WHITEPAPER SERIES 1 · VERSION 1.1 · JUNE 2026

THE COOPERATIVE BIOREFINERY MODEL

A Regenerative Fiscal-Environmental Architecture — where natural capital recognition becomes wealth creation for the populations closest to the ecosystem.

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ABSTRACT

This paper sets out the architectural framework for a regenerative fiscal-environmental model in which the biological value of marine living systems is monetised at pharmaceutical-compound resolution, the wealth generated flows to the cooperatives closest to the ecosystem, and the

environmental damage caused by the unprocessed biomass is reversed as a structural byproduct of the wealth creation itself.

The framework operates above the carbon-credit and ecosystem-service layers of existing natural capital recognition by recognising the molecular compound diversity of living biological systems as a productive asset class that synthetic chemistry cannot replicate, accessible only when biological integrity is preserved through cold-process extraction. The framework operates beside Chami's ReGDP (Regenerative GDP) macro-financial scaffolding by providing the institutional form — cooperative ownership of the processing apparatus — through which ReGDP can actually appear on sovereign balance sheets rather than as offshore-held assets.

Patent-protected cold-process technology developed by Neurosync Technologies Limited enables the commercial recovery of fucoidan with native sulphation, intact microbial holobiont fractions, polymerised phlorotannins, diterpenoids from invasive macroalgae, and certified-removal biochar from feedstocks — pelagic sargassum, invasive *Rugulopteryx okamurae*, and other macroalgal biomass — that currently inflict measured economic damage of more than $13.5 billion annually on the Florida coastline alone (Woods Hole Oceanographic Institution, 2026), with comparable losses across the Caribbean basin, Mediterranean basin, and Atlantic Macaronesia. Eight institutional engagements across five marine basins on three continents constitute the present instantiation phase. The architecture is replicable across every coastal community affected by harmful algal bloom and every region with invasive macroalgae eradication programmes.

KEYWORDS

Natural capital recognition · Regenerative GDP (ReGDP) · cooperative ownership · biorefinery · sargassum · *Rugulopteryx okamurae* · fucoidan · holobiont · phlorotannin · diterpenoid · biochar · carbon removal · ecosystem services · macroalgal biomass · cold-process extraction · pharmaceutical-grade biocompounds · sovereign balance sheets · regenerative localism

SECTION 01

INTRODUCTION

The natural capital recognition movement of the 2015–2026 decade has produced tradeable carbon credits, biodiversity offsets, and ecosystem service valuations. The economic logic underpinning these instruments — that living nature constitutes foundational economic infrastructure that the prevailing economic logic has mispriced — is correct and necessary. The Regenerative GDP (ReGDP) framework developed by Ralph Chami and Blue Green Future extends this argument into formal macro-financial scaffolding, with implications for sovereign debt-to-GDP trajectories, fiscal volatility, sovereign credit ratings, and financial stability that few existing natural capital instruments have reached.

Two layers of the natural capital recognition argument remain operationally unaddressed by existing instruments. The first is the molecular compound layer above ecosystem services: the pharmaceutical-resolution biocompounds — fucoidan with native sulphation, intact microbial holobionts, polymerised phlorotannins, diterpenoids from invasive macroalgae — that living biological systems produce and synthetic chemistry cannot replicate. These compounds are accessible only when the biological system that produces them is preserved in its living state and processed without thermal destruction. Conventional commercial processing of macroalgal biomass begins with thermal drying that destroys both the holobiont and the native compound sulphation. The biocompound asset class has therefore remained commercially unrecoverable to date.

The second is the institutional form through which natural capital recognition produces measurable ReGDP contributions on sovereign balance sheets. Tradeable carbon credits and ecosystem-service valuations have predominantly captured value for institutional buyers in northern hemisphere capitals rather than for the communities closest to the ecosystems being valued. The asymmetry creates a political economy problem: programmes built on it require continued political will to sustain, and the populations whose livelihoods depend on the ecosystems remain economically marginal to the markets that price those ecosystems. Natural capital recognition has therefore stalled as a movement, even as the macro-financial scaffolding has matured.

This paper sets out the architectural framework — termed here the **Cooperative Biorefinery Model** — that addresses both layers simultaneously. The framework combines cold-process biocompound extraction with cooperative ownership of the processing apparatus, such that the molecular compound diversity of marine biological systems is monetised at pharmaceutical resolution, the wealth generated flows to the cooperatives closest to the ecosystem, and the environmental damage caused by the unprocessed biomass is reversed as a structural byproduct of the wealth creation itself.

Section 2 sets out why carbon-credit-based natural capital recognition has stalled as a deployable movement. Section 3 introduces the cooperative ownership principle and

demonstrates that it resolves the political economy problem at the structural level. Section 4 introduces the biocompound layer above ecosystem services and demonstrates the value multiplication available when biological integrity is preserved through processing. Section 5 sets out the current deployment map across eight institutional engagements in five marine basins. Section 6 sets out the replication and licensing architecture designed to preserve cooperative ownership at scale. Section 7 sets out five propositions that hold the architecture together as an integrated system. Section 8 concludes.

SECTION 02

WHY CARBON-CREDIT NATURAL CAPITAL RECOGNITION HAS STALLED

Ralph Chami, formerly of the International Monetary Fund and now CEO and Co-Founder of Blue Green Future, has developed the Regenerative GDP (ReGDP) framework to recognise living nature as productive economic infrastructure on national balance sheets. His argument — that ecosystem flows generate long-duration low-volatility revenues that should be recognised as macro-critical infrastructure rather than treated as environmental externalities — is correct and necessary. The framework's implications for sovereign debt-to-GDP trajectories, fiscal volatility, sovereign credit ratings, and financial stability mark a substantive advance over the carbon-credit-only conception of natural capital.

The deployment instruments built to date, however, are not yet the architecture that ReGDP requires. The existing carbon credit and ecosystem service instruments have predominantly captured value for institutional buyers rather than for the communities that steward the ecosystems being valued.

2.1 The political economy problem

Populations in unequal economies correctly perceive that environmental regimes tend to extract additional resources from them without redistributing the gains. The Yellow Vests in France protested a carbon tax. The Mexican Caribbean tourism industry registers public frustration at being asked to manage sargassum sustainably while losing billions annually. The Andalucían fishing communities at Tarifa watching their coast invaded by *Rugulopteryx okamurae* perceive correctly that the global discourse about ocean health benefits Cambridge and Geneva more than it benefits them. Environmental virtue, when it does not carry economic redistribution, becomes another form of metropolitan condescension.

Programmes built on this asymmetry require political will, administrative continuity, and donor patience. They depend on whether the next government, the next agency director, the next election cycle maintains the policy direction. They are vulnerable to the political cycle precisely because they ask citizens to sacrifice for an abstract collective good. They are not movements. They are interventions, and interventions reverse when the political will reverses.

2.2 What carbon credits cannot price

Carbon credits monetise one dimension of biological value — sequestration capacity measured in tonnes of CO_2 equivalent. ReGDP extends this to ecosystem-service flows. But living biological systems produce compound diversity at molecular resolution that synthetic chemistry cannot replicate. The natural sulphation patterns of fucoidan, the proteomic

complexity of microbial holobionts, the polymerisation diversity of phlorotannins, and the diterpenoid bioactivity of *Rugulopteryx okamurae* are the high-value end of the natural capital spectrum. These compounds exist precisely because the biological system that produces them is intact — not because that system stores carbon or provides an ecosystem service.

Published research from the University of Rochester in March 2025 demonstrated that fucoidan extracted by conventional thermal processes produces a 13% median lifespan extension in male aged mice and 4-fold activation of the SIRT6 longevity gene (Seluanov & Gorbunova, 2025). The thermal extraction process used in that study destroyed approximately 75% of the native sulphation that gives fucoidan its bioactivity. Holobiont-intact, cold-processed fucoidan is mechanistically superior to the material used in the Rochester study but has never been studied in any longevity, oncology, or other therapeutic context, because no commercial process previously existed to produce it. The University of York Centre for Novel Agricultural Products (CNAP) has confirmed in writing that no scientific studies exist on cold-processed holobiont-intact sargassum-derived fucoidan. The architecture set out in this paper creates a category of biological material that has never existed before.

This is the territory beyond the carbon credit market and beyond ecosystem-service valuation: biocompound value that is generated only when natural systems are preserved in their living state and processed without destroying that state.

SECTION 03

THE COOPERATIVE OWNERSHIP PRINCIPLE

The structural innovation that distinguishes the architecture from existing natural capital instruments is the cooperative ownership principle. Each deployment site is a locally-constituted cooperative or equivalent local structure native to the host territory. The local entity owns the equipment, holds the operating contracts, employs the workforce, accumulates the working capital, and retains 90% of operational value generated.

3.1 The structural design

At the lead deployment site now in active institutional engagement, projected Year 3 operational revenue accrues principally to the cooperative. The majority covers cooperative operating expenses, member distributions, and accumulation of working capital for subsequent phase deployment. A minority share flows to Neurosync as royalty against the patent portfolio. The remaining value enters the host territory as wages, supplier payments, tax contributions, and member dividends. By Year 5 at full subsequent-phase deployment, the cooperative is operating at multiples of this baseline as pharmaceutical-compound revenue streams come online.

> *This is not a corporate social responsibility overlay or a community-benefits clause attached to a privately-held operation. It is the structural design of the architecture.*

The Neurosync incentive is aligned with cooperative success because Neurosync revenue is a percentage of cooperative revenue. The cooperative is structurally invested in continued biological productivity of the ecosystem because cooperative revenue depends on continued biomass throughput. The architectural alignment between economic incentive and environmental outcome is structural rather than contractual.

3.2 Resolution of the political economy problem

A programme requires the political system to keep funding it. A movement requires only that each participant be individually better off than they were before participating. The cooperative biorefinery model is the latter.

This is structurally different from the way climate intervention has been deployed for two decades, which has depended on convincing populations to accept short-term economic costs for long-term collective benefit. The cooperative biorefinery model offers short-term

economic benefit and long-term collective benefit simultaneously. There is no sacrifice to convince anyone of. There is only opportunity to organise around.

When the first cooperative deployment demonstrates measurable revenue retention, neighbouring communities do not need to be convinced of the merits of cooperative valorisation — they apply to participate. The model becomes the proof, and the proof becomes the demand signal. This is the institutional dynamic that converts a programme requiring continued political will into a self-propagating movement where each prospective participant is structurally better off than before engagement.

SECTION 04

THE BIOCOMPOUND LAYER BEYOND CARBON

The most consequential element of the architecture is the biocompound layer. Carbon credits monetise one dimension of biological value. ReGDP extends this to ecosystem services. Biocompounds monetise the molecular diversity that exists only when biological systems are preserved in their living state.

4.1 The cold-process principle

Every existing commercial process for sargassum and other macroalgae begins with thermal drying at temperatures well above the threshold at which holobiont structure and native fucoidan sulphation degrade. This first step alone destroys the molecular complexity that constitutes the high-value end of the biocompound spectrum. The downstream products from conventional thermal processing — algal meal, low-grade alginate, basic biochar — are commodities at commodity pricing.

Neurosync's patent-protected technology preserves biological integrity throughout the extraction cascade. Operating well below the thermal degradation threshold, the cascade recovers pharmaceutical-grade fucoidan with native sulphation, intact holobiont fractions, polymerised phlorotannins, and certified-removal biochar from the post-extraction residue. A companion cascade applies the same cold-process discipline to invasive macroalgae biomass from active eradication programmes, with post-extraction residue pyrolysed into marine concrete eco-mooring blocks incorporating olivine — a single product line that provides Posidonia seagrass protection, artificial reef habitat, and certified carbon dioxide removal simultaneously. Technical detail is covered under the Neurosync patent portfolio; commercial specification is available under NDA.

4.2 Compound value versus sequestration value

Biocompound value is not an upgrade to carbon credit value. It is a different valuation axis entirely. Carbon credits price sequestration capacity in tonnes of CO_2 equivalent. Biocompounds price molecular complexity that synthetic chemistry cannot replicate — pharmaceutical-grade raw materials, cosmetic active ingredients, nutraceutical and antimicrobial fractions, research-grade reagents, regenerative scaffold material — categories that command pharmaceutical-grade pricing where carbon credits command commodity-grade pricing. A facility that produces both, as the cold-process cascade does, captures value on both axes simultaneously, with the carbon credit revenue stabilising early-stage cash flow and the biocompound revenue ramping over the longer term as regulatory notifications complete.

4.3 Implications for natural capital recognition

Natural capital recognition needs to extend from carbon sequestration metrics to ecosystem-service valuation to biological compound diversity. The economic turning point arrives not when carbon credits become more widespread but when the molecular diversity of living biological systems is recognised as the foundational productive asset it actually is. Sargassum at the Guadeloupean coastline is not waste to be disposed of. *Rugulopteryx okamurae* at Tarifa is not a problem to be eradicated. These are biological manufacturing platforms whose compound diversity exceeds anything pharmaceutical chemistry can currently synthesise. The cooperative biorefinery is the apparatus through which the platform output is realised commercially. The cooperative ownership is the structure through which the realisation flows to the population that hosts the platform.

SECTION 05

THE DEPLOYMENT MAP — EIGHT INSTITUTIONAL ENGAGEMENTS ACROSS FIVE BASINS

The cooperative biorefinery model is being instantiated through institutional engagements across five distinct marine basins. No site is yet commissioned. Engagement stages vary from active formal dialogue to recent outreach awaiting response. The breadth of basin engagement is itself part of the architecture: ReGDP and natural capital recognition require operational instances across multiple sovereign jurisdictions to validate as a framework rather than as a single regional pilot.

The classification below distinguishes between engagement stages: *active dialogue* indicates formal two-way conversation with confirmed institutional counterparties; *advanced engagement* indicates substantive discussions held with follow-up awaited; *pitch submitted* indicates formal proposal under institutional review; *recent outreach* indicates initial institutional contact within the normal response window; *outreach in progress* indicates initial contact made with substantive response pending.

BASIN / SITE	STAGE	INSTITUTIONAL COUNTERPARTIES	CASCADE
French Caribbean — Guadeloupe	Active dialogue	ADEME Guadeloupe (Plan Sargasses orchestration). Commune de Petit-Bourg (Direction de la Mer). COVACHIM-M2E Université des Antilles. Université de York Centre for Novel Agricultural Products partnership. CICV form in preparation; institutional call scheduled.	NTL-PROCESS-001 sargassum
US Caribbean — Miami / Florida	Active dialogue	US strategic partnership in place (NDA and Non-Circumvention executed). Miami-Dade Special Projects Administration. Florida tech ecosystem partners. US academic oceanographic institutions. US oncology research collaborators.	NTL-PROCESS-001 sargassum, Bio-Farm cascade
Mediterranean — Balearics	Advanced engagement	Servicio de Vigilancia de Posidonia, Govern de les Illes Balears. Substantive discussions held; follow-up meeting to be scheduled.	Bio-Farm cascade + eco-mooring NTL-MOOR-001
Gulf sovereign wealth — Saudi Arabia	Pitch submitted	Future Investment Initiative Institute (PIF-affiliated platform), Riyadh. Submitted 25 May 2026, awaiting review decision. Strategic alignment with Saudi Green Initiative and Middle East Green Initiative framings.	Architecture-level engagement; cascade selection by deployment region
Mediterranean — Strait of Gibraltar (Andalucía)	Recent outreach	Consejería de Sostenibilidad, Medio Ambiente y Economía Azul, Junta de Andalucía (Biodiversidad). Outreach 22 May 2026, within normal response window. Plan de Gestión approved July 2025 establishes management framework. Pilot zone Cádiz / Algeciras / Tarifa.	NTL-PROCESS-003 invasive *Rugulopteryx okamurae*

BASIN / SITE	STAGE	INSTITUTIONAL COUNTERPARTIES	CASCADE
Atlantic Macaronesia — Madeira	Outreach in progress	Secretaría Regional de Turismo, Ambiente e Cultura (Madeira regional government). Initial contact routed to Secretaría Regional 30 April 2026.	NTL-PROCESS-001 sargassum
French Caribbean — French Guiana	Outreach in progress	CRPMEM Guyane (fishing cooperative). Port du Larivot site identified (20,000 m², VALOSARG designated zone). BlueActionAA BAAC-01 funding channel.	NTL-PROCESS-001 sargassum
Mexican Caribbean — Quintana Roo	Outreach in progress	Outreach made through state and federal Mexican channels. Installed barrier and biogas systems documentably failing against record 2026 sargassum volumes.	NTL-PROCESS-001 sargassum

Table 2. Engagement stages and institutional counterparties across the eight current deployment sites.

5.1 Why this breadth matters at the ReGDP level

Chami's framework needs operational instances across multiple sovereign jurisdictions to validate as a macro-financial scaffolding rather than a single regional experiment. The deployment map above spans French DOM, Portuguese autonomous region, US state, Mexican state, two Spanish autonomous communities, and Gulf sovereign wealth. Each jurisdiction has distinct tax frameworks, regulatory regimes, currencies, and political institutions. A model that proves operationally across this jurisdictional breadth is structurally different from a model that works only in one regional context. It is institutionally portable in a way that conventional carbon credit programmes are not, because the cooperative entity in each jurisdiction is a native institution of that jurisdiction rather than an offshore vehicle owned by metropolitan capital.

5.2 The Mexican Caribbean case

The Mexican Caribbean illustrates the structural advantage of the cooperative biorefinery model in the most challenging deployment context. Quintana Roo is currently operating the largest dedicated sargassum response globally — 17,000 metres of anti-sargassum barriers (9,500 metres deployed in 2025 plus 7,500 metres added in 2026), 16 Mexican Navy surface units, 39,500+ tonnes collected by May 2026 against projections of up to 130,000 tonnes for

the season. Only 5 of 140 monitored beaches are sargassum-free according to the state monitoring network. The 2025 disposal expenditure (hotel sector approximately $135 million USD plus state expenditure of approximately $6.5 million USD) was positioned as the turning point for reclaiming the beaches. The 2026 season demonstrates that conventional disposal-focused responses cannot keep pace with the volumes the Atlantic is producing.

The political-economic dynamics around the 2025 expenditure constrain state-level engagement with structurally different approaches. The realistic entry pathways for cooperative biorefinery models in the Mexican Caribbean therefore run through federal Mexican channels (SEMARNAT and SEMAR operating above state-level political constraints), through municipal-level engagement at communities not benefiting from the state strategy, through private capital arbitrage, or through public mobilisation that creates federal-level pressure independent of state government endorsement. The architecture exists; the entry pathway requires patience with the political-economic dynamic the current expenditure cycle has created.

The state's Comprehensive Sanitation and Circular Economy Centre follows the conventional thermal-process biogas-and-fertiliser pathway that produces commodity outputs at commodity pricing. The cooperative biorefinery model offers the Mexican Caribbean a structurally different proposition: the same sargassum volume converted to pharmaceutical-grade fucoidan revenue, EBC-Feed biochar with Verra and Puro carbon credits, and cooperative ownership that retains value in the Mexican Caribbean rather than as feedstock for offshore operators.

SECTION 06

THE REPLICATION AND LICENSING ARCHITECTURE

The eight active engagements above are the first instantiation phase. The architecture is designed for global replication. The patent portfolio protects the architecture during the period of demonstration. Once the model is proven at multiple sites across multiple basins, the patents become the licensing instrument through which cooperatives in additional territories can access the architecture under terms that preserve the cooperative ownership principle.

6.1 The licensing principle

Patent licensing in conventional commercial models extracts maximum economic rent from licensees while protecting the licensor's market position. The licensing principle described here is structurally different. Licensing terms include three non-negotiable elements: (i) the operating entity must be a cooperative or analogous community-ownership structure native to the host territory; (ii) the cooperative retains a minimum 80% of operational value, with the remaining proportion split between Neurosync royalty and local scientific partner contributions; (iii) all carbon credits, biocompound revenues, and environmental restoration contracts must accrue to the host territory rather than to offshore vehicles.

These terms protect the architecture itself. A licensing regime that permitted profit-extractive deployment would defeat the purpose. The architecture optimises for the proliferation of cooperatives operating the model rather than for the maximisation of royalty rates against fewer deployments. A hundred cooperatives operating at €1 million annual revenue generate the same royalty as ten cooperatives operating at €10 million annual revenue, and produce ten times the ecosystem restoration footprint, ten times the political legitimacy, and ten times the demand pressure on the next prospective host territory.

6.2 The fiscal architecture

Each cooperative is a taxable entity in its host territory. The 90% operational value remains local and is recognised in territorial tax accounts. Carbon credit revenue is recognised in the territory of generation. Biochar contracts under Plan Chlordécone IV, Andalucían Plan de Gestión, or analogous frameworks are spent in host territory accounts. Pharmaceutical compound exports generate foreign exchange for the host territory. Each cooperative becomes a meaningful tax contributor to its host government, which in turn becomes structurally invested in the cooperative's success.

> *This is the fiscal inversion from extractive colonialism to regenerative localism. In the extractive model, natural*

> *resources flowed from periphery to centre, and the periphery received discretionary transfers. In the regenerative model, natural systems are valued in situ, processed in situ, monetised in situ, and the in-situ population captures the upside.*

The carbon-credit version of natural capital recognition could not deliver this because the financial instruments themselves were structured for metropolitan ownership. The cooperative-owned biocompound version, processed at source, can. This is the institutional form that ReGDP requires to actually appear on sovereign balance sheets rather than as offshore-held assets that contribute to other countries' GDP.

SECTION 07

FIVE PROPOSITIONS THAT HOLD THE ARCHITECTURE TOGETHER

The cooperative biorefinery model is politically durable across cycles of government, rotations of agency directors, changes of European Commission priorities, transitions of US municipal administrations, and fluctuations of the carbon credit market price. The cooperatives do not depend on continued political will. They depend on continued biological productivity of the ecosystems they steward and on continued operation of pharmaceutical, agricultural, and energy markets that purchase their outputs. Catalytic institutional support is necessary to cross the initial activation threshold for the first deployments; thereafter the model is self-propagating.

Five propositions hold the architecture together as an integrated system:

#	PROPOSITION	WHY IT MATTERS
01	Biological systems are preserved in their living state, not destroyed before processing	Unlocks biocompound value at pharmaceutical resolution; eliminates the 'extract then dispose' logic of conventional biomass processing
02	The compound diversity of living systems is monetised at molecular resolution	Multiplies the per-tonne value of feedstock by 100× to 1,000× over carbon credit valuation alone
03	The economic upside accrues to populations closest to the ecosystem via cooperative ownership	Resolves the political economy problem that has stalled natural capital recognition for a decade
04	Environmental restoration is a structural byproduct of wealth creation, not a precondition for it	Eliminates the 'sacrifice for collective good' political vulnerability of conventional climate intervention
05	Replication is licensed under terms that preserve cooperative ownership, not extractive deployment	Ensures architectural integrity at scale; aligns incentives with proliferation rather than rent-extraction

Table 3. The five integrated propositions that constitute the architecture.

These five propositions are not separable. Removing any one of them defeats the architecture. A cold-process technology owned by a conventional corporate structure produces biocompound revenue but does not become a movement. A cooperative ownership model attached to a conventional thermal process produces low-grade biomass commodities and does not produce biocompound revenue. Carbon credits without biocompounds do not multiply value sufficiently to sustain a cooperative; biocompounds without carbon credits leave Year 1 cash flow underwritten. The five propositions are an integrated system.

SECTION 08

CONCLUSION

Ralph Chami concluded his Blue Economy Summit 2026 keynote with the observation that we still have a chance to make the transition from planetary tipping points to economic turning points, but that time is no longer an abstract variable. He is correct on both counts. ReGDP is the macro-financial scaffolding that this conversation has needed.

The transition Chami calls for arrives when three conditions are met simultaneously.

First, living ecosystems are treated as strategic assets rather than free resources. The cooperative biorefinery model is the structural realisation of this principle. The sargassum at the Guadeloupean coastline, the *Rugulopteryx* at Tarifa, the Caribbean basin biomass at Quintana Roo and Miami all become biological manufacturing platforms rather than disposal problems.

Second, regeneration becomes economically rewarded. The cooperative model rewards regeneration directly: ecosystem preservation produces continuing compound flows, while ecosystem destruction collapses the revenue base. The economic incentive is aligned with environmental outcomes structurally, not contractually.

Third, corporate and national balance sheets begin to reflect dependency on natural capital alongside financial capital. The cooperative is the institutional form in which this reflection occurs first. Each cooperative balance sheet is a literal accounting of natural capital: the equipment that processes the biomass, the contracts that sell the outputs, the ecosystem that produces the feedstock. Each cooperative is a contributor to the national accounts of its host territory in a way that conventional carbon credit issuance to offshore vehicles is not.

These three conditions arrive simultaneously in the cooperative biorefinery architecture. They do not arrive sequentially through carbon credit market expansion, biodiversity offset standardisation, or natural capital accounting reform. They arrive structurally when the architecture is deployed. Eight institutional engagements across five marine basins on three continents are the present instantiation phase.

> *The cooperative biorefinery model is not a programme that requires continued political will to sustain. It is an architecture that requires only catalytic institutional engagement to demonstrate, after which it proliferates by the demand of prospective host territories that observe the prosperity created at the demonstrated sites.*

The transition Chami calls for begins at each deployment. The economic turning point is not coming; it is being constructed. Each cooperative biorefinery commissioned is the turning point arriving for the population it serves.

REFERENCES

[1] Beron-Vera, F.J., Olascoaga, M.J., Miron, P., Bonner, S. (2026). Origin attribution of the Great Atlantic Sargassum Belt. *PNAS Nexus*.

[2] Chami, R. (2026). From Planetary Tipping Points to Economic Turning Point. Keynote address, Blue Economy Summit 2026, Milan. Blue Green Future / One Ocean Foundation.

[3] Devault, D.A., Pierre, R., Marfaing, H. et al. (2021). Sargasses: contamination et conséquences pour la valorisation. Synthèse d'expertise ADEME, France.

[4] Lapointe, B.E., Brewton, R.A., Herren, L.W. et al. (2021). Nutrient content and stoichiometry of pelagic Sargassum reflects increasing nitrogen availability in the Atlantic Basin. *Nature Communications* 12, 3060.

[5] Mogollón, R. et al. (2024). Economic impact of *Rugulopteryx okamurae* on coastal communities in the Strait of Gibraltar. *Wetlands Ecology and Management*.

[6] Neurosync Technologies Limited (2026a). NTL-PROCESS-001: Cold-Process Integrated Extraction Cascade for Pelagic Sargassum Biomass. UK Patent Application, filed April 2026.

[7] Neurosync Technologies Limited (2026b). NTL-PROCESS-003: Cold-Process Cascade for Invasive Marine Macroalgae Biomass. UK Patent Application filed May 2026.

[8] Neurosync Technologies Limited (2026c). NTL-SARG-001: Sargassum Bio-Farm Infrastructure. UK Patent Application, filed March 2026.

[9] Ranguin, R., Jean-Marius, C., Yacou, C., Gaspard, S., Feidt, C., Rychen, G., Delannoy, M. (2020). Reduction of chlordecone environmental availability by soil amendment of biochars and activated carbons from lignocellulosic biomass. *Environmental Science and Pollution Research*.

[10] Seluanov, A., Gorbunova, V. et al. (2025). Fucoidan as senotherapeutic and SIRT6-dependent DNA repair activator. *bioRxiv*, March 2025. DOI: 10.1101/2025.03.24.645072.

[11] Stephan, P., Leglize, P., Garcia, L. et al. (2025). Effects of biochar from algae (*Sargassum spp.*) on the fertility of two chlordecone contaminated West Indies soil. *PLoS ONE*.

[12] Wang, M., Hu, C., Barnes, B.B. et al. (2019). The great Atlantic Sargassum belt. *Science* 365(6448), 83-87.

[13] Woods Hole Oceanographic Institution (WHOI) (2026). Economic impact of sargassum landfall on southeast Florida and statewide tourism, recreation, and fisheries economies. *Harmful Algae*, January 2026.

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ACKNOWLEDGEMENTS

The author acknowledges the institutional engagement and scientific input of partner institutions cited in the deployment map above. Substantive academic partnership with the University of York Centre for Novel Agricultural Products has been formative to the cold-process cascade development. Industrial partnership across the eight institutional engagements documented in Section 5 has shaped the architectural framework presented here.

CONFLICT OF INTEREST DECLARATION

The author is the Founder and Director of Neurosync Technologies Limited, the entity that holds the patent portfolio underpinning the architecture described in this paper. This paper sets out the architectural and economic framework within which Neurosync Technologies operates commercially. The framework analysis is intended to make the architecture publicly available for institutional engagement, academic discussion, and citation, rather than to constitute a commercial pitch for any specific transaction.

LICENCE

SUGGESTED CITATION

Harper, K. (2026). The Cooperative Biorefinery Model: A Regenerative Fiscal-Environmental Architecture. Neurosync Technologies Limited Whitepaper Series 1, Version 1.1. Solihull, United Kingdom: Neurosync Technologies Limited.

ENGAGE WITH THE ARCHITECTURE

For institutional engagement, partnership discussions, or licensing enquiries, contact Neurosync Technologies Limited directly. The architecture is being

demonstrated through eight institutional engagements across five marine basins.

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