C02-FUEL CIRCULAR SYSTEM

📌 Overview

EcoLoop is an interactive climate-technology simulation built to visualize how atmospheric CO_2 can be captured, converted into synthetic e-fuel, and recycled in a closed-loop system.
Although purely front-end and simulation-based, the platform is designed to resemble a real operational control center used in next-generation carbon removal facilities.

EcoLoop integrates four major layers:

- Live environmental monitoring
- Engineering workflow visualization
- AI-powered climate modeling & strategy generation
- Immersive narrative storytelling

The experience aims to educate, inspire, and demonstrate future sustainable technologies.

🚀 Features

Dashboard — Global CO_2 Intelligence Hub

- A real-time simulation that displays the planet's carbon condition and fuel synthesis performance.

CO_2 Captured (Geospatial Simulation)

- Values increase dynamically based on global CO_2 density, inspired by CO-Earth–style datasets.
- Simulated fluctuations mimic environmental variability.
- User input does not affect capture rate — the system behaves autonomously.

Fuel Generated (Proportional Yield Estimator)

- Fuel output is directly proportional to CO_2 captured.
- Predictive modeling gives rough fuel estimates.
- Demonstrates dependency between carbon intake and fuel synthesis.

System Efficiency (Dynamic Behavior)

- Efficiency fluctuates realistically based on simulated system conditions.
- Behavior approximates:

Atmospheric CO_2 PPM (Stability Threshold)

- Updates every minute.
- Critical Alert Mode activates when levels exceed ~420 PPM.
- System generates automated operational recommendations.

Planetary Globe Visualization

- Background shifts between blue → stable and red → critical states.
- Includes animated rotating globe.
- Stabilization nodes appear as pulsing dots.

Extraction vs Production Graph

Real-time animated graph visualizing:

- CO_2 extraction rate
- Fuel production rate

Live Operations Feed

Displays actionable system messages and diagnostics.

Process Map — Engineering the Carbon-to-Fuel Pathway

🌀 Direct Air Capture

“Huge fans draw in ambient air. Chemical sorbents selectively bind with CO_2, separating it from other gases.”

⚡ Green Hydrogen Production

“Renewable energy powers electrolyzers that split water into Hydrogen and Oxygen.”

🔥 Reaction Chamber

“Captured CO_2 and H_2 undergo a Reverse Water-Gas Shift reaction to form methanol precursors.”

💧 Fuel Synthesis

“Crude methanol is refined into drop-in e-fuels compatible with existing engines.”

♻️ Zero-Net Use

“Vehicles burn the synthetic fuel, releasing CO_2 that is captured again, forming a perpetual carbon loop.”

Includes voice narration and clickable nodes for engineering details.

Gemini AI — Planetary Modeling, Optimization & Strategy Engine

📈 Global Analysis

- CO_2 rise vs temperature anomaly (2000–2025)
- Climate risk correlations
- Predictive visual insights

🔧 Tech Simulator (10 MW → 1000 MW)

Adjust parameters such as:

- Capture capacity
- Energy assumptions
- Technology type

Outputs estimated carbon removal, energy demand, and fuel potential.

🤖 AI Chatbot Assistant

- Answers climate, engineering, and CO_2 questions
- References live simulation data
- Provides analytical and educational support

📊 Strategy Planning

- Country-specific strategy generation
- AI-created 20-year environmental impact modeling
- Recommendations for DAC scaling and infrastructure planning

Story Mode — Immersive Climate Narrative

📕 Chapter 1 — The Invisible Threat

Industrial emissions have thickened the atmosphere, pushing the planet toward a tipping point.

🤖 Chapter 2 — AI-Driven Capture

Gemini AI optimizes DAC arrays by predicting airflow and saturation patterns.

🚗 Chapter 3 — Sustainable Mobility

Captured carbon becomes e-fuel, enabling carbon-neutral aviation, shipping, and transport.

♻️ Chapter 4 — The Circular Future

A fully closed-loop carbon system where humanity thrives sustainably.

Category	Technology
Framework	React
Language	TypeScript(.ts, .tsx), html
Data	JSON simulations
AI Logic	Custom Gemini Service
Rendering	ReactDOM

📁 Folder Structure

/components

AInsights.tsx

Dashboard.tsx

Navigation.tsx

ProcessMap.tsx

StoryMode.tsx

/services

geminiService.ts

App.tsx

index.html

index.tsx

metadata.json

types.ts

▶️ Running the Project

Install dependencies:

--npm install

Start dev server:

--npm run dev

Build production files:

--npm run build

🎯 Purpose

EcoLoop serves as:

- A climate-tech demonstration tool
- A CO_2-to-fuel educational simulator
- A prototype for future sustainability platforms
- A storytelling + analytics experience
- A conceptual model for closed-loop ecosystems

📪 Contact

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