

M C P S E R V E R

N O C O D E

C L O U D H O S T E D

CO₂ Compression & Transport Designer MCP

Build efficient carbon capture and transport systems.

CO₂ Compression & Transport Designer MCP gives your AI agent the engineering math needed for CCS and CCUS projects. It handles the heavy lifting for pipeline sizing, compression stage calculations, and phase stability checks. You can run cost trade-off analyses between CAPEX and OPEX directly within your preferred MCP-compatible client.

A+ Quality Score 100/100

ccs

ccus

co2

pipeline

compression

thermodynamics



The connectivity layer between AI and the world's software.

Vinkius sits between AI and every application. All communication passes through Vinkius Cloud via the Model Context Protocol (MCP) — with governance, observability, and security at every layer.

Your AI Connections Run Through Vinkius Cloud

The world's largest
managed MCP catalog

Vinkius is the connectivity layer where AI connects to the software your business already runs. We handle the hosting, the security, the credentials, the uptime — you get agents that actually do things.

We operate the world's largest managed MCP catalog. Major SaaS platforms, CRMs, databases, and cloud providers — running, monitored, production-ready. This MCP server is hosted and maintained by the Vinkius Cloud for AI Agents.

The agent doesn't manage credentials, doesn't manage uptime, doesn't manage security. Vinkius does.

— Architecture principle

Four Pillars of the Vinkius Runtime

01 — Security by design

Credentials stay encrypted at rest via AES-256. The AI agent never touches raw keys — they're injected into a sandboxed V8 isolate at runtime. Actions are logged, and connections have an emergency kill switch.

03 — Deterministic observability

Eight immutable metrics per endpoint: request volume, p95 latency, error rate, active connections, cost attribution. A live payload feed logs every tool call with mutation detection.

02 — Built on MCP Fusion

This MCP server was built with **MCP Fusion**, the open-source framework (Apache 2.0) that powers the entire Vinkius catalog. Schema-as-firewall strips undeclared fields, compiled PII redaction runs at zero overhead, and cryptographic lockfiles produce git-diffable audit trails.

04 — Autonomous operations

Servers are deployed, monitored, and patched autonomously. New capabilities and security patches ship weekly. Zero-downtime deployments ensure continuous availability across all managed MCP servers.

AES-256

Encryption at rest

Ed25519

PKI vault signatures

24h TTL

Ephemeral session keys

V8 Isolate

Sandboxed execution

One Token. Instant Access.

Every MCP server on Vinkius is accessed through a **Connection Token**. Tokens are generated in the cloud dashboard and produce a unique MCP endpoint URL. Paste this URL into any MCP-compatible client — no SDK required.

A single token can serve **multiple AI clients simultaneously**, or you can issue separate tokens per client for granular access control. Each token tracks its own request count, last activity timestamp, and can be individually enabled or revoked.

MCP ENDPOINT`https://edge.vinkius.com/{token}/mcp`

Claude



Cursor



VS Code



Windsurf



Grok



Gemini

Security Is the Architecture

Security in Vinkius is not a feature — it's the foundation of the runtime. The gateway enforces multiple independent protection layers between AI agents and third-party APIs.

01 — Ed25519 PKI Vault

Every workspace has an Ed25519 Master Key. Session keys are generated ephemerally (24h TTL) and signed by the Master Key. Credentials never leave the vault boundary.

02 — V8 Isolate Sandboxing

Tool code runs inside isolated-vm V8 isolates with 64 MB memory caps and per-request timeouts. No filesystem access, no network access except through the SSRF-guarded fetch bridge.

03 — SSRF Guard

All outbound HTTP requests are DNS-resolved and validated before execution. Private IP ranges (10.x, 172.16-31.x, 192.168.x, AWS metadata 169.254.x) are blocked at the network layer.

05 — Cryptographic Audit Trail

Every request is signed into a SHA-256 hash chain with Ed25519 signatures. Events form a tamper-proof, SIEM-exportable forensic record.

04 — DLP & PII Redaction

A ResponseGuard pipeline intercepts every tool response. Configurable redaction patterns strip sensitive fields (emails, SSNs, card numbers) before data reaches the AI agent.

06 — Honeypot Trap System

Phantom credentials are injected into isolated environments. If a honeypot is used outside Vinkius infrastructure, the server is quarantined instantly.

Emergency Kill Switch

EU AI Act Art. 14(1)
Compliant

The kill switch is an **emergency halt** mechanism — not a simple toggle. When triggered, it executes three actions atomically:

01 — Server deactivated

The MCP server is immediately taken offline across the entire cluster.

02 — All tokens revoked

Every connection token is invalidated. Total lockout — reconnection blocked until new tokens are issued.

03 — WebSocket connections killed

Active connections terminated via Redis pubsub broadcast. Propagates to every runtime node in the cluster.

Full Visibility. Zero Guesswork.

The Vinkius cloud dashboard includes a full MCP Governance suite — real-time analytics and security controls for production AI operations.

Control Plane

KPI dashboard with request volume, latency, success rate, token consumption, and AI-generated operational briefings.

FinOps

Cost tracking per tool, payload compression savings, budget optimization signals, and consumption trends.

Firewall & DLP

PII redaction activity, sensitive data protection counters, and security event timeline.

Agent Activity

Which AI clients are connecting, how often, and what they're doing — real-time session tracking.

Tool Health

Slowest and most error-prone tools, with actionable root-cause insights and performance baselines.

Incident Log

Error trends, failure rates, status-code breakdowns, and forensic audit trail access.

Get started at cloud.vinkius.com — connect your AI agent in under 60 seconds.

CO₂ Compression & Transport Designer MCP

4 tools available

Cloud-hosted on Vinkius

You can now bring specialized carbon capture engineering directly into your AI workflow. This MCP provides the specific thermodynamic and mechanical tools required to design CO₂ transport infrastructure. Instead of manually calculating pressure drops or compression requirements, you tell your agent the flow rate and target pressures, and it handles the math.

You can use it to verify if your CO₂ will stay in a supercritical or dense phase throughout the entire route, preventing phase change issues during transport. It also lets you balance the cost of larger diameter pipes against the electricity costs of higher compression. Whether you are sizing a new pipeline or optimizing an existing transport route, this MCP turns your AI client into a specialized CCS design assistant.

Core Capabilities

01 — Phase Stability Verification

The agent checks if CO₂ remains supercritical or dense throughout the transport route.

02 — Compression Sizing

The agent calculates the number of stages and power needed for specific pressure jumps.

03 — Pipeline Dimensioning

The agent determines physical pipe diameters and operating conditions.

04 — Cost Optimization

The agent evaluates the balance between pipe CAPEX and compression OPEX.

One Click on Vinkius — From Prompt to Execution

Available at vinkius.com/en/ai-agent-connect/co2-compression-transport-designer — connect your AI agent in three steps.

- 01 Connect your client like Claude or Cursor to the Vinkius hosted MCP.
- 02 Provide your transport parameters like mass flow, pressure, and temperature.
- 03 The agent calls the specific engineering tool to perform the math.
- 04 Review the calculated dimensions, power needs, or cost optimizations.

Connect your AI client to Vinkius to start running engineering calculations immediately.

Built For

This MCP is built for engineers working on carbon capture and storage infrastructure.

CCS Engineers

They use the agent to run rapid thermodynamic checks and sizing calculations.

Process Engineers

They hand off mass flow and pressure data to the agent to get compression configurations.

Project Economists

They use the cost optimization tool to compare different pipeline design scenarios.

What Changes When You Connect

- 01 Reduces manual calculation errors in thermodynamic modeling.
- 02 Speeds up the trade-off analysis between pipe size and power use.

- 03** Provides instant verification of phase stability for supercritical CO₂.
-

Real-World Applications

Route Feasibility

Check if a proposed CO₂ transport route will maintain the necessary phase state.

Compression Planning

Determine the exact power and stage count needed to move CO₂ from source to pipeline.

CAPEX/OPEX Balancing

Find the sweet spot between spending on larger pipes and spending on electricity for compressors.

Pipeline Sizing

Calculate the required diameter for specific mass flow rates and distances.

Patterns to Avoid

Vague thermodynamic requests

❌ AVOID

Ask your agent to just 'make sure the CO₂ is safe to move' without providing specific mass flow or pressure targets.

✓ INSTEAD

Provide exact flow rates and target pressures, then use ``validate_phase_stability`` to confirm the fluid stays in the required dense or supercritical phase.

Ignoring CAPEX/OPEX trade-offs

❌ AVOID

Choosing the largest possible pipe diameter to minimize compression needs without checking the total project cost.

✓ INSTEAD

Run a trade-off analysis using ``optimize_transport_cost`` to find the balance between pipe capital costs and compression electricity expenses.

Manual stage calculation

❌ AVOID

Trying to guess how many compressor stages you need based on rough pressure estimates.

✓ INSTEAD

Input your pressure requirements into ``calculate_compression_requirements`` to get the exact stage count and power needed.

The Right Fit

CCS engineers and process designers should connect this MCP to automate thermodynamic calculations. Project economists should use it to run rapid cost scenarios. If your work doesn't involve designing or optimizing CO2 transport infrastructure, this MCP isn't for you.



4 Specialized Engineering Tools for CO2 Transport Design

These tools handle the heavy lifting for thermodynamic modeling, pipeline sizing, and cost-based trade-off analysis.

#	TOOL	DESCRIPTION
01	validate_phase_stability	Checks if the CO2 stays in the required dense or supercritical phase during transport. It ensures the fluid properties remain stable across the entire route.
02	calculate_compression_requirements	Determines the specific compression configuration needed. It calculates the number of stages and total power required to reach target pressures.
03	design_pipeline_parameters	Sets the physical dimensions and operating conditions for the transport line. It calculates diameter and arrival pressures based on your input parameters.
04	optimize_transport_cost	Runs trade-off analyses between different design choices. It compares the capital cost of pipeline diameter against the operating cost of compression power.

See It in Action

Real prompts you can use once this MCP is connected to your AI agent through Vinkius Cloud.

U Calculate the compression requirements for 500 kg/s of CO2 moving from 5 MPa to 15 MPa.



The system requires 3 compression stages with a total power requirement of 42.5 MW to reach the target pressure.

U What is the optimal pipeline diameter for a 100 km transport route at 500 kg/s?



The optimal diameter for this route is 0.45 meters, ensuring the arrival pressure remains above the critical threshold.

U Will CO2 stay supercritical at 10 MPa and 35 degrees Celsius?



Yes, the CO2 remains in a stable supercritical state with a criticality margin of 1.2 MPa.

Frequently Asked Questions

01 What clients can I use with this MCP?

You can use this MCP with any compatible client including Claude, Cursor, Windsurf, and VS Code.

02 Do I need to host the MCP myself?

No, Vinkius hosts and manages the MCP for you. You just connect and use it.

03 Can this tool help with supercritical CO2 transport?

Yes, the `validate_phase_stability` tool specifically verifies if CO2 stays in a dense or supercritical phase.

04 How does the cost optimization work?

The `optimize_transport_cost` tool evaluates the trade-off between pipeline diameter costs and compression power costs.

05 Does this MCP handle compression math?

Yes, the `calculate_compression_requirements` tool determines the necessary stages and power requirements.

06 How do I calculate the power needed for CO2 transport?

You can use the `'calculate_compression_requirements'` tool by providing the source pressure, target pressure, and mass flow rate.

07 Can I check if the CO2 stays in a supercritical state?

Yes, the `'validate_phase_stability'` tool allows you to verify if the CO2 remains in the supercritical or dense phase based on operating pressure and temperature.

08 How is the pipeline diameter determined?

The `'design_pipeline_parameters'` tool calculates the optimal diameter by evaluating pressure drops over the specified distance and mass flow rate.

Go Live in 60 Seconds

Get your connection token from cloud.vinkius.com, then paste the endpoint URL into any MCP-compatible client.

YOUR MCP ENDPOINT

`https://edge.vinkius.com/[TOKEN]/mcp`

CLIENT	WHERE TO CONFIGURE
 Claude AI	Profile → Customize → Connectors → "+" → Add custom connector → Paste endpoint
 Cursor	Settings → Features → MCP Servers → "+ Add New MCP Server" → Type: SSE → Paste endpoint
 VS Code	Ctrl/Cmd+Shift+P → "MCP: Add Server" → add <code>"co2-compression-transport-designer": { "url": "..." }</code>
 Windsurf	MCP Settings → <code>mcp_settings.json</code> → Add endpoint URL
 ChatGPT	Settings → Tools & plugins → Add MCP server → Paste endpoint
 Gemini	Extensions → Add MCP Server → Paste endpoint URL

ASK AN AI ABOUT THIS

Let your preferred AI explain this MCP server

-  **Ask ChatGPT** 
-  **Ask Claude** 
-  **Ask Perplexity** 
-  **Ask Gemini** 
-  **Ask Grok** 

READY TO CONNECT

CO₂ Compression & Transport Designer is live on Vinkius Cloud.

Get your connection token, paste it into your AI agent, and
start building. No SDK. No deployment. Just results.

Start at cloud.vinkius.com →

vinkius.com · support@vinkius.com

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DOCUMENT INFORMATION

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Platform	Vinkius Cloud for AI Agents
Endpoint	<code>https://edge.vinkius.com/{token}/mcp</code>

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