emission right expressed in tCO₂/MWh. Its legal or contractual character is established through an approved PPA-linked, regulatory, ETS, or host-country basis. Its quantity is established separately through an approved plant-specific emission factor or plant-specific legal allocation for the originating coal plant under the SPARC product code.

When a SPARC is created from lower-emission delivery, the registry compares the embedded emission right of the SPARC with the verified emissions associated with the delivered MWh.

$ARC_{QUANTITY}$ is calculated as:

$$ARC_{QUANTITY} = Embedded_Emission_Right - Verified_Delivery_Emissions.$$

Only positive differences result in ARC issuance. For renewable delivery, verified operational emissions may be minimal, depending on the approved accounting boundary. In that case, the ARC normally represents most or all of the embedded emission right carried by the SPARC.

ARC issuance is rule-based. Once the SPARC stream, embedded emission right, metered delivery, and renewable evidence have been verified, the ARC can be issued according to the product code. The relevant reference point is not a discretionary hypothetical baseline. It is the coal-backed production and emission right recorded in the registered SPARC stream.

The ARC is issued to the account designated in the SPARC stream agreement, subject to product-code rules and host-country requirements. The recipient may be the renewable operator, the coal operator, a jointly controlled

account, or another nominated beneficiary. The commercial allocation of ARC value is negotiated by the parties, while ARC issuance remains governed by the registry and the host-country framework.

4.7 Domestic and international use of ARCs

ARCs can serve different functions depending on the host-country framework.

In a domestic setting, ARCs may record unused emission rights, support power-sector emissions accounting, provide an incentive for coal-to-clean substitution, or interact with a domestic ETS or carbon pricing system.

Where a formal ETS exists, an ARC may be backed by an unused ETS allowance or allocation. ARC issuance should then be linked to cancellation, withdrawal, or equivalent treatment of the underlying emission right so that the same tonne cannot be used elsewhere.

Where no ETS exists yet, an ARC may be backed by a PPA-linked emission right recognized under the SPARC product code and by the host government. This allows SPARC to operate as a bridge toward a future ETS by identifying coal-backed production rights, assigning embedded emission rights, and recording their non-use when renewable generation fulfills the stream.

For international use, host-country authorization is required. The government may define ARCs as eligible for international transfer, subject to verification, registry controls, no-double-counting safeguards, and corresponding adjustments where required. This can create an investable class of unused emission rights linked to verified coal-to-clean substitution. International buyers may value ARCs because they are tied to a specific coal-backed production right, a delivered lower-emission MWh, and a recorded reduction in coal generation. This allows international carbon finance to support renewable firming, coal dispatch reduction, and ETS readiness while preserving sovereign control over NDC accounting.

SPARC therefore gives governments a practical choice. They can retain ARCs for domestic climate targets, cancel them to tighten the power-sector emissions path, use them within a domestic ETS, or authorize selected ARCs for international transfer.

4.8 Transferability of SPARC streams

In this design, transferability attaches primarily to the SPARC stream.

A SPARC stream may be amended, assigned, novated, or transferred where the applicable rules allow it. This may be necessary if the renewable operator sells the underlying asset, restructures its portfolio, changes the delivery configuration, or is replaced by another eligible delivery party. Any change must preserve the delivery obligation, metering requirements, payment rules, and ARC allocation rules defined in the registered stream, unless those terms are expressly amended.

Changes to a SPARC stream should follow the same sequence as the original stream creation. The affected commercial parties first agree the amendment, assignment, novation, or transfer. The revised stream is then submitted for the applicable regulatory, system-operator, or registry approval where required.

Transferability should be controlled rather than open-ended. The registry records any approved change in the delivery party, stream parameters, payment rules, or ARC allocation. Confirmation by the relevant system operator, regulator, or authorized market body may be required before the revised stream takes effect.

This preserves commercial flexibility without creating a spot market in uncertain future MWh. The stream can move or be amended where continuity of performance is maintained. Individual SPARCs arise only from delivered

MWh.

4.9 Dispatch outcome

When renewable generation delivers MWh under a registered SPARC stream, the originating coal unit does not produce those MWh. The shift is visible in metered delivery data and reflected in the coal plant's lower output.

SPARC reduces coal generation by changing who fulfills the contracted energy band. It does not require immediate plant retirement, PPA termination, or full contract buyout. The coal plant remains available for reliability, while its energy output can decline over time as more SPARC streams are fulfilled by lower-emission generation.

Over time, repeated SPARC stream arrangements can reduce the annual load factor of coal plants while preserving contractual continuity and grid stability. Structural retirement may become possible later, but it is not a precondition for verified emissions reduction.

The operational sequence is direct:

- SPARC streams are registered.
- Eligible MWh delivered under a stream create SPARCs.
- REC or equivalent energy-attribute evidence confirms renewable MWh where applicable.
- ARCs record unused emission rights.
- The PPA remains intact while production shifts from coal to lower-emission generation.

Overview of instruments and records

The SPARC mechanism uses several linked records and instruments. Each has a distinct function.

ITEM	WHAT IT IS	FUNCTION IN SPARC
SPARC product code	The rulebook under which the mechanism operates.	Defines how SPARC streams are registered, how SPARCs are created, how eligible REC or equivalent evidence is linked, how embedded emission rights are calculated, and how ARCs are issued.
SPARC stream	The registered basket of rights and obligations attached to a defined delivery band inside an existing coal PPA.	Defines the forward commercial and operational arrangement between the coal operator and the approved delivery party. It carries the right to supply power, the right to receive the associated payment, the embedded right to emit carbon, and the corresponding delivery, availability, replacement-power, and capacity obligations where applicable.
SPARC	The MWh-level record created when one eligible MWh is delivered under a registered SPARC stream.	Records that a specific MWh fulfilled a specific coal-backed delivery band. It links the delivered MWh to the originating PPA, delivery party, payment right, and embedded emission right.
REC or equivalent energy-attribute certificate	The recognized evidence of renewable electricity generation.	Confirms the renewable generation attribute of the MWh used to fulfill the SPARC stream. It does not by itself record the coal-PPA substitution or the unused emission right.
Embedded emission right	The emission entitlement attached to the SPARC through an approved legal or contractual basis and quantified through a plant-specific emission factor or plant-specific legal allocation for the originating coal plant.	Defines the amount of carbon the originating coal-backed MWh would have been permitted to emit under the SPARC framework.
ARC	The registry instrument representing the unused emission right from a SPARC.	Issued when the verified emissions of the delivered MWh are lower than the embedded emission right. It may be used domestically, integrated with an ETS, cancelled, or authorized for international transfer according to host-country rules.
Host-country authorization	The sovereign approval required for international use of ARCs.	Determines whether selected ARCs may be transferred internationally and whether corresponding adjustments or other no-double-counting safeguards are required.

The distinction between these items preserves claim discipline. The REC or equivalent certificate evidences the renewable MWh. The SPARC records that the renewable MWh fulfilled a coal-backed delivery band. The ARC records the unused emission right created by that substitution.

4.10 Adoption models for CFPP participation

The operational mechanics described in Sections 4.1 to 4.9 use the bilateral subcontracting model as the base case. This is the preferred pathway for early adoption because it allows a SPARC stream to be created within the existing PPA framework while keeping the coal-fired power plant operator as the formal contractual counterparty.

Two adoption models are conceivable: bilateral subcontracting and formal PPA conversion. Both use the same SPARC product code, registry logic, SPARC creation rules, and ARC issuance logic. The difference lies in the legal standing of the delivery party relative to the underlying PPA.

Model A: Bilateral subcontracting

Under the bilateral subcontracting model, the coal-fired power plant operator retains its full legal standing as the contractual party to the utility, market operator, regulator, and system operator. The PPA is not reassigned or replaced. Instead, the CFPP operator enters into a SPARC stream agreement with a renewable operator or other approved delivery party.

The SPARC stream agreement defines the band to be fulfilled, the applicable delivery and availability obligations, the payment-sharing rules, the embedded emission right, and the allocation of ARC value. Once the stream is

recognized by the relevant regulator, system operator, or registry process, it becomes a registered SPARC stream.

The renewable operator becomes the approved delivery party for the registered SPARC stream. Its role is to fulfill the agreed band and create SPARCs through eligible, evidenced MWh delivery under that stream.

From the perspective of the offtaker, regulator, and system operator, the CFPP operator remains the grid-facing party unless the applicable jurisdiction requires a different treatment. Settlement, capacity payments, and grid interactions continue to flow through the CFPP operator's existing interfaces. The CFPP operator then compensates the delivery party according to the SPARC stream agreement.

This structure preserves the existing regulatory relationship while allowing the underlying energy performance to shift. The CFPP operator retains a negotiated share of the PPA value and avoids fuel, variable operating cost, and selected performance risks for the MWh it no longer produces. The delivery party earns the agreed compensation for fulfilling the stream, bears the defined delivery risk, and receives ARC value where the stream agreement and host-country rules allocate that value to it.

PARTY	ROLE	ECONOMIC OUTCOME
CFPP operator	PPA counterparty and SPARC stream originator	Continues to receive PPA payments through the existing interface; retains a negotiated share of value; avoids fuel, variable operating cost, and selected performance risks for delivered SPARC MWh.
Renewable operator or approved delivery party	Delivery party under the SPARC stream agreement	Fulfills the registered stream; receives agreed compensation from the CFPP operator; bears defined delivery, replacement-power, and performance obligations; may receive ARC value according to the stream agreement.
Regulator, system operator, or registry body	Recognition, dispatch, metering, and registry oversight	Recognizes or records the SPARC stream; maintains dispatch and system-security authority; confirms the evidence required for SPARC creation and ARC issuance.

MECHANISM NOTE

Lower-friction adoption pathway

Model A avoids a full replacement of the PPA counterparty. The coal operator remains the grid-facing entity, while the SPARC stream agreement defines how an approved delivery party fulfills a defined band inside the existing PPA. The mechanism still requires the relevant regulatory, system-operator, or registry recognition, but it avoids a full PPA novation as the starting point.

Open design questions for this model require validation by jurisdiction. These include whether SPARC stream agreements can be arranged bilaterally or must be tendered, whether a change in physical injection point requires separate approval, how the product code should record the distinction between the PPA counterparty and the delivery party, and how settlement data should flow between the CFPP operator, delivery party, registry, and system operator.

Model B: Formal PPA conversion

Under the formal PPA conversion model, a regulator formally recognizes the renewable operator or other approved delivery party as a contractual participant for a defined part of the PPA. The converted band becomes a SPARC stream through a formal regulatory process rather than a bilateral subcontracting structure alone.

This model may provide greater transparency and stronger legal standing for the delivery party. It may also simplify direct settlement, direct recognition of delivery obligations, and formal allocation of emission rights or

ARC value. It is therefore relevant for later-stage rollout, sandbox programs with explicit regulatory sponsorship, or markets where the regulator has already created a green substitution pathway.

The trade-off is higher transaction cost and regulatory complexity. Formal PPA conversion may require public-interest review, PPA amendment, lender consent, tariff treatment, licensing review, and a clearer decision on whether the delivery party becomes visible in the regulated settlement architecture. It may also create a risk that the wider PPA is reopened when only a limited band was intended to be converted.

Selecting a model

The choice between models depends on regulatory appetite, deal maturity, market design, and the desired legal standing of the delivery party.

Model A is the lower-friction pathway for early pilots and bilateral validation. It allows the parties to test the economics of SPARC streams while preserving the formal PPA interface. Model B is the more formal pathway for markets where regulators are ready to recognize the delivery party directly within the PPA structure.

Both models preserve the same operating principle. The SPARC stream is the forward basket of rights and obligations. Individual SPARCs are created only when eligible MWh are delivered under the registered stream. ARCs arise only when those SPARCs are created from lower-emission delivery and the embedded emission right is not used.

5. Economic incentives and value creation

SPARC economics begin with the stream agreement. The stream agreement defines how a delivery party fulfills an approved band inside an existing PPA, how payment is shared, which risks move between the parties, and how ARC value is allocated.

The economic test is direct: can the stream agreement compensate the delivery party sufficiently for performance while preserving the coal operator's financial position relative to self-delivery?

5.1 The commercial structure

SPARC creates a commercial pathway for lower-emission delivery inside an existing coal PPA. The coal-fired power plant operator remains the PPA-facing party. The offtaker, utility, or market operator continues to pay the coal operator under the existing PPA. The coal operator enters into a SPARC stream agreement with a renewable operator or another approved delivery party for a defined band inside that PPA.

The PPA remains intact. It continues to define the relationship between the coal operator and the offtaker, utility, or market operator. The SPARC stream agreement defines the relationship between the coal operator and the delivery party for the agreed band.

The stream agreement defines the delivery band, performance obligations, payment formula, risk allocation, and treatment of ARC value. The delivery party fulfills the agreed band when the applicable dispatch, scheduling, nomination, or settlement rules allow delivery under that band. The coal operator shares the PPA payments associated with the stream according to the agreed formula, retains the remaining value, and avoids costs, risks, or obligations associated with producing or supporting the relevant delivery band itself.

The economic framework tests whether the relevant value sources are sufficient to support a voluntary SPARC stream agreement:

- avoided fuel cost;
- risk relief for the coal operator;
- released capacity or availability value where the delivery party assumes the matching firm obligation;
- the delivery party's cost of lower-emission performance;
- ARC value from the unused emission right;
- any recognized grid value created by the delivery profile or injection point.

A SPARC stream clears only if these values can be shared so that the coal operator remains whole and the delivery party is paid enough to perform.

5.2 SPARC stream profiles

A SPARC stream is a defined delivery band inside an existing PPA. Its shape depends on the underlying plant, the delivery party's capability, and the operating flexibility of the power system.

For coal-linked SPARC streams, the main commercial case is likely to be a firm or near-firm band. A coal-fired power plant has limited ability to ramp around intermittent injections. It will normally require a predictable delivery obligation that reduces its own production in an orderly way. A firm daytime band, a firm twelve-hour band, a seasonal firm block, or another clearly defined availability-backed profile gives the coal operator a commercially intelligible substitute for self-delivery.

Other generating assets may support more flexible stream designs. A gas-fired plant or another rampable resource may be able to accommodate a shaped delivery profile, including a solar-shaped daily curve, because it can adjust output more easily around the delivery party's generation pattern. In those cases, the SPARC stream may be less firm, provided the stream agreement and system rules define how the originating plant, the delivery party, and the system operator manage the resulting profile. A flexible stream will often be modelled as energy-only unless the stream agreement assigns capacity or availability value to the stream and the delivery party assumes the matching firm obligation.

The stream design determines the economics. A firm band usually carries higher delivery cost and higher performance risk, but it may be more valuable to the coal operator and easier to recognize as a true substitution. Where a firm band assigns capacity or availability value to the stream, that value can be released to support delivery payment only where the delivery party assumes the matching firm obligation. Balancing, replacement-power, penalty, and performance exposure remain part of the stream agreement's cost and risk allocation. A shaped stream may be cheaper for the delivery party to perform, but it may require a more flexible originating plant or a more active settlement design.

5.3 Dispatch and settlement value

A PPA defines the commercial terms under which a plant is paid. It does not by itself determine actual dispatch in each settlement interval. Dispatch remains under the authority of the system operator, market operator, or other applicable grid process. Depending on the jurisdiction, delivery may occur through centralized dispatch, scheduling, nomination, bilateral settlement, or another approved mechanism.

This matters for SPARC economics. The value associated with a SPARC stream is not a fixed quantity of guaranteed energy revenue. It is the total PPA value assigned to the SPARC stream, expressed per eligible MWh. It

includes the expected value of payments that arise when eligible MWh are dispatched, scheduled, nominated, delivered, metered, and paid under the PPA or the applicable market rules, plus any capacity or availability value assigned to the stream.

The SPARC stream agreement therefore defines a payment formula, not merely a fixed transfer. That formula can combine several elements:

PAYMENT LAYER	DESCRIPTION
Capacity or availability component	Payment for maintaining the capability required by the stream, where the underlying PPA includes capacity or availability remuneration and the delivery party assumes corresponding obligations.
Energy component	Payment linked to eligible MWh that are dispatched, scheduled, nominated, delivered, metered, and settled under the PPA or applicable market rules.
Performance adjustments	Adjustments for non-delivery, imbalance, replacement power, curtailment, penalties, or other performance outcomes allocated under the stream agreement.
ARC allocation	Allocation of ARC value where lower-emission delivery creates an unused emission right and the product-code and host-country rules allow issuance.
Grid-value allocation	Allocation of any recognized grid value created by the delivery profile or injection point.

For analytical purposes, these components can be expressed in expected MWh-equivalent terms. This allows the parties to compare payments, costs, and risks on a common basis. The notation used below is therefore an expected-value framework. It does not imply that every payment is fixed in advance or that dispatch is controlled by the contracting parties.

Capacity and availability payments should be assigned to the SPARC stream and converted into MWh-equivalent value using expected eligible MWh for that stream. Actual dispatched MWh remain subject to the system operator. A detailed stream agreement may therefore use an expected-MWh denominator for the illustrative model and a periodic true-up if actual eligible MWh differ materially from expectation.

This stream value is defined as V_{STREAM} .

5.4 Coal operator economics

The coal operator assigns fulfillment of a SPARC stream when the arrangement preserves its economic position relative to self-delivery.

The coal operator reduces its own generation when a delivery party performs the agreed band. In return, it avoids fuel cost, avoids variable operating cost, receives risk relief where selected downside exposure moves away from it, and retains an agreed share of the stream value.

The retained value may include more than one payment layer. Where the underlying PPA includes capacity or availability remuneration, the stream agreement can allocate part of that value to the coal operator, the delivery party, or both, depending on which party assumes the corresponding availability obligation. Where the PPA includes energy remuneration, the relevant value is usually linked to MWh that are dispatched, scheduled, nominated, delivered, metered, and settled.

This distinction matters for the coal operator's floor. A firm SPARC stream may allow the coal operator to reduce performance risk and release capacity or availability value to the delivery party. A shaped or less firm stream may leave more balancing, ramping, or replacement-power exposure with the coal operator, raising the retained value it requires. The framework assumes that a rational coal operator will release capacity or availability value only

where the delivery party assumes the matching firm obligation and the coal operator preserves the value required for fixed-cost recovery, required margin, residual PPA standing, and retained obligations.

The coal operator's minimum retained value can be expressed as:

$$V_{COAL REQ} = V_{STREAM} - C_{AVOIDED} - R_{RELIEF} - V_{CAP RELEASED}$$

Where:

- V_{STREAM} is the total PPA value assigned to the SPARC stream, expressed per eligible MWh.
- $C_{AVOIDED}$ is the cost the coal operator avoids when it does not fulfill the relevant delivery band itself, including fuel, variable operating cost, avoidable emissions cost, and any fixed operating cost genuinely avoided at the stream scale.
- R_{RELIEF} is the expected coal-side downside risk no longer borne by the coal operator, expressed per eligible MWh.
- $V_{CAP RELEASED}$ is the capacity or availability value available for delivery-party payment because the delivery party assumes the matching firm obligation for the SPARC stream. It equals $V_{CAP STREAM} - V_{CAP RETAINED}$, where $V_{CAP STREAM}$ is the capacity or availability value assigned to the stream and $V_{CAP RETAINED}$ is the capacity or availability value the coal operator retains for fixed-cost recovery, debt service, required margin, residual PPA standing, retained regulatory responsibility, or retained obligations.

The coal operator is financially whole when its retained value under the stream agreement is at least equal to $V_{COAL REQ}$. If the retained value is below that level, the coal operator is better off fulfilling the stream itself.

5.5 Delivery party economics

The delivery party fulfills a SPARC stream when the value it receives is sufficient to cover delivery cost, performance risk, and required return.

For a renewable delivery party, the required value can be expressed as:

$$V_{DELIVERY REQ} = C_{DELIVERY} + R_{DELIVERY}$$

Where:

- $C_{DELIVERY}$ is the cost of eligible delivery, including generation, firming, storage, balancing, replacement power, financing premium, incremental operating cost, and compliance where applicable.
- $R_{DELIVERY}$ is the delivery party's risk premium for performance, imbalance, curtailment, replacement power, and other obligations allocated under the stream agreement.
- $V_{DELIVERY REQ}$ is the total value the delivery party needs to cover delivery cost, performance risk, and required return.
- V_{ARC} is ARC value allocated to the delivery party under the stream agreement and applicable product-code or host-country rules.
- V_{GRID} is recognized grid value allocated to the delivery party, where such value exists.

The delivery party is economically willing to perform when delivery payment, allocated ARC value, recognized grid value, or another agreed value source is sufficient to cover $V_{DELIVERY REQ}$. If ARC value or grid value is allocated to the coal operator instead, those values do not support the delivery party's economics unless the stream agreement shares that value with the delivery party.

This formulation keeps the economics tied to the stream agreement. $P_{DELIVERY}$ is the payment to the delivery party for fulfilling the SPARC stream, expressed per eligible MWh. It may take the legal form of a per-MWh delivery fee, an availability payment, a share of realized settlement value, a true-up mechanism, or a combination of these elements. ARC value and grid value are separate value sources that may top up the delivery party's position where they are allocated to the delivery party and can be monetized with sufficient certainty.

Efficient fossil or flexible delivery party

An efficient or more flexible fossil generator may also fulfill a SPARC stream where doing so allows it to capture operational efficiency gains relative to the originating plant and improve its own asset utilization under existing contractual conditions.

In this case, willingness to fulfill is determined by the delivery party's own contribution margin after accounting for fuel, variable operating expenditure, emission intensity, ramping capability, and required return discipline. The stream is fulfilled when the agreed compensation allows the delivery party to capture positive value relative to its own delivery economics.

This pathway may be relevant where full renewable substitution is not yet technically or economically feasible for a given band. It can still reduce fuel use or emissions intensity if fulfillment shifts toward a lower-cost or lower-emission resource.

5.6 Clearing condition

A SPARC stream clears when both sides can be satisfied at the same time. The coal operator must retain enough value to remain whole. The delivery party must receive enough value to perform.

In simplified form:

$$P_{DELIVERY} + V_{ARC} + V_{GRID} \geq V_{DELIVERY REQ}$$

And:

$$_{Coal Retained Value} \geq V_{COAL REQ}$$

Where capacity or availability value is assigned to the SPARC stream, it can support delivery payment only where the delivery party assumes the matching firm obligation. Flexible streams are usually modelled without this layer unless the agreement assigns capacity or availability value and the matching firm obligation to the delivery party. Firm bands may release the corresponding value where the delivery party assumes the matching firm obligation, subject to the coal operator retaining the value required for fixed-cost recovery, required margin, residual PPA standing, and retained obligations.

The maximum stream payment available while preserving the coal operator's retained value is $P_{DELIVERY MAX} = C_{AVOIDED} + R_{RELIEF} + V_{CAP RELEASED}$. The combined feasibility condition can therefore be expressed as:

$$P_{\text{DELIVERY MAX}} + V_{\text{ARC}} + V_{\text{GRID}} \geq V_{\text{DELIVERY REQ}}$$

This condition states the economic logic of SPARC. A stream agreement clears when avoided coal cost, risk relief, released capacity or availability value, ARC value, and any recognized grid value are large enough to cover $V_{\text{DELIVERY REQ}}$ while preserving the coal operator's retained value.

All variables should be expressed on a consistent settlement-period or expected eligible-MWh basis. Capacity or availability value should be allocated to the same expected eligible-MWh denominator used for delivery cost and risk, with true-up treatment defined where required.

ARC value and grid value should generally be treated as top-up value sources rather than assumed upfront revenue. The stream model should first calculate the value available from avoided fuel cost, risk relief, and released capacity or availability value, then identify any residual value that must be supplied by ARC value, recognized grid value, public support, offtaker premium, or another agreed source.

As renewable generation cost declines, storage cost declines, dispatch integration improves, and carbon value increases, the clearing range widens. This expands the feasible range for repeated SPARC stream assignment over time without requiring contract termination or forced retirement.

Further technical detail, parameter assumptions, and sensitivity analysis should be developed in supporting seller-side and delivery-side economics frameworks that use the SPARC stream as the forward commercial object and actual settlement outcomes as the basis for payment.

Framework formulas

TERM	DEFINITION	FORMULA
V_{STREAM}	Total PPA value assigned to the SPARC stream, expressed per eligible MWh	Energy value assigned to eligible MWh plus capacity or availability value assigned to the stream, net of expected performance deductions where applicable.
$V_{CAP\ STREAM}$	Capacity or availability value assigned to the SPARC stream, expressed per eligible MWh	Allocated capacity or availability payment for the SPARC stream divided by expected eligible MWh under the SPARC stream.
$V_{CAP\ RETAINED}$	Capacity or availability value retained by the coal operator	Capacity or availability value required for fixed-cost recovery, debt service, required margin, residual PPA standing, retained regulatory responsibility, or retained obligations.
$V_{CAP\ RELEASED}$	Released capacity or availability value	$V_{CAP\ STREAM} - V_{CAP\ RETAINED}$ counted only where the delivery party assumes the matching firm obligation for the SPARC stream.
$C_{AVOIDED}$	Coal cost avoided when the SPARC stream is fulfilled by another delivery party	Avoided fuel cost plus avoided variable operating and maintenance cost, avoidable emissions cost, and genuinely avoided fixed operating cost where applicable.
R_{RELIEF}	Monetized risk relief for the coal operator	Expected annual avoided downside cost divided by expected eligible MWh under the stream.
$V_{COAL\ REQ}$	Minimum retained value required by the coal operator	$V_{STREAM} - C_{AVOIDED} - R_{RELIEF} - V_{CAP\ RELEASED}$
$P_{DELIVERY}$	Payment to the delivery party for fulfilling the SPARC stream	Per-MWh fee, availability payment, revenue share, true-up, or blended compensation expressed per eligible MWh.
$P_{DELIVERY\ MAX}$	Available stream payment for delivery-party compensation while the coal operator remains whole	$C_{AVOIDED} + R_{RELIEF} + V_{CAP\ RELEASED}$
$C_{DELIVERY}$	Delivery party cost of eligible performance	Generation cost plus firming, storage, balancing, replacement-power, financing premium, incremental operations, and compliance where applicable.
$R_{DELIVERY}$	Delivery party risk premium	Expected downside cost from performance, imbalance, curtailment, replacement-power, and other obligations allocated under the stream agreement.
$V_{DELIVERY\ REQ}$	Total value required by the delivery party	$C_{DELIVERY} + R_{DELIVERY}$
$ARC_{QUANTITY}$	Unused emission right per delivered MWh	$Embedded_Emission_Right - Verified_Delivery_Emissions$.
$NET_{ARC\ PRICE}$	Net price used to value ARC quantity	Gross carbon price adjusted for issuance probability, authorization probability, registry fees, transfer discounts, transaction costs, and any required host-country or other sharing.
V_{ARC}	ARC value allocated to the delivery party	$ARC_{QUANTITY} \times NET_{ARC\ PRICE}$ where ARCs are allocated to the delivery party.
V_{GRID}	Grid value allocated to the delivery party	Recognized grid value from the delivery profile or injection point, where such value exists and is allocated to the delivery party.
Clearing condition	Economic feasibility test	$P_{DELIVERY\ MAX} + V_{ARC} + V_{GRID} \geq V_{DELIVERY\ REQ}$

6. Regulatory architecture

SPARC is designed to work through existing power-market institutions and a dedicated SPARC registry. The regulatory task is to recognize SPARC streams, authorize eligible delivery parties, validate delivery evidence, and support creation or issuance of the resulting SPARC and ARC records.

The architecture follows established energy-attribute tracking-system practice. A recognized approving authority validates the underlying event. A register records the approved object, maintains chain of custody, and supports audit. For SPARC, the relevant approving authority is expected to be the grid or system operator in most markets, because it controls or validates dispatch, scheduling, metering, and settlement data. The SPARC registry is operated by SPARC Labs.

6.1 Stream registration and SPARC creation

SPARC requires two related but distinct registry actions.

The first action is SPARC stream registration. A defined delivery band inside an existing PPA is registered as a SPARC stream after the relevant system operator, regulator, or authorized approving body recognizes the stream and its operating parameters. The registered SPARC stream records the source PPA reference, delivery band or profile, delivery period, approved delivery party, applicable performance obligations, settlement treatment, embedded emission right, and evidence requirements.

The second action is MWh-level SPARC creation and registry issuance. A SPARC is created and issued as a registry record only after eligible delivery occurs under a registered SPARC stream and the required evidence has been submitted and validated. The evidence package may include dispatch instructions, scheduling or nomination records, metering data, settlement records, energy-attribute evidence, and any other documentation required by the SPARC product code.

This sequence preserves the distinction between the forward commercial object and the ex-post delivery record. The SPARC stream is registered before delivery so that the parties, the system operator, and the register know which band is eligible. Individual SPARCs are created after delivery so that each MWh-level record corresponds to an evidenced eligible MWh.

6.2 Institutional involvement across adoption models

SPARC can operate through more than one adoption model. The institutional depth changes, but the core functions remain the same: SPARC stream recognition, delivery validation, MWh-level SPARC creation, and ARC issuance.

Under **Model A (Bilateral Subcontracting)**, the PPA remains intact. The coal operator remains the PPA-facing party and enters into a SPARC stream agreement with a renewable operator or another approved delivery party. The coal operator notifies the relevant regulator and system operator of the proposed SPARC stream. The system operator or authorized approving body reviews the delivery band, dispatch or scheduling parameters, metering arrangements, and operational implications. The regulator may issue a non-objection or recognition statement where required under local law. Once these steps are complete, the SPARC stream can be registered in the SPARC registry.

The bilateral agreement does not itself create SPARCs. It creates the commercial basis for registering the SPARC stream. SPARCs are created and issued as registry records only when eligible MWh are delivered under that registered SPARC stream and the required evidence is validated.

Model A avoids full PPA replacement, but it does not assume that private contracting alone is sufficient. Depending on the jurisdiction and the underlying PPA, the parties may still need side letters, limited amendments, recognition statements, metering protocols, settlement procedures, lender consents, or other instruments that allow delivery by the approved delivery party to be recognized without terminating or replacing the original PPA.

Under **Model B (Formal PPA Conversion)**, the relevant delivery band is recognized through a formal PPA amendment, regulatory authorization, or equivalent conversion instrument. The energy regulator approves the conversion, the system operator validates the operational parameters, and the SPARC stream is registered under the resulting mandate. This model creates a stronger formal link between the PPA and the SPARC stream, but the issuance sequence remains the same: stream registration first, delivery second, MWh-level SPARC creation third.

In both models, environmental authority involvement remains separate from power-market recognition. The environmental authority or other designated carbon-accounting body validates the embedded emission parameters and the conditions under which ARCs may be issued. ARC issuance depends on verified emissions from delivered MWh being lower than the embedded emission right carried by the corresponding SPARC, subject to the SPARC product code and applicable host-country rules.

6.3 Regulatory incentive mechanisms

Regulators may support voluntary adoption by giving coal operators a clear commercial reason to register and fulfill SPARC streams. The strongest incentive may be additional recognized clean-delivery opportunity linked to the operator's demonstrated use of SPARC streams.

One pathway is a PPA extension or supplemental approved delivery band. A regulator or offtaker could allow a coal operator that assigns part of its existing PPA to SPARC streams to register additional clean-delivery capacity, extend the term of an approved clean-delivery arrangement, or receive recognition for a future SPARC stream beyond the current PPA allocation. The logic is simple: a plant operator that uses SPARC streams to reduce coal generation and support lower-emission delivery receives a commercial pathway to continue earning from clean delivery rather than only from coal output.

This incentive should be tied to actual substitution. Additional approved delivery access should follow demonstrated SPARC stream performance, validated delivery evidence, and compliance with the relevant system-operator and product-code rules. It should not create SPARCs before delivery occurs, and it should not create ARCs unless the delivered SPARC carries an embedded emission right and verified emissions are lower than that right.

This structure reduces dependence on carbon price alone. A regulator can reward early SPARC adoption through contract duration, approved delivery capacity, or clean-delivery recognition while preserving the underlying PPA and avoiding mandatory plant retirement. The incentive is not a new free-standing environmental claim. It is a regulated commercial bridge from coal-backed PPA value toward lower-emission fulfillment.

6.4 Product code structure

SPARC is intended to align with I-TRACK-style product-code governance, using established tracking-system principles as the model for registry operation, issuance controls, chain of custody, and audit. It does not create a new regulatory regime. It uses a registry architecture to record power-market recognition, delivery evidence, and carbon-accounting outcomes in a controlled evidentiary chain.

The product code should govern at least five functions:

1. registration of SPARC streams;

2. eligibility of coal operators, delivery parties, system operators, and other participants;
3. evidence required for MWh-level SPARC creation and registry issuance;
4. calculation and issuance of ARCs from unused embedded emission rights;
5. transfer, holding, cancellation, and audit rules for issued records.

The SPARC registry will record both the registered SPARC stream and the SPARCs issued from eligible delivery under that stream. It will also link any ARC issued from the unused embedded emission right attached to a delivered SPARC. This creates a single evidentiary chain from the source PPA, through the registered SPARC stream, to delivered MWh, issued SPARCs, and any resulting ARCs.

Registry design remains open. SPARC may rely on existing tracking-system infrastructure, a SPARC-operated register, or another approved arrangement. The choice will depend on product-code approval, technical integration, and the requirements of the relevant market and governance body.

SPARC Labs is expected to maintain the SPARC product-code framework and either operate the register or coordinate with the approved registry operator. The intended I-TRACK alignment provides the registry governance reference point, while national regulators, system operators, or other authorized approving bodies validate the market-specific facts required for stream recognition and post-delivery SPARC creation. The register records those validated outcomes and performs issuance where the product code and applicable mandate allow it. The register records the outcome; it does not replace the public authority of the regulator or system operator.

6.5 Institutional roles

MECHANISM NOTE

Separation of mandates

SPARC depends on a clear separation of institutional mandates. The energy regulator governs market eligibility, consumer protection, and the legal recognition of the SPARC stream arrangement. The system operator governs operational integrity: dispatch, scheduling, metering, and delivery validation. The I-TRACK Foundation provides the intended product-code and tracking-system governance framework. SPARC Labs maintains the product-code framework and either operates the register or coordinates with the approved registry operator. The environmental authority governs embedded emission parameters, ARC issuance conditions, and host-country accounting treatment.

None of these roles substitutes for the others. A SPARC stream requires power-market recognition before it can be registered. A SPARC requires validated eligible delivery before it can be created and recorded. An ARC requires verified emissions from the delivered MWh to be lower than the embedded emission right carried by the corresponding SPARC before it can be issued under the SPARC product code and applicable host-country accounting rules. The regulatory architecture preserves those distinctions so that energy delivery, contractual settlement, registry evidence, and carbon claims remain separate but linked.

The table below summarizes the core institutional functions and how they scale across the two adoption models.

INSTITUTION	CORE FUNCTIONS	MODEL A	MODEL B
Energy regulator	Defines eligibility; recognizes or approves the regulatory basis for SPARC streams; protects consumers and market integrity	May issue non-objection or recognition for the bilateral SPARC stream arrangement	Formally approves the PPA conversion, amendment, or equivalent regulatory instrument
Grid / system operator	Validates delivery bands, dispatch or scheduling parameters, metering arrangements, and delivery evidence; may act as authorized SPARC stream approving authority	Reviews the proposed stream and validates delivery evidence for post-delivery SPARC creation and registry issuance	Acts under explicit regulatory mandate and validates conversion parameters and delivered MWh
I-TRACK Foundation	Provides the intended product-code and tracking-system governance framework for registry operation, issuance controls, chain of custody, and audit	Product-code alignment supports voluntary or sandbox implementation	Product-code alignment supports formal implementation under the approved regulatory structure
SPARC Labs / SPARC registry operator	Maintains product-code infrastructure; operates the SPARC registry or coordinates with the approved registry operator; records SPARC streams, issued SPARCs, ARC links, chain of custody, and audit data	Registers recognized SPARC streams and records SPARCs based on validated evidence	Registers formally approved SPARC streams and records SPARCs based on validated evidence
Market operator or offtaker	Provides settlement data and interfaces where required	Supports settlement evidence and payment reconciliation where applicable	Supports settlement evidence under the approved conversion structure
Environmental authority or carbon-accounting body	Validates embedded emission parameters; supervises ARC issuance conditions; protects host-country and NDC consistency	Required for ARC issuance and host-country treatment	Required for ARC issuance and host-country treatment

7. SPARC as ETS infrastructure for PPA-heavy power systems

An emissions trading system reduces covered emissions by defining emission rights, tracking their use, and requiring regulated entities to account for the emissions they produce. In the power sector, this task becomes harder when coal generation sits inside long-term PPAs. The ETS can price emissions, but the market still needs an operational pathway through which lower-emission delivery can replace coal generation while reliability, settlement, and contractual integrity are preserved.

SPARC provides one such pathway. A SPARC stream defines a coal-linked delivery band that can be fulfilled by an approved lower-emission delivery party. Delivered MWh are metered and evidenced. SPARCs record eligible delivery under the registered SPARC stream. ARCs record the unused embedded emission right where verified emissions are lower than the embedded emission right carried by the corresponding SPARC. The legal cap, covered entities, allowance allocation, surrender obligations, penalties, and market supervision remain sovereign ETS functions. SPARC provides the contractual, registry, and evidence infrastructure that can make those functions work inside PPA-heavy power systems.

7.1 The ETS implementation challenge in the power sector

The purpose of an ETS is to reduce covered emissions with integrity. The standard design assumes that regulated entities can respond to a carbon price by changing fuel use, production, dispatch behavior, investment, or allowance purchases. In PPA-heavy power systems, that response can be constrained. Dispatch remains with the system operator, while the PPA defines the commercial position around delivery: who is paid, who carries

availability obligations, who bears non-delivery or replacement-power risk, and whose emissions are associated with the contracted MWh. A carbon price can make coal generation more expensive, but it does not by itself create a practical substitution pathway for lower-emission delivery inside the existing contract structure.

This is the implementation gap SPARC addresses. It creates a defined delivery band that can be performed by another approved delivery party, while the PPA remains intact and the evidence chain records what was delivered, what was paid for, and which emission right was used or left unused.

7.2 What SPARC makes trackable

SPARC makes the relevant parts of a coal-backed delivery arrangement separately visible and auditable. A registered SPARC stream records the delivery band, the approved delivery party, the payment or settlement treatment, the embedded emission right, and the evidence requirements. This makes the forward delivery arrangement traceable before any MWh is delivered.

A SPARC record shows that one eligible MWh fulfilled the registered SPARC stream and was evidenced through the required metering, settlement, and attribute systems. An ARC records the unused embedded emission right from the delivered SPARC where verified emissions are lower than the embedded emission right. Together, these records connect contract performance, metered delivery, payment treatment, and emission-right accounting. The registered SPARC stream gives the registry evidence a contractual and operational object that lower-emission delivery can actually fulfill.

7.3 SPARC streams as ETS-ready objects

The registered SPARC stream is the ETS-ready object. It is ETS-ready because it identifies the delivery band, the party responsible for fulfillment, the embedded emission right, and the evidence required to determine whether that right was used. The stream also identifies the source PPA, the delivery period, and the operating parameters. Once delivery occurs, issued SPARCs provide the MWh-level record of performance. Where verified emissions are lower than the embedded emission right, ARCs record the unused portion.

This structure allows an ETS or host-country framework to connect emission-right treatment to actual lower-emission delivery. The claim is not based only on an annual emissions report or a modeled baseline. It is tied to a registered delivery band, evidenced MWh, and a recorded emission right.

7.4 Attaching emission rights to SPARC streams

Under an ETS or host-country framework, allocation concerns emission rights, allowances, or recognized emission quantities. A government may allocate or recognize emission rights in the ordinary ETS or domestic policy process. Those emission rights can then be attached to registered SPARC streams that correspond to approved coal-linked delivery bands. The embedded emission right becomes part of the SPARC stream record.

When eligible delivery occurs, the SPARC record shows that the relevant MWh was fulfilled under the registered stream. The ARC shows whether the embedded emission right was unused. The ETS or host-country framework then determines how that unused right is treated for domestic accounting, allowance cancellation, compliance, or international transfer. This preserves the role of the ETS: SPARC supplies the delivery-band and evidence infrastructure, while the ETS or host-country framework supplies the legal treatment of emission rights.

7.5 Three levels of ambition

SPARC can support emissions governance at three levels. In a **pre-ETS setting**, SPARC can operate as a host-country-recognized substitution and accounting mechanism. The embedded emission right may be recognized through a PPA-linked framework, host-country recognition of the SPARC product code, or another domestic authorization pathway, and its quantity must be derived from a plant-specific emission factor or plant-specific legal allocation. In this setting, SPARC helps the host country identify coal-backed delivery bands, record lower-emission fulfillment, and account for unused embedded emission rights before a full ETS exists.

In an **ETS-compatible setting**, SPARC can prepare the data, registry, and evidence structure that a later ETS would need. Registered SPARC streams identify eligible delivery bands. SPARC records show MWh-level performance. ARCs record unused embedded emission rights. This creates an auditable data layer that can inform future allocation, MRV, compliance design, and power-sector coverage.

In an **ETS-integrated setting**, the embedded emission right can correspond to an actual allowance, allocation, or recognized emission quantity under the ETS. ARC issuance should then be linked to cancellation, withdrawal, or equivalent treatment of the underlying emission right so that the same tonne cannot be used twice. The ETS remains responsible for allowance rules and compliance obligations. SPARC provides the stream-level and MWh-level evidence that allows the unused right to be identified and treated correctly.

7.6 Compliance and enforcement

SPARC-side controls work through evidence reconciliation at two points. A SPARC is created only when eligible delivery under a registered SPARC stream is validated against dispatch instructions, metering data, and settlement records. An ARC is issued only when verified emissions from the delivered MWh are independently confirmed to fall below the embedded emission right, with the margin recorded and the source records retained.

The relevant evidence may include dispatch instructions, schedules or nominations, metering data, settlement records, energy-attribute evidence, and registry records. These records allow the system operator, regulator, SPARC registry, and environmental authority to verify that the delivery occurred, that the correct stream was fulfilled, and that the carbon-accounting claim is supported.

Where an ETS requires allowance surrender, that requirement remains an ETS rule. The ETS compliance architecture remains responsible for allowance surrender, compliance deadlines, penalties, and enforcement. SPARC supplies the delivery and registry evidence needed to determine whether an embedded emission right was used, left unused, cancelled, withdrawn, or otherwise treated under the applicable ETS or host-country rules.

7.7 Treatment of unused emission rights

The treatment of unused emission rights remains a sovereign decision. A host government may cancel unused rights to tighten the national emissions path. It may retain them for domestic climate accounting. It may allow them to be used within a domestic ETS where the rules permit, provided the underlying emission right is cancelled, withdrawn, or otherwise controlled so the same tonne cannot be used twice. It may also authorize selected ARCs for international transfer under Article 6.2. International transfer requires host-country authorization, registry controls, no-double-counting safeguards, and corresponding adjustments where required.

International transfer is therefore not automatic. It depends on host-country authorization and the applicable accounting framework. SPARC provides the evidence chain: the source PPA, the registered SPARC stream, the delivered MWh, the embedded emission right, and the unused portion recorded as an ARC. The government determines how that evidence may be used.

This is the practical ETS value of SPARC. It gives governments a way to connect coal-to-clean substitution with emission-right accounting, while preserving reliability, settlement integrity, and sovereign control over carbon-market treatment.

8. Implementation pathway

Implementation proceeds through four phases: bilateral validation, structured simulation, sandbox deployment, and broader rollout. The sequence tests the commercial object first, then the evidence chain, then institutional operation under controlled conditions. Scaling only follows once the delivery-band, settlement, registry, and carbon-accounting steps have been validated together.

8.1 Existing traction and comparable precedents

SPARC is not built in a vacuum. It builds on established energy-attribute tracking infrastructure, including REC systems and I-TRACK-style registry governance for product-code rules, issuance controls, chain of custody, and audit. That infrastructure already provides part of the digital backbone for tracking verified energy attributes across Southeast Asia and globally. SPARC adds a distinct evidentiary layer: records showing that an eligible MWh fulfilled a SPARC stream and, where applicable, that the embedded emission right was not used.

The mechanism design also draws on well-established precedents. Tradable production right systems have been deployed across multiple sectors to manage the reallocation of market access, drive efficiency, and prevent unsustainable oversupply. This is the institutional problem SPARC addresses in the power sector: how to define a coal-backed delivery band, allow another party to fulfill it, and record the resulting delivery and emission-right treatment.

Agriculture sector examples

Tradable quotas in agriculture directly limit commodity production to stabilize markets or protect resources.

- **Canadian Dairy Supply Management System:** Regulates milk production through national quotas allocated to provinces, then to farmers. Quotas are tradable among producers, allowing efficient reallocation while capping total output to match demand and avoid surpluses. Farmers buy and sell quota shares, often at high values, for example around CAD 40,000 per cow in some provinces. The system has been active since the 1970s.
- **EU Milk Quotas (Historical, 1984–2015):** Capped national milk production to curb overproduction, with quotas allocated to farmers and tradable within countries, including through exchanges in the United Kingdom and France. Trading allowed consolidation among efficient producers, but the system was phased out in 2015 due to market liberalization.

Fisheries sector examples

Fisheries quota systems are among the most established tradable production-right systems. They ration catch to sustain stocks while allowing rights to move among eligible participants.

- **New Zealand Quota Management System (QMS) with Individual Transferable Quotas (ITQs):** Covers over 100 species, setting total allowable catches annually. ITQs allocate permanent, divisible shares of the total

allowable catch to fishers, and those shares are freely tradable. Introduced in 1986, the system has reduced overfishing and consolidated fleets for efficiency.

- **Icelandic Individual Transferable Quota (ITQ) System:** Allocates vessel-specific quotas as shares of annual total allowable catches for species such as cod. Quotas are permanent, divisible, and tradable, promoting sustainable harvesting. Enacted in 1990, the system covers nearly all commercial fisheries and has rebuilt stocks such as cod.
- **US Pacific Halibut and Sablefish ITQ Program (Alaska):** Sets total allowable catches and allocates tradable quota shares to licensed fishers. Trading allows entry and exit, reducing the race to fish and improving safety and economics. The program has been operational since 1995.

These precedents are not carbon-market analogues. They are implementation precedents for defining rights, assigning performance, recording use, and supervising transfer. The carbon-accounting claim remains specific to SPARC and depends on the embedded emission right, validated delivery evidence, and the applicable host-country or ETS treatment.

8.2 Bilateral validation

Implementation begins with bilateral engagement. The purpose is to test whether a candidate coal-linked delivery band can become a SPARC stream before any sandbox or market process is launched. The relevant parties may include the PPA-facing coal operator, renewable operator or other approved delivery party, offtaker, system operator, energy regulator, environmental authority, and registry or product-code operator.

Bilateral validation focuses on five questions:

1. whether a defined delivery band can be identified inside the existing PPA;
2. whether an approved delivery party can fulfill that SPARC stream under the applicable dispatch, scheduling, metering, and settlement rules;
3. whether the coal operator, offtaker, and delivery party can agree the payment, risk-transfer, availability, and replacement-power terms;
4. whether the required evidence exists to create SPARCs from delivered MWh;
5. whether the embedded emission right and any resulting ARC can be recognized under the applicable product-code, host-country, or ETS framework.

This phase should not create SPARCs or ARCs. It identifies candidate SPARC streams, commercial constraints, evidence gaps, and regulatory questions that must be resolved before controlled implementation.

Initial bilateral validation is focused on two priority markets. In the **Philippines**, priority engagement includes the Department of Energy and ACEN, a participant in the first CCCI transaction and an early mover in coal transition finance in the region. In **Thailand**, priority engagement includes EGAT, the national utility and a central actor in any grid-level implementation, alongside Agora Energiewende and the Energy Transition Partnership, both of which provide analytical and institutional support for power-sector decarbonization.

In parallel, outreach is being directed toward the **MAS Traction** ecosystem, an energy-transition working group for the financial industry convened by the Monetary Authority of Singapore. This may provide a channel to engage capital-market participants whose participation could be needed to scale SPARC transactions.

8.3 Structured simulation

Structured simulation converts candidate SPARC streams into technical and commercial test cases. The simulation should use real or representative asset portfolios, dispatch patterns, settlement data, variable costs, firming costs, emissions factors, and grid constraints. Its purpose is to test whether the stream-first mechanism can clear commercially and fit operational dispatch and settlement constraints.

Simulation objectives include:

1. testing coal-operator retained value and delivery-party required value under realistic cost inputs;
2. estimating SPARC creation and ARC issuance under different dispatch and fulfillment patterns;
3. quantifying congestion, firming, replacement-power, and reliability effects;
4. identifying the data fields required for SPARC stream registration, SPARC creation, and ARC issuance;
5. identifying specific regulatory, system-operator, and registry adjustments required for sandbox operation.

Simulation is therefore a validation tool, not a substitute for implementation. It converts bilateral alignment into quantified conclusions and defines the operating rules that a sandbox must test.

8.4 Sandbox deployment

If bilateral validation and simulation indicate feasibility, a controlled sandbox can test the mechanism under defined oversight conditions. The sandbox should be limited by asset portfolio, delivery period, geography, participant group, or a combination of these limits.

During the sandbox phase:

1. selected coal-linked delivery bands are recognized or approved as SPARC streams;
2. each SPARC stream is registered with defined delivery, payment, risk, evidence, and embedded-emission-right parameters;
3. approved delivery parties fulfill SPARC streams under the applicable dispatch and settlement rules;
4. SPARCs are created only after eligible delivered MWh are validated against the required evidence;
5. ARCs are issued only where verified emissions are lower than the embedded emission right carried by the corresponding SPARC;
6. registry, reporting, audit, ARC issuance or cancellation, linked energy-attribute certificate treatment, and host-country treatment rules are tested before broader adoption.

The sandbox validates operational process, institutional coordination, and evidence integrity. It should also expose where the mechanism creates friction: dispatch priority, settlement timing, metering granularity, replacement-power obligations, registry handoffs, tax treatment, or consumer-cost concerns.

8.5 Broader rollout

Following successful sandbox validation, SPARC could expand toward broader market coverage. Broader rollout would not require immediate retirement of coal assets or termination of existing PPAs. It would require a repeatable process for recognizing eligible delivery bands, registering SPARC streams, validating delivery, creating SPARCs, issuing ARCs where applicable, and determining the treatment of unused emission rights.

Rollout steps include:

1. adoption of eligibility rules for source PPAs, delivery bands, approved delivery parties, and evidence requirements;
2. formal recognition of the SPARC product code and registry process where required;
3. integration of system-operator, settlement, metering, and energy-attribute evidence into SPARC creation;
4. integration of ARC accounting with the relevant environmental authority, ETS registry, or host-country accounting process where applicable;
5. expansion of participation to additional eligible coal operators, delivery parties, offtakers, and financial counterparties.

At full rollout, SPARC would become standardized infrastructure for assigning fulfillment of coal-backed delivery bands and recording the resulting MWh-level delivery and emission-right treatment. The PPA remains the commercial foundation. SPARC provides the mechanism for progressive dispatch-based decarbonization while preserving reliability, settlement integrity, and institutional control.

9. Strategic positioning

9.1 Core proposition

SPARC is a market-based mechanism for shifting fulfillment of coal-backed delivery bands from coal generation to lower-emission delivery, one MWh at a time.

It operates within the existing power-market architecture and works with rights already present in coal PPAs: the right to supply power, the right to receive associated payment, and the embedded emission right. By linking delivery evidence to emission-right accounting, SPARC aligns power-market incentives with decarbonization objectives without requiring immediate asset-level buyouts or new external subsidy pools.

9.2 Mechanism identity

SPARC is:

- A dispatch-based decarbonization mechanism.
- A contractual and registry mechanism for assigning fulfillment of coal-backed delivery bands.
- A way to create MWh-level SPARC records from validated lower-emission delivery.
- A potential evidence layer for sector-wide carbon compliance, where ARCs record unused embedded emission rights.

It shifts delivery one MWh at a time. It does not depend on capital-intensive buyouts or external subsidy pools to trigger impact.

9.3 Relationship to retirement finance and transition mechanisms

SPARC addresses dispatch-level substitution. It enables coal operators to reduce output progressively while retaining contractual continuity and generating incremental value from unused embedded emission rights.

Where full retirement becomes economically rational, separate retirement finance mechanisms may accelerate permanent closure. In that context, SPARC can reduce the remaining structural burden by lowering average utilization and exposing high-cost capacity earlier.

SPARC and retirement finance, therefore, operate at different layers:

- SPARC manages dispatch-level substitution.
- Retirement finance manages asset-level exit.

Together, they form a sequential pathway from lower-emission fulfillment of coal-backed delivery bands to structural phase-out.

A Note on This Draft

SPARC is a concept in development. This white paper is a starting point for conversation, not a concluded design. The mechanism described here reflects our current thinking, which will evolve as we engage with operators, regulators, and market participants across the region. We are not attached to any specific formulation (structure, terminology, regulatory pathway, or economic logic), and we welcome challenge, alternative framings, and practical pushback. If something in this document does not work in your context, we want to know. The goal of circulating this draft is to stress-test ideas, not to defend them.

To engage with the SPARC development process, please contact info@sparc.now