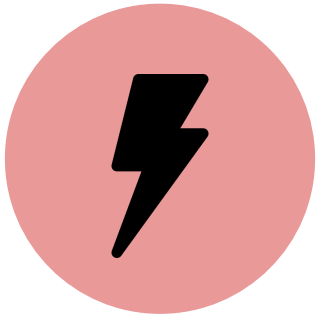
Carbon Upcycled

Electrocatalytic-Thermocatalytic Conversion of CO_2 to Carbon Nanofibers

Three key challenges limit carbon dioxide removal

We must reduce annual CO2 emissions by **54% before 2030** to realize < 1.5 °C warming (Intergovernmental Panel on Climate Change)

Energy-intensity



Permanence

Cost

Nature 610, 687–692 (2022), Nature Catalysis *7*, 98–109 (2024)

Carbon Upcycled solves the key CDR challenges

Brookhaven National Laboratory: *CO2 fixation into carbon nanofibres using electrochemical–thermochemical tandem catalysis*

Energy-intensity

Self-Sustaining Reaction

Permanence

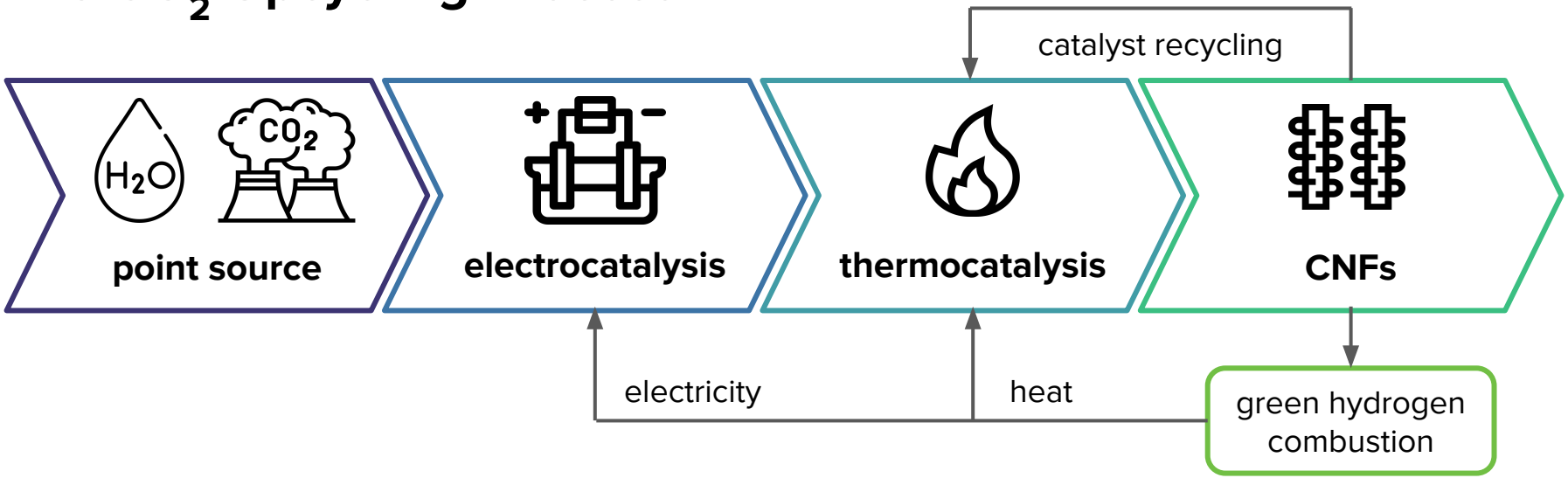
Solid Carbon Sequestration

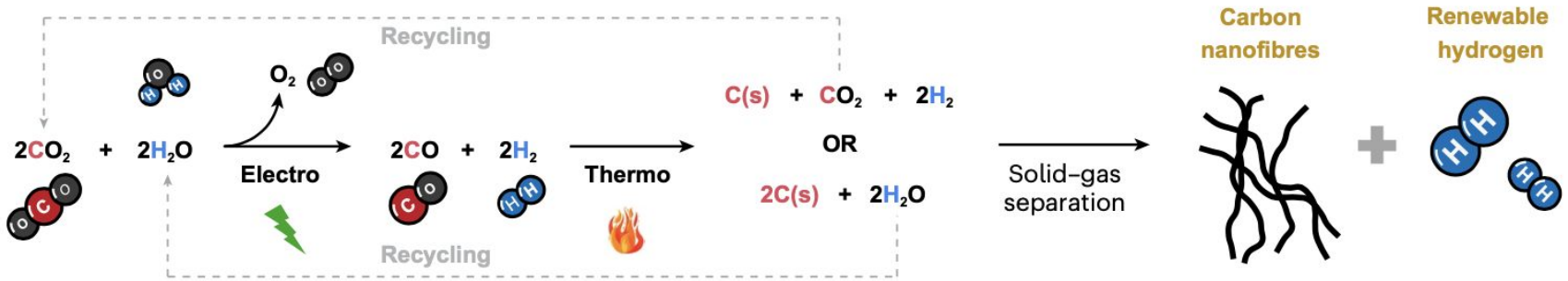
Cost

CO2 Valorization

Nature 610, 687–692 (2022), Nature Catalysis *7*, 98–109 (2024)

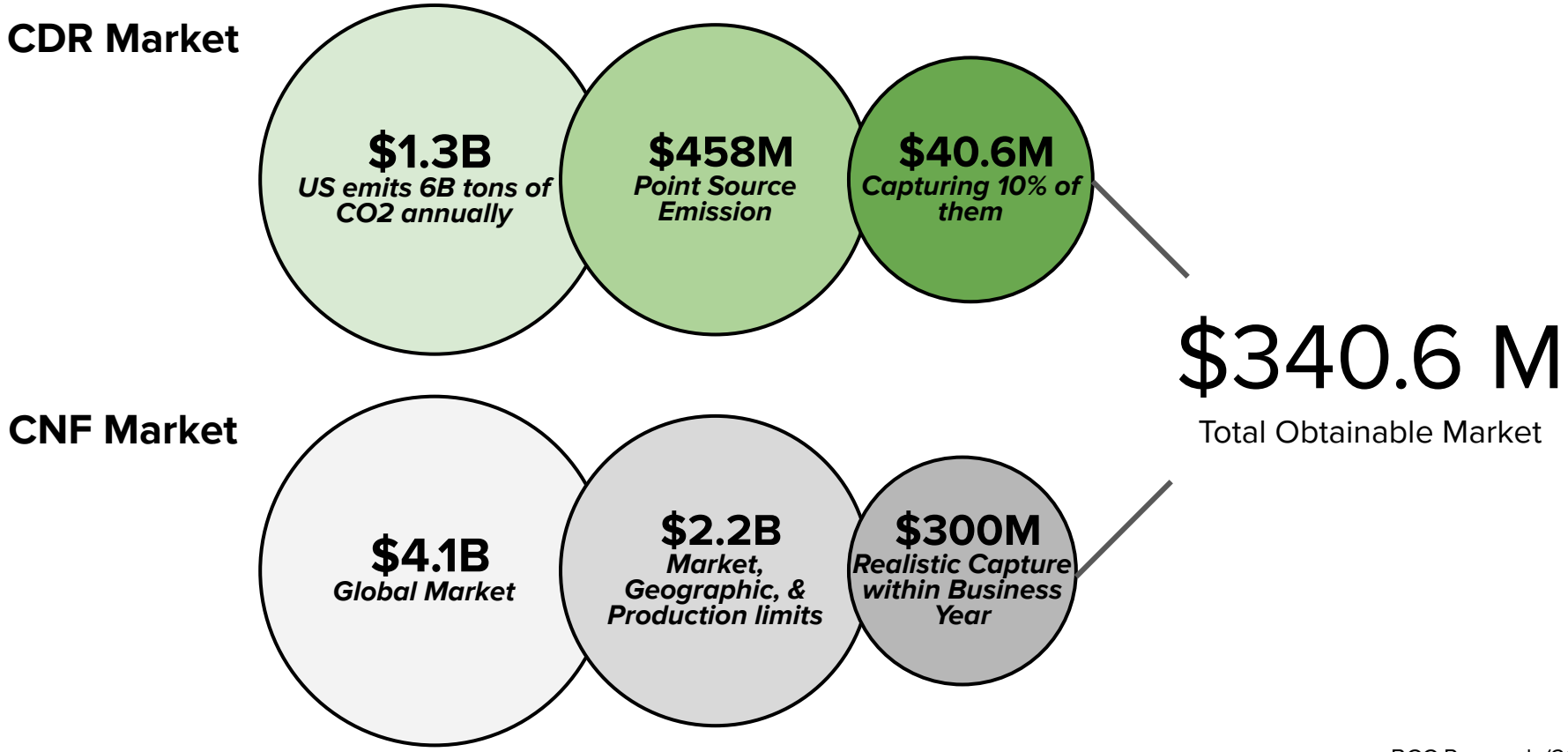
The CO_2 Upcycling Process





Nature Catalysis *7*, 98–109 (2024)

Carbon Upcycled captures both CDR & CNF market



BCC Research (2022)

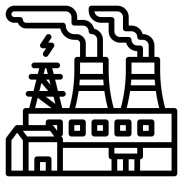
Carbon Upcycled provides unique value to our customers

Heavy CO_2 Emitters

Customer Incentives

- Regulations
- 45Q Tax Credit
- Future-Proofing
- Brand Image
- Lower Cost

Target Market



Power Plants

5316 tons CO_2 emitted

10.4% capture

552 tons CO_2 captured

$19 k tax credit

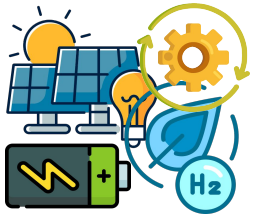
Congressional Research Service (2023)

Carbon Upcycled provides unique value in CDR Market

	Carbon Upcycled	Carbon Valorization	Carbon Capture	Carbon Utilization
CO_2 Capture	✓	✗	✓	✗
Energy-Efficient	✓	✗	✓	✗
Permanent Sequestration	✓	✗	✗	✗
CO_2 Valorization	✓	✓	✗	✗
Profitability	✓	✓	✓	✓

Carbonova	Svante, Recarbon, Mantel	Twelve, OxCCU, Lydian

Carbon Upcycled will profit through two markets



Primary Market
tandem CDR reactors

Secondary Market
carbon nanofiber

Primary Market: CDR Reactors

Revenue-Sharing Model

Tier 1

$1,500,000 per reactor + 20% of CNF revenue

Tier 2

$1,000,000 per reactor + 10% of CNF revenue

Tier 3

$750,000 per reactor + 0% of CNF revenue

Key Benefits

Reduced cost of CDR technologies

Tailor pricing to different companies

Direct customer relationship

Secondary Market: Low-Cost CNF

1 2

Current CNF production methods are expensive and don't produce at high volumes.

Target Markets

Chemical Industry

$105.2 M

CAGR 15.0%

Energy

$142.4 M

CAGR 8.8%

Electronics

$74.5 M

CAGR 12.0%

Aerospace

$12.4M

CAGR 7.3%

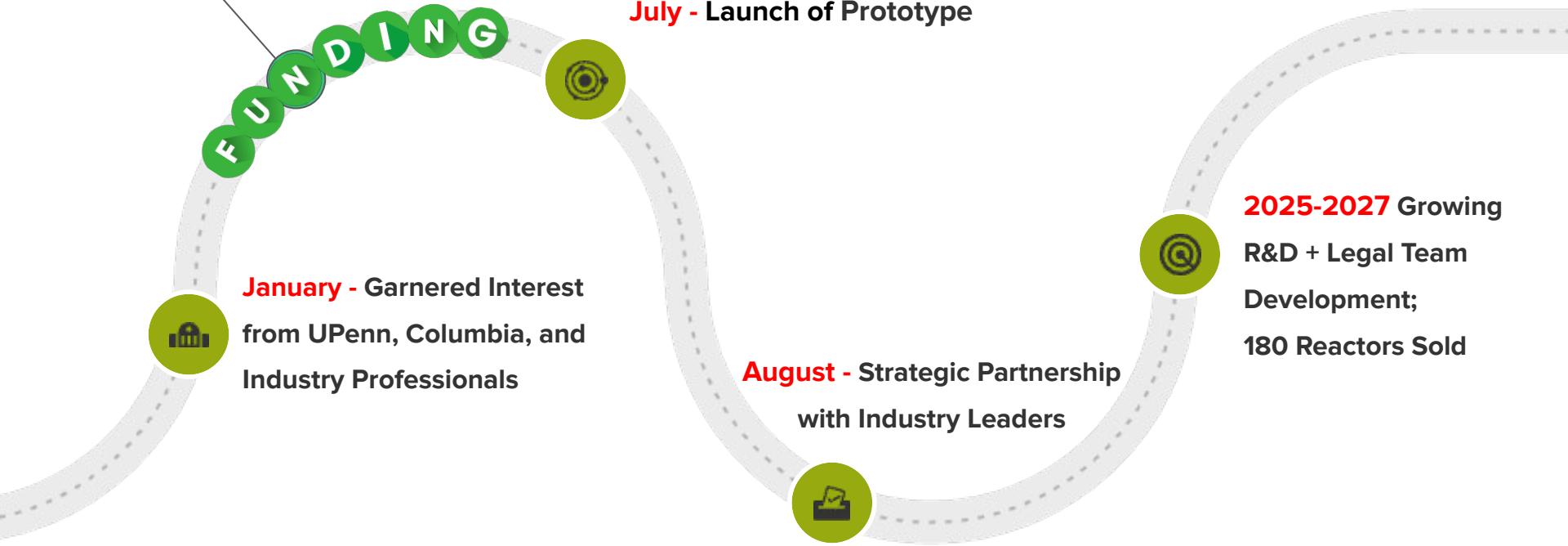
Cement

$11.4 M

CAGR 3.7%

Carbon Upcycled's roadmap to revolutionize CO_2 removal

We are here



January - Garnered Interest from UPenn, Columbia, and Industry Professionals

July - Launch of Prototype

August - Strategic Partnership with Industry Leaders

2025-2027 Growing R&D + Legal Team Development; 180 Reactors Sold

Our Team

Colby Snyder

UPenn VIPER ‘26

Chemical Engineering and Physics

Chloe Ng

UPenn VIPER ‘26

Chemical Engineering and Earth Science

Kyle Zhang

UPenn M&T '26

Business and Computer Science

Mentors

Jingguang Chen

Brookhaven National Lab and Columbia University

Zhenhua Xie

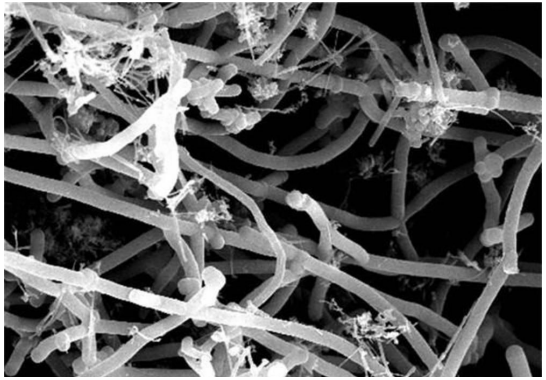
Columbia University

Gad Allon

The Wharton School

Social Impact

Protecting Industrial Jobs



Supplying Advanced Materials

Halting Climate Change

Appendix

Carbon Upcycled

If all goes wrong, $400M Gross Profit in three years

Over 1.5x of predicted costs and under 10% market penetration of BOTH CDR reactors AND CNF than already predicted.

P&L	Year 1	Year 2	Year 3
Net Sales	$105,662,000	$169,656,800	$195,544,324
COGS	$18,360,000	$25,920,000	$25,920,000
Gross Profit	$87,302,000	$143,736,800	$169,624,324
Exp. etc.	$19,685,681	$26,605,770	$29,093,991
Net Income	$67,616,319	$117,131,030	$140,530,333

$400M Gross Profit**; $320M** Net Income

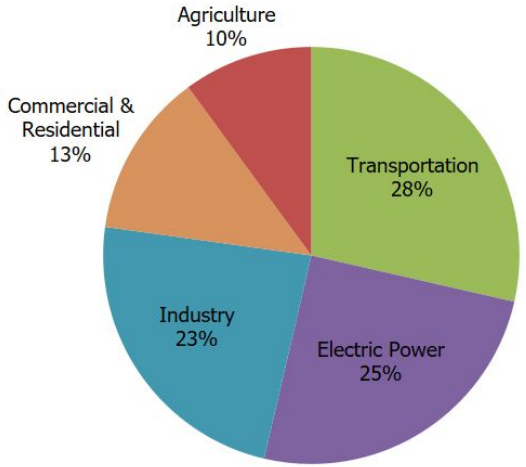
By year 1, we plan to have exponentially more leverage for the business, expecting over $1.4B in revenue in the next three years, and possibly exponentially more

Our Three Years Detailed

CAPEX $840,000	Property, Plant, and Equipment (PP&E): land, lab, machinery and lab equipment Inventory: Long Term Materials used in the development of reactors
Expenses $1,247,541	R&D: annually growing by 50% Shipping Miscellaneous
Personnel $1,465,771	+6 Engineers +1-2 Corporate Lawyers
Sales $400,663,124	Reactor: $1.5M worth of carbon credit reduction (costs $367k to make) CNF: $1k / kg (current market is at $6k / kg) 5 Cement Plants → 10 Cement Plants

CO_2 removal is vital, but current approaches aren't enough

- Industrial sector is responsible for **35%** of U.S. energy consumption and **23%** of carbon emissions, and power generation is responsible for an **additional 25%** of emissions.
- CO_2 accelerates global warming, which **disproportionately harms vulnerable populations** in the U.S. and beyond
- Existing carbon capture approaches are **energy intensive, require scarce materials, or fail to permanently sequester carbon**



EIA, 2024; EPA, 2024

Carbon Upcycled Reactor Performance Metrics

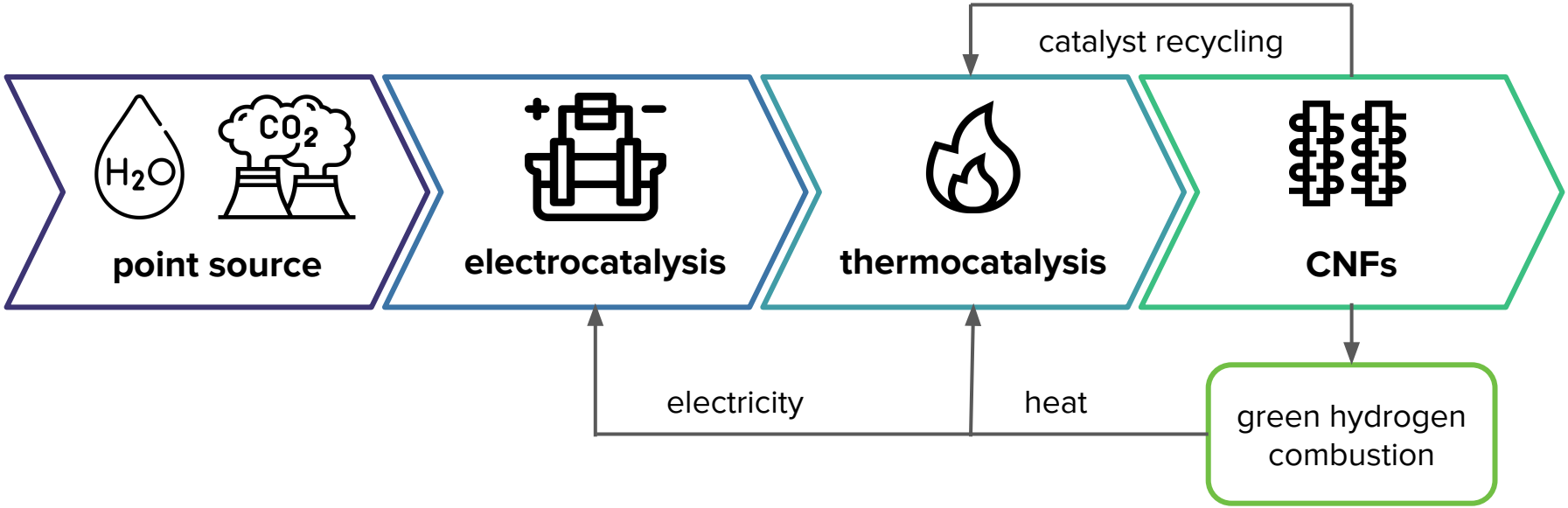
Amount of CO_2 released by typical 500 MW Natural Gas Power Plant:

- 12 GWh/day * 443 kg CO_2/MWh = **5316 tonnes CO2/day** or 2 megatonnes/year

Amount of CO_2 removed by Carbon Upcycled Reactor:

- 1 g of catalysts can remove 46 g CO2 per hour (Brookhaven National Lab)
- 500 kg catalysts in our full-scale reactor = 23 tonnes CO2/hr = **552** tonnes/day
    - 10.4% of daily carbon output
- 1 m^3 reactor would cost **367k** (based on price of catalyst, process units, and mechanical components) and house 500 kg catalyst

The CO_2 upcycling process in detail



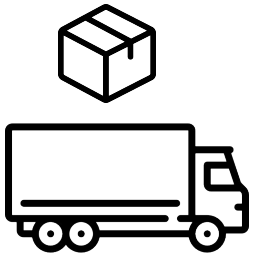
1. **CO_2 abatement:** 1 m^3 reactor installed at point source
2. **Pd(C) electrocatalysis** of $CO_2 + H_2O \rightarrow CO + H_2 + O_2$ (105 kWh/kg CNF)
3. **FeCo thermocatalysis** of $CO + H_2 \rightarrow C_{nf} + H_2O$ (56 kWh/kg CNF)
4. **CNFs separated** by filtration and magnets, enabling 100% catalyst recovery
5. **Self-sustaining reaction**: excess H_2 combusted to power reaction (-161 kWh/kg CNF)

Direct-to-consumer distribution minimizes emissions

CNF Distribution

1. Determine closest partner

2. Utilize local courier services



Limiting CNF transportation maximizes Carbon Upcycled's CDR potential

Carbon Nanofibers

Chemical Industries

Catalysts

- Utilizes high surface area and electrical conductivity ➜ enhance dispersion of catalysts and facilitate electron transfer
- *ie production of fine chemicals, pharmaceuticals, and air and water purification*

Adsorbents

- Utilizes porous structure and high surface area
- *ie treatment of industrial effluents, water purification, and air purification*

Renewable Energy

Energy Storage Devices

- Utilizes high electrical conductivity and mechanical strength
- *ie lithium-ion batteries, super capacitors, and other energy storage devices*

Photovoltaics

- Utilized to create more lightweight, flexible, and enhanced photovoltaic materials

Fuel Cells

- Utilized as catalysts supports for electrochemical reactions that generate electricity