



THE TRANSFORMATION LAYER

CONVERSION, ENERGY INTEGRATION AND CARBON ASSET GENERATION

From preserved biomass
to environmental, economic
and social value.



INFRASTRUCTURE
THAT TRANSFORMS.



BIOCHAR

Permanent
carbon storage.



ENERGY

Renewable
power and heat.



INTEGRATION

Zero waste,
full efficiency.



VALUE

Carbon assets
and green markets.



TERRITORIES

Regeneration and
local prosperity.

TIERRAS DE MONTAÑA — INSTITUTIONAL FRAMEWORK

ORIGIN INFRASTRUCTURE SERIES — VOLUME III

THE TRANSFORMATION LAYER: CONVERSION, ENERGY INTEGRATION AND CARBON ASSET GENERATION

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EDITORIAL NOTE ON VOLUME NUMBERING

The numbers assigned to the ORIGEN Infrastructure Series (Volume I, II, III) are specific to this series and do not correspond to the Volume numbers of the Tierras de Montaña Institutional Framework Collection (Volumes 0–X). The ORIGEN series is an operational sub-series that applies the principles of the Constitutional Collection to the specific domain of biological infrastructure. This distinction ensures clarity between institutional governance and technical methodology.

PREFACE

Volume I defined the doctrine. Volume II defined the preservation of Biological Capital at origin.

Volume III defines the transformation of preserved biomass into environmental, economic, and social assets.

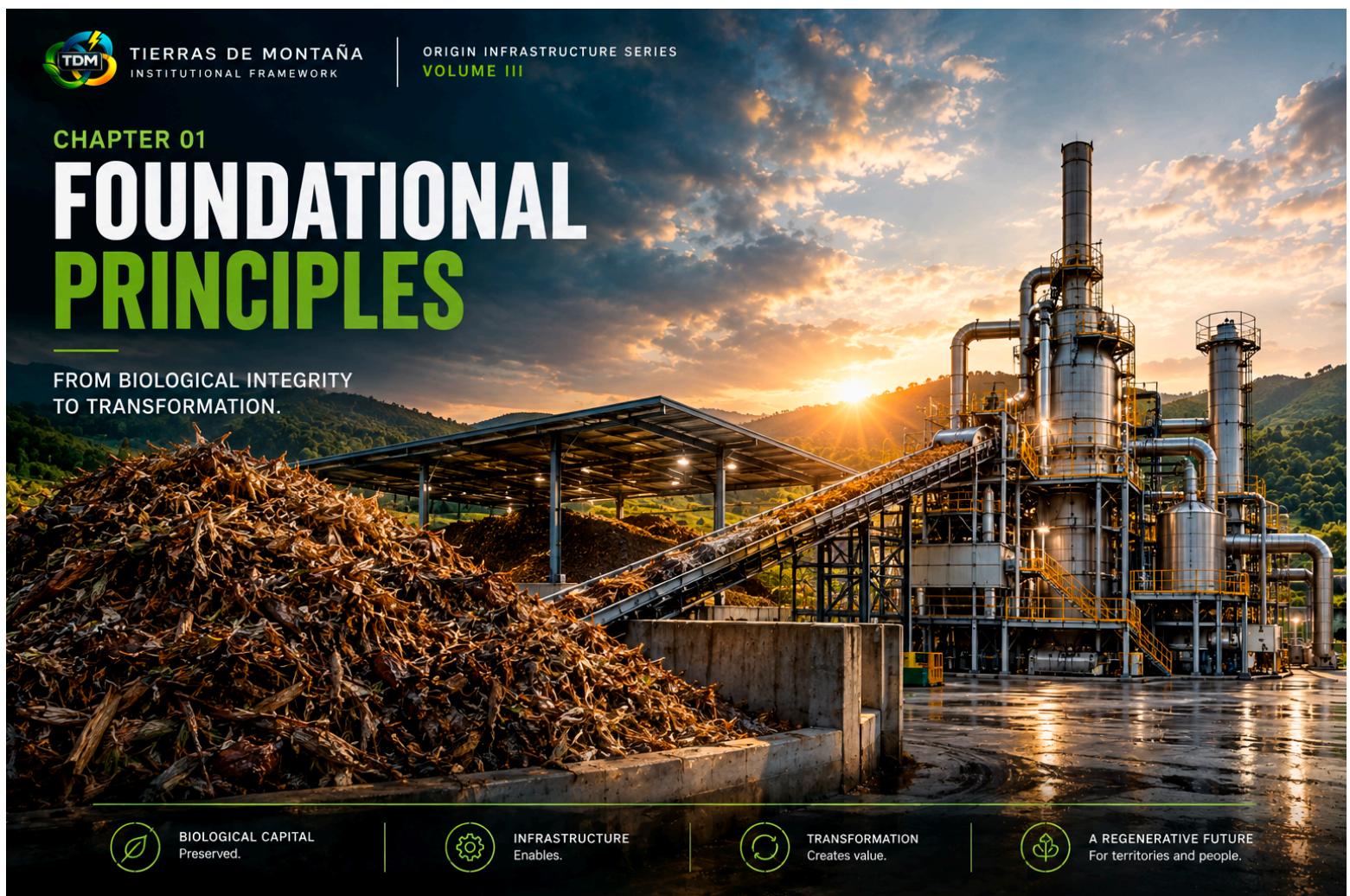
The outputs of this layer include biochar, renewable energy, and potential carbon removal assets, which are subject to applicable MRV, verification, and certification requirements.

This volume begins where Volume II ends: with biomass in a state of Biological Integrity. It describes the conversion technologies, energy integration systems, and carbon asset generation mechanisms that transform stabilized biomass into biochar, renewable energy, and potential carbon removals.

The Transformation Layer is not a collection of independent technologies. It is an integrated system designed to maximize value extraction while maintaining the principles of ORIGEN:

- **Preservation precedes transformation** — conversion only occurs on biomass that has achieved Biological Integrity
- **Infrastructure precedes technology** — the preservation layer determines the quality of the transformation
- **Biology governs the system** — the characteristics of the preserved biomass define the conversion pathway

This volume does not prescribe specific equipment. It defines the methodological framework for selecting, integrating, and operating transformation technologies within the TDM institutional architecture.



CHAPTER 1 — FOUNDATIONAL PRINCIPLES

1.1 The Transformation Imperative

Preservation is not an end in itself. It is the necessary condition for efficient transformation.

Biomass that has achieved Biological Integrity possesses:

- Stable carbon content
- Reduced moisture (<25-30%)
- Retained nutrients
- Consistent physical properties
- Predictable energy density

These characteristics enable reliable, efficient conversion.

Without preservation, transformation is:

- Inefficient — energy is lost to drying and incomplete conversion
- Unpredictable — feedstock variability leads to inconsistent outputs
- Environmentally problematic — emissions from incomplete combustion
- Economically unviable — high costs and low yields

The Preservation Layer ensures that transformation receives a standardized, high-quality input. The Transformation Layer converts that input into potential value.

1.2 The Three Core Principles of Transformation

Principle 1 — The Quality of Transformation Cannot Exceed the Quality of Biological Capital Received

This is a fundamental engineering truth. No reactor, however sophisticated, can compensate for poor feedstock quality.

Feedstock Quality	Transformation Outcome
Biological Integrity achieved	Maximum yield, consistent quality, minimal emissions
Partial degradation	Reduced yield, variable quality, increased emissions
Significant degradation	Unviable process, wasted energy, environmental harm

The reactor is only as good as the biomass it receives.

Principle 2 — Transformation Must Preserve the Carbon Removed

The objective of CDR is permanent carbon removal. Transformation must ensure that the carbon captured in biomass remains stable.

Requirement	Mechanism
Stable carbon	Pyrolysis converts labile carbon to stable biochar (>80% Cfix target)
Permanence	Biochar persists in soil >100 years (projected)
Verifiability	MRV systems track and certify removals
No double counting	Chain of custody ensures unique claims

Principle 3 — Energy Integration Maximizes Value

Biomass contains stored energy. Transformation must capture and valorize that energy, not waste it.

Energy Stream	Valorization Pathway
Thermal energy	Drying, roasting, heating
Electrical energy	ORC cogeneration, syngas combustion
Chemical energy	Syngas, bio-oil, biochar

The Transformation Layer is not a single technology. It is an integrated energy system.

1.3 Relationship to Volume II

Volume II (The Preservation Layer) and Volume III (The Transformation Layer) are **structurally inseparable**.

Aspect	Volume II	Volume III
Function	Preserve Biological Capital	Transform Biological Capital into assets
Location	Farm/Origin	Collection Center/Processing Hub
Input	Wet agricultural residues	Stabilized biomass (Biological Integrity)
Output	Stabilized biomass (<25-30% moisture)	Biochar, energy, potential carbon assets
Infrastructure type	Passive physical systems	Active industrial systems

The transition is linear: Preservation → Integrity → Transformation.

No transformation occurs without prior preservation.

CHAPTER 2 — TECHNOLOGICAL FRAMEWORK

2.1 Technology Selection Criteria

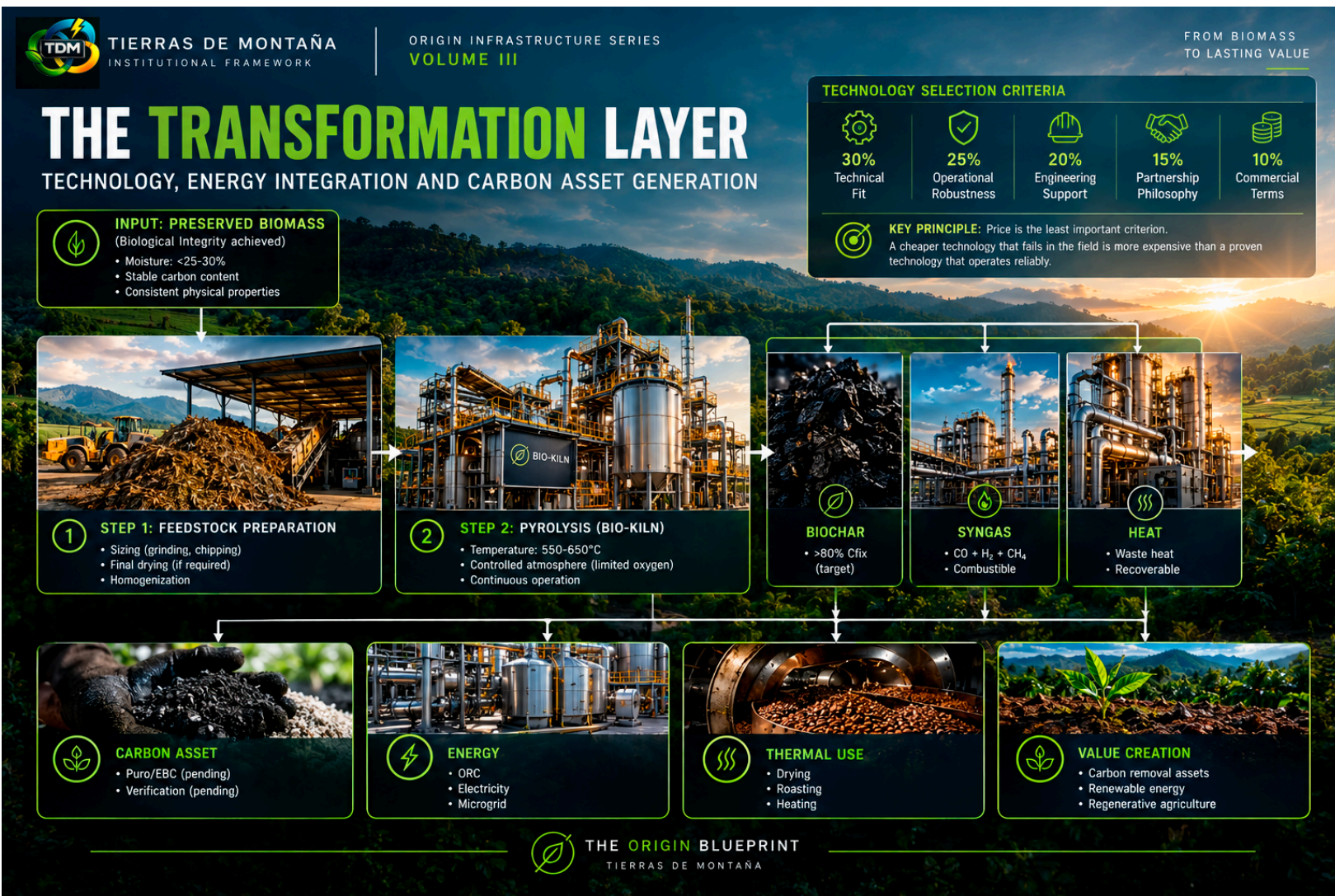
Technology selection within the TDM framework follows the principles established in Volume I:

Criterion	Weight	Rationale
Technical Fit	30%	Does it work with our biomass, our scale, our climate?
Operational Robustness	25%	Can it operate continuously in tropical, remote conditions?
Engineering Support	20%	Does the supplier provide process integration, FEED support, local commissioning?
Partnership Philosophy	15%	Are they open to co-development, replication, long-term alliance?
Commercial Terms	10%	Is pricing transparent, fair, aligned with project bankability?

Key Principle: Price is the least important criterion. A cheaper technology that fails in the field is more expensive than a proven technology that operates reliably.

2.2 The Transformation Pathway

The Transformation Layer is organized as a sequence of integrated steps:



2.3 Technology Archetypes

Archetype	Description	Application
Continuous Pyrolysis	Biomass is continuously fed into a reactor, producing a steady stream of biochar and syngas	High-volume operations, consistent feedstock, industrial scale
Batch Pyrolysis	Biomass is processed in discrete batches	Small-scale operations, variable feedstock, demonstration projects
Gasification	Biomass is converted to syngas at higher temperatures (>700°C) with controlled oxygen	Energy-focused applications, combined heat and power
Torrefaction	Mild pyrolysis (200-300°C) for pre-treatment	Upgrading biomass quality before further processing

TDM's preferred technology archetype is Continuous Pyrolysis due to:

- Consistent output quality
- Scalability
- Proven reliability
- Integration with ORC cogeneration

CHAPTER 3 — THE BIO-KILN: THERMOCHEMICAL CONVERSION

3.1 Technology Overview

The BIO-KILN is a **continuous pyrolysis reactor** designed for processing stabilized biomass into high-quality biochar and syngas.

Parameter	Specification
Technology	Continuous pyrolysis, 550-650°C
Feedstock	Biomass with moisture <25%
Biochar output	Cfix >80% (design target)
Operation	24/7 continuous
Thermal self-sufficiency	Fully self-sustaining (syngas combustion)
Syngas utilization	Combustion for heat, ORC for electricity
Proven track record	4+ years continuous operation in complex conditions

Technical Partners: GreenPower Ukraine (20+ years engineering experience)

3.2 Pyrolysis Process — Technical Description

The BIO-KILN operates through a controlled thermochemical process:

Stage	Temperature	Process	Output
1. Drying Zone	100-150°C	Residual moisture removed	Dry biomass
2. Pyrolysis Zone	350-550°C	Thermal decomposition in oxygen-limited atmosphere	Syngas + biochar
3. Cooling Zone	Cooling to <50°C	Controlled cooling (al-dente quenching)	Stable biochar
4. Syngas Combustion	Syngas burned in combustion chamber	Heat for self-sufficiency	Thermal energy

The "Al-Dente" Quenching Principle:

Like cooking pasta al dente, biochar is cooled at the precise moment of maximum carbon fixation and mineral retention:

Result	Mechanism
Maximum Cfix	Reaction stopped at optimal carbon purity
Potassium retention	Minerals fixed in biochar pores (not volatilized)
Nutrient retention	N, P, K preserved in biochar matrix
Structural integrity	Porosity and surface area maximized

3.3 Syngas Composition and Utilization

Syngas generated during pyrolysis has the following typical composition:

Component	Percentage	Application
CO	15-25%	Combustible
H₂	10-20%	Combustible
CH₄	2-5%	Combustible
CO₂	10-20%	Non-combustible
N₂	30-45%	Carrier gas

Syngas Energy Value: 5-10 MJ/Nm³

Utilization Pathway	Application
Thermal	Heating the reactor (self-sufficiency)
Drying	Biomass pre-drying
ORC	Electricity generation
Roasting	Zero-emission coffee roasting

The syngas system is designed for full thermal self-sufficiency. No external fuel is required.

3.4 Biochar Quality Specifications — Design Targets

Biochar 1A — Premium Grade (Design Targets):

Parameter	Specification	Standard	Status
Fixed Carbon (Cfix)	>80%	EBC, Puro.earth	DESIGN TARGET — laboratory verification pending
H/Corg Ratio	<0.7	Puro.earth	DESIGN TARGET — laboratory verification pending
Moisture	<5%	EBC	DESIGN TARGET
Ash content	<10%	EBC	DESIGN TARGET
Heavy metals	Below EBC threshold	EBC	DESIGN TARGET
PAH	Below EBC threshold	EBC	DESIGN TARGET
Particle size	2-20 mm	Customer specification	DESIGN TARGET
Surface area (BET)	>200 m ² /g	IBI	DESIGN TARGET

3.5 Operational Parameters and Efficiency

Parameter	Value	Optimization
Temperature	550-650°C	Maximizes Cfix, minimizes volatilization
Residence time	1-3 hours	Complete pyrolysis, high carbon conversion
Feedstock moisture	<25%	Maximizes energy efficiency

Biochar yield	20-30% of dry biomass	Dependent on feedstock and temperature
Syngas generation	30-40% of biomass energy	Combusted for self-sufficiency
Waste heat	40-50% of biomass energy	Recovered for drying and ORC

Thermal Efficiency Calculation:

Parameter	Value
Biomass energy input	100% (reference)
Syngas energy	35%
Biochar energy	25%
Waste heat	40%
Internal energy use	20% (drying, reactor heating)
Net usable energy	80% (35% syngas + 25% biochar + 20% waste heat)

CHAPTER 4 — ENERGY INTEGRATION

4.1 The Energy Valorization Principle

Pyrolysis generates significant thermal energy. This energy must be captured and valorized, not wasted.

The system produces three energy streams:

Energy Stream	Source	Valorization Pathway
A — Thermal (70-90°C)	Waste heat from reactor cooling	Pulp drying (eliminates lixiviates)
B — Thermal (180-240°C)	Syngas combustion exhaust	Zero-emission coffee roasting
C — Electrical (10-180 kWe)	ORC turbine using waste heat	Plant self-sufficiency + surplus electricity

4.2 Trigeneration System

The TDM system is designed as a **trigeneration facility**:



CHAPTER 4

ENERGY INTEGRATION

CAPTURE. VALORIZE. CREATE VALUE.



STABILIZED BIOMASS
(Biological Integrity)
<25-30% moisture



PYROLYSIS REACTOR
(BIO-KILN)



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- A** Thermal (70-90°C) → Pulp drying (eliminates lixiviates)
- B** Thermal (180-240°C) → Zero-emission coffee roasting
- C** Electrical (10-180 kWe) → Plant self-sufficiency + surplus electricity



FLOW A – THERMAL (70-90°C)
Waste heat from reactor cooling



FLOW B – THERMAL (180-240°C)
Syngas combustion exhaust



FLOW C – ELECTRICAL (10-180 kWe)
ORC turbine using waste heat



COFFEE PULP DRYING

- Eliminates lixiviates
- Reduces weight
- Prepares feedstock



ZERO-EMISSION COFFEE ROASTING

- No fossil fuel
- Potential Scope 3 reduction



PLANT POWER

- Self-sufficiency
- Surplus sale
- Microgrid / Peak shaving



4.3 ORC COGENERATION

ORC (Organic Rankine Cycle) technology converts low-temperature waste heat into electricity.

Parameter	Value	Status
Technology	Organic Rankine Cycle turbine	ENGINEERING ASSUMPTION
Thermal input	70-180°C	ENGINEERING ASSUMPTION
Electrical capacity	10-180 kWe	ENGINEERING ASSUMPTION — partner under discussion
Efficiency	10-15% (thermal-to-electrical)	ENGINEERING ASSUMPTION
Annual availability	>90% (continuous operation)	ENGINEERING ASSUMPTION
Lifespan	20+ years	ENGINEERING ASSUMPTION
Maintenance	Low (no combustion, minimal moving parts)	ENGINEERING ASSUMPTION



ORC BENEFITS

- **No additional fuel** – Uses waste heat from pyrolysis
- **Low emissions** – No combustion in ORC system
- **Proven technology** – Decades of industrial use
- **Plug-and-play** – Modular design, easy integration
- **High availability** – Minimal downtime



ELECTRICITY GENERATION POTENTIAL

Pyrolysis Capacity	ORC Capacity	Annual Generation
1 t/hour	10-50 kWe	80-400 MWh/year
2 t/hour	50-100 kWe	400-800 MWh/year
3 t/hour	100-180 kWe	800-1,400 MWh/year

Status: ORC partner is currently under discussion. Final specification will be confirmed prior to implementation.



4.4 ZERO-EMISSION COFFEE ROASTING

Flow B (180-240°C thermal) is used for zero-emission coffee roasting.

Parameter	Value	Status
Temperature	180-240°C	ENGINEERING ASSUMPTION
Fuel source	Syngas exhaust (clean combustion)	ENGINEERING ASSUMPTION
Emissions	Zero fossil fuel use	DESIGN TARGET
Coffee quality	Comparable to conventional roasting	ENGINEERING ASSUMPTION
Scope 3 reduction	Potential for significant reduction	PROJECTED



VALUE PROPOSITION

Aspect	Conventional Roasting	TDM Zero-Emission
Fuel source	Natural gas / electricity	Waste syngas heat
CO ₂ emissions	Direct and indirect	Zero (waste heat only)
Cost	Variable (market dependent)	Zero (free heat)
Scope 3 claims	Limited	Potential for full offset



**CIRCULAR ENERGY.
REGENERATIVE VALUE.
LASTING IMPACT.**

4.3 ORC Cogeneration

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Annual availability	>90% (continuous operation)	ENGINEERING ASSUMPTION
Lifespan	20+ years	ENGINEERING ASSUMPTION
Maintenance	Low (no combustion, minimal moving parts)	ENGINEERING ASSUMPTION

ORC Benefits:

Benefit	Mechanism
No additional fuel	Uses waste heat from pyrolysis
Low emissions	No combustion in ORC system
Proven technology	Decades of industrial use
Plug-and-play	Modular design, easy integration
High availability	Minimal downtime

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Coffee quality	Comparable to conventional roasting	ENGINEERING ASSUMPTION
Scope 3 reduction	Potential for significant reduction	PROJECTED

Value Proposition:

Aspect	Conventional Roasting	TDM Zero-Emission
Fuel source	Natural gas / electricity	Waste syngas heat
CO₂ emissions	Direct and indirect	Zero (waste heat only)
Cost	Variable (market dependent)	Zero (free heat)
Scope 3 claims	Limited	Potential for full offset

CHAPTER 5 — CARBON ASSET GENERATION

5.1 The Carbon Asset Framework

The TDM system generates **potential carbon removal assets** through biochar production.

Carbon Removal Pathway:

Step	Mechanism	Status
1. Carbon capture	Biomass absorbs CO ₂ during growth	ASSUMED
2. Carbon stabilization	Pyrolysis converts labile carbon to stable biochar	DESIGN TARGET
3. Carbon storage	Biochar applied to soil (>100 years permanence projected)	PROJECTED — verification methodology dependent on soil application and monitoring
4. Carbon verification	MRV system tracks, monitors, verifies	PENDING
5. Carbon certification	Puro.earth, EBC, Verra certification	PENDING
6. Carbon sale	Carbon Removal Units sold to buyers	PROJECTED

Section 5.2 — Carbon Accounting (Final Version with Status Labels)

5.2 Carbon Accounting — Integrated Territorial System

Step 1 — Harvest and Biomass Characterization:

Parameter	Value	Status
Fresh cherries harvested	10,000 kg	INPUT
Initial moisture	80%	INPUT
Dry matter	2,000 kg	CALCULATED
Wet pulp (after depulping)	4,000 kg	ASSUMED
Pulp moisture	85%	ASSUMED
Pulp dry matter	600 kg	CALCULATED
Solids in suspension (mucilage/sugars)	400 kg	NEW — CLOSED BALANCE

Step 2 — Preservation (Volume II):

Parameter	Value	Status
Pulp entering preservation	4,000 kg	INPUT
Moisture after stabilization	22%	TDM DESIGN STANDARD
Stabilized biomass	769 kg	CALCULATED
Water removed	3,231 kg	CALCULATED
Biological Integrity achieved	Supported by indicators	MEASURED RESULT

Step 3 — Transformation (Integrated Territorial System):

Feedstock Source	Dry Weight	Yield	Biochar Output	Status
Stabilized pulp (from 4,000 kg wet)	600 kg	25%	150 kg	CALCULATED
Dried parchment (from 2,000 kg wet @ 20.8%)	1,584 kg	25%	396 kg	CALCULATED
Centralized farm residues (prunings, etc.)	~2,600 kg	25%	650 kg	ASSUMED
TOTAL INTEGRATED SYSTEM	~4,784 kg	25%	~1,196 kg	ESTIMATED

Note on biochar output: The biochar output of ~1,196 kg is the estimated integrated system output. For commercial planning and simplicity, the figure of 1,000 kg is used as a **planning reference** (commercial rounding). This distinction must be maintained in all carbon accounting. The biochar output is an **integrated territorial system output**, not a single batch from the 10,000 kg cherries alone.

5.3 Carbon Removal Calculation — Stoichiometric Equivalent

Formula:

$$\text{Carbon Removed (kg CO}_2\text{e)} = \text{Biochar Mass (kg)} \times \text{Cfix (\%)} \times 3.67$$

For 1,000 kg of Biochar (at 80% Cfix target):

Parameter	Value	Status
Biochar mass	1,000 kg	PLANNING REFERENCE
Cfix content	80%	DESIGN TARGET
Carbon mass	800 kg	CALCULATED
CO ₂ equivalent	2,936 kg CO ₂ e	CALCULATED

Note: This is the **stoichiometric equivalent** of the carbon content, not a verified removal value. Actual net removals depend on full lifecycle assessment and third-party verification.

5.4 Certification Standards — Eligibility and Projected Compliance

Puro.earth

Requirement	TDM Status	Evidence
Feedstock sustainability	Agricultural residues only	ELIGIBILITY CRITERION
Biochar production	Continuous pyrolysis, <650°C	ELIGIBILITY CRITERION
Cfix >80%	Design target	DESIGN TARGET
H/Corg <0.7	Design target	DESIGN TARGET
Permanence >100 years	Biochar in soil	PROJECTED
No double counting	Full chain of custody	ELIGIBILITY CRITERION
Third-party verification	Greenchar MRV	PENDING

EBC (European Biochar Certificate)

Requirement	TDM Status	Evidence
Feedstock	Agricultural residues	ELIGIBILITY CRITERION

Production temperature	550-650°C	ELIGIBILITY CRITERION
Carbon content	>80% Cfix target	DESIGN TARGET
Heavy metals	Below limits	DESIGN TARGET
PAH	Below limits	DESIGN TARGET
Application	Soil amendment	ELIGIBILITY CRITERION

Verra (VM0044 — Biochar Methodology)

Requirement	TDM Status	Evidence
Additionality	Project-based, not business-as-usual	PROJECTED
Baseline	Methane emissions avoided	PROJECTED
Leakage	Assessed and mitigated	PROJECTED
Permanence	>100 years	PROJECTED
Monitoring	Continuous MRV	PENDING
Verification	Independent third party	PENDING

5.5 Carbon Revenue Projection

Parameter	Value	Status
Net carbon removal per batch	~2.5 tCO ₂ e	ESTIMATED, PENDING VERIFICATION
Annual batches	1,600-2,800	ASSUMED
Annual carbon removal	4,000-7,000 tCO ₂ e	PROJECTION
Carbon price	\$150/tCO ₂ e	ASSUMED
Annual revenue	\$600,000 – \$1,050,000	PROJECTION, BASED ON ASSUMED PRICE

5.6 Zero Tolerance for Double Counting

In strict compliance with Volume I, Article 17.5, the platform enforces an absolute zero-tolerance rule for the duplication of environmental claims.

Double Counting Prevention Measures:

Measure	Mechanism
Unique identification	Each carbon asset has a unique ID
Chain of custody	Full tracking from biomass to credit
Registry integration	Puro.earth and EBC registries
Reconciliation	Greenchar balances all metric tons
Audit trail	Complete documentation available
Verification	Independent third-party audits

No carbon removal certificate may be claimed or issued if the underlying biomass has been claimed under any separate agricultural offset, soil carbon, or corporate supply chain scope mitigation scheme.

CHAPTER 6 — MRV AND CERTIFICATION

6.1 The MRV Architecture

In alignment with Volume II (Observing Net), MRV is conceived as a continuous, biological cognitive cycle integrated directly into the physical infrastructure layers.

Three-Loop MRV Architecture:



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ORIGIN INFRASTRUCTURE SERIES
VOLUME III



MRV AND CERTIFICATION

6.1 THE MRV ARCHITECTURE

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**THREE-LOOP MRV ARCHITECTURE**

1 **LOOP 1:
BIOMASS TRACEABILITY**



✓ M-1.1 Wet Weight at Origin (calibrated scales)

✓ M-1.2 Moisture Verification (oven-drying / pin meters)

✓ M-1.3 Payload Reduction Factor (5:1 mass ratio)

✓ **Verifies:** Scope 3 transport fuel savings (scenario result)

2 **LOOP 2:
PASSIVE SANDWICH INFRASTRUCTURE SENSING**
(Volume II)



✓ M-2.1 Thermodynamic Log (temperature data, 60-70°C peak)

✓ M-2.2 Leachate Absorption Ratio (biochar capture)

✓ M-2.3 Nutrient Retention Rate (N, P, K analysis)

✓ **Verifies:** Methane avoidance (qualitative), nutrient retention

3 **LOOP 3:
BIO-KILN SENSOR INTEGRATION**
(Volume III)



✓ M-3.1 Pyrolysis Thermal Stability (500-650°C continuous)

✓ M-3.2 AI-Dente Quenching Log (water injection)

✓ M-3.3 Syngas Auto-Combustion Feedback (thermal efficiency)

✓ **Verifies:** Biochar quality (design targets), energy efficiency

6.2 LABORATORY CERTIFICATION REQUIREMENTS

To qualify for the issuance of Puro.earth Carbon Ownership Removal Certificates, the biochar must meet strict laboratory criteria.

Parameter	Requirement	Method	Status
Fixed Carbon Content (Cfix)	>80%	Elemental analysis (ASTM D1762-84)	DESIGN TARGET
H/Corg Ratio	<0.7	Elemental analysis	DESIGN TARGET
Moisture	<5%	Gravimetric method	DESIGN TARGET
Ash	<10%	Gravimetric method	DESIGN TARGET
Heavy metals	Below EBC limits	ICP-MS	DESIGN TARGET
PAH	<12 mg/kg	GC-MS	DESIGN TARGET
Surface area (BET)	>200 m ² /g	BET analysis	DESIGN TARGET

6.3 CERTIFICATION LIFECYCLE AND TRACEABILITY

Every batch of premium biochar returned to the farm floor is assigned a unique identifier and registry entry.

Step	Action	Responsible	Status
1	Biomass harvest Register GPS coordinates, producer ID	Farm operator	PENDING
2	Preservation Log process parameters, indicators	Volume II operator	PENDING
3	Transportation Weight, moisture, chain of custody	Logistics coordinator	PENDING
4	Pyrolysis Process parameters, batch ID	BIO-KILN operator	PENDING
5	Biochar certification Laboratory analysis, batch certification	Greenchar	PENDING
6	Credit issuance Puro.earth/EBC registration	Greenchar	PENDING



Auditors can track the biological lifecycle from cherry harvest to pyrolysis reactor, through to its final destination as an agricultural soil amendment.



THE ORIGIN BLUEPRINT
TIERRAS DE MONTAÑA

6.2 Laboratory Certification Requirements

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Ash	<10%	Gravimetric method	DESIGN TARGET
Heavy metals	Below EBC limits	ICP-MS	DESIGN TARGET
PAH	<12 mg/kg	GC-MS	DESIGN TARGET
Surface area (BET)	>200 m ² /g	BET analysis	DESIGN TARGET

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1. Biomass harvest	Register GPS coordinates, producer ID	Farm operator	PENDING
2. Preservation	Log process parameters, indicators	Volume II operator	PENDING
3. Transportation	Weight, moisture, chain of custody	Logistics coordinator	PENDING
4. Pyrolysis	Process parameters, batch ID	BIO-KILN operator	PENDING
5. Biochar certification	Laboratory analysis, batch certification	Greenchar	PENDING
6. Credit issuance	Puro.earth/EBC registration	Greenchar	PENDING

Auditors can track the biological lifecycle from cherry harvest to pyrolysis reactor, through to its final destination as an agricultural soil amendment.

CHAPTER 7 — SYSTEMIC CONCLUSION

7.1 The Volume III Proposition

Volume III is not a technology manual. It is an integrated framework for transforming preserved biomass into verifiable environmental, economic, and social assets.

The Transformation Layer is the third and final operational layer of the ORIGIN system:

7.2 The Complete System

When all three volumes are integrated, the complete ORIGIN system is:

TIERRAS DE MONTAÑA
INSTITUTIONAL FRAMEWORK

ORIGIN INFRASTRUCTURE SERIES
VOLUME III

SYSTEMIC CONCLUSION

THE COMPLETE ORIGIN SYSTEM

From the vision to the value. A unified framework for regenerative infrastructure and carbon asset generation.

VOLUME I
THE ORIGIN BLUEPRINT
Doctrine, principles, concepts, and the Origin Decision Matrix.

VOLUME II
THE PRESERVATION LAYER
Passive infrastructure at origin → Biological Integrity.

VOLUME III
THE TRANSFORMATION LAYER
BIO-KILN → Biochar + Energy + Potential Carbon Assets.

7.3 THE INSTITUTIONAL DOCTRINE

The TDM system does not transport biomass. It transports value.
Infrastructure determines outcomes. Volume I, II and III form a unified system:

VOLUME I
defines the vision.

VOLUME II
preserves the value.

VOLUME III
transforms the value into potential assets.

Together, they ensure that Biological Capital is preserved, logistics are optimized, transformation is efficient, and the territory is regenerated.

THE ORIGIN BLUEPRINT
TIERRAS DE MONTAÑA

7.3 The Institutional Doctrine

The TDM system does not transport biomass. It transports value.

Where competitors ship water and pay for the privilege, TDM ships optimized feedstock and creates multiple potential revenue streams.

Infrastructure determines outcomes.

Volume I (Blueprint), Volume II (Preservation), and Volume III (Transformation) form a unified system:

- **Volume I defines the vision.**
- **Volume II preserves the value.**
- **Volume III transforms the value into potential assets.**

Together, they ensure that Biological Capital is preserved, logistics are optimized, transformation is efficient, and the territory is regenerated.

TECHNICAL REVISION LOG — VOLUME III v1.2

ID	Location	Original Statement	Revised Statement	Reason
R26	Preface	"verified carbon removals"	Replaced with "potential carbon removal assets, subject to MRV and third-party verification"	Baseline M5 — CRITICAL
R27	Ch. 3	"Cfix >80%" and ">100 years permanence"	Reclassified as DESIGN TARGET and PROJECTED with status labels attached	Baseline M6 — HIGH
R28	Ch. 5	Carbon values without attached status	Added status labels to tables (ESTIMATED, PENDING, PROJECTION)	Baseline M7 — HIGH
R29	Ch. 4	ORC specifications as facts	Reclassified as ENGINEERING ASSUMPTION; partner status clarified	Baseline M9 — MEDIUM
R25	Metadata	No clarification on volume numbering	Added editorial note distinguishing ORIGEN volumes from Institutional Collection volumes	Baseline I1 — HIGH

End of Volume III — The Transformation Layer (Version 1.2)

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