

A REVIEW OF GLOBAL AND U.S. TOTAL AVAILABLE MARKETS FOR CARBONTECH

Executive Summary

Executive Summary

KEY FINDINGS

- Carbontech is an emerging industrial sector that captures, transports, and converts different forms of “waste carbon” into a diverse array of valued products and services in a climate-beneficial way.
- The economic opportunity for carbontech is huge: The US total available market (TAM) is \$1.07 trillion per year, and global TAM is \$5.91 trillion per year. The total available market includes all revenue from products that could be feasibly made from carbontech materials or conversion processes.
- The largest segment is fuels, which composes 85% of the U.S. market and 66% of the global market.
- The top three global markets include fuels (\$3.82 trillion), building materials (\$1.37 trillion), and plastics (\$0.41 trillion).
- Carbontech touches both global commodities and high-value consumer goods, highlighting the diversity of products and associated business models included in the sector.

Executive Summary

WHY DOES CARBONTECH MATTER?

- Carbontech provides a market value for waste carbon, alongside existing merchant CO₂ markets, which creates an economic incentive to capture and convert waste carbon rather than release it into the atmosphere. This incentive makes carbontech products more climate beneficial than fossil-derived incumbent products.
- These products can also help lower technology costs for carbon capture and conversion technologies by providing a demand-side incentive to capture and use waste carbon feedstocks. This can help support future emissions reductions and carbon removals.

WHAT IS CARBONTECH?

Carbontech can be defined as an emerging industrial sector that captures, transports, and converts different forms of “waste carbon” into a diverse array of valued products and services in a climate-beneficial way. Since carbontech recycles waste carbon that would otherwise perpetuate climate change, carbontech materials are comparably climate beneficial compared to the incumbent material or product.

WHAT IS THE SCOPE AND PURPOSE OF THIS MARKET SIZING REPORT?

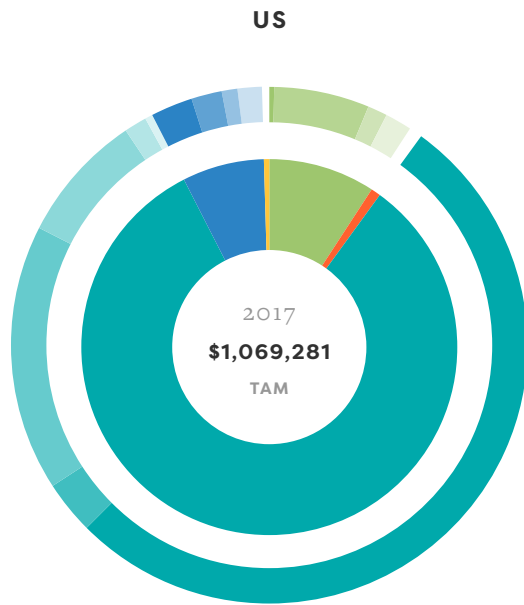
Currently, a number of innovators—both in startups and, to a lesser extent, established firms—are working to recycle waste carbon feedstocks into valuable products to create climate-beneficial products that perform as well as or better than the incumbent. In addition to the capture and reuse of atmospheric or point-source CO₂, these products and materials, referred to as carbontech, utilize carbon-based feedstocks such as methane, agricultural residues, and municipal solid waste. All of these carbon wastes would return to the atmosphere in a business-as-usual scenario, so their recycling into carbontech products is climate-beneficial regardless of whether those products retain the carbon for long periods (e.g., concrete) or only a short time (e.g., a fuel that is burned).

The primary purpose of this white paper is to quantify the total available market for these products in 2017, in the U.S. and globally, using a transparent methodology and open-source data. We examined existing technologies and business models for proof of concepts to demonstrate viable feedstocks and conversion processes that could penetrate or disrupt existing market sectors. This report serves as a tool for entrepreneurs, investors, and academics to understand the value proposition for producing commodities and consumer goods using recycled carbon feedstocks. This report does not intend to offer precise values of each market sector, but instead provides a reasonably robust order of magnitude for the total available market for carbontech products.

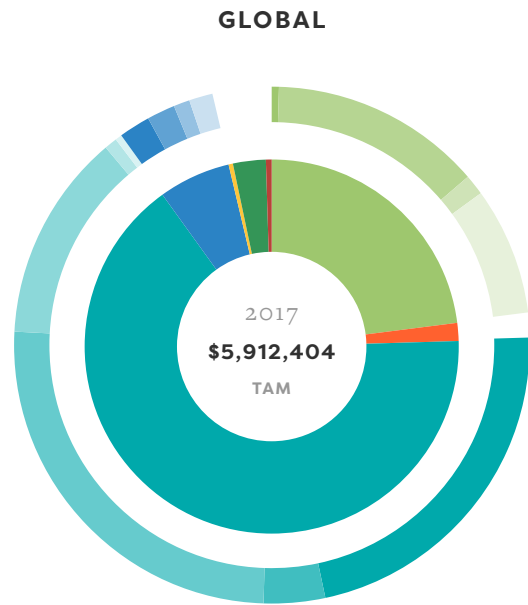
METHODOLOGY

Wherever possible we cited open-source data from the U.S. Geological Survey, U.S. Forestry Service, U.S. Department of Agriculture, the International Energy Agency, and the U.S. Energy Information Administration. Where necessary, we also cited high-level findings from market research firms to corroborate our estimates or estimate markets for which no open-source data was available. For market segments detailed below, we cite existing proof of concept for carbontech products that could fill demand for the incumbent product.

KEY CARBONTECH MARKET SEGMENTS AND FINDINGS



PRODUCT	\$ IN MILLIONS
BUILDING MATERIALS	\$101,130
● Cements	\$1,240
● Concretes	\$65,000
● Asphalts	\$12,190
● Aggregates	\$22,700
WOOD-BASED PANELS	\$12,508
FUELS	\$882,149
● Gasoline	\$543,400
● Jet Fuel	\$38,760
● Diesel	\$186,660
● Natural Gas	\$83,705
● Ethanol	\$23,550
● Biodiesel	\$6,074
PLASTICS	\$71,694
● High density polyethylene	\$25,393
● Linear Low density polyethylene	\$20,502
● Low density polyethylene	\$11,522
● Polypropylene	\$14,276
CHEMICALS	\$1,800
AGRICULTURE AND AQUACULTURE	N/A
CONSUMER GOODS	N/A
TOTAL	\$1,069,281



PRODUCT	\$ IN MILLIONS
BUILDING MATERIALS	\$1,368,100
● Cements	\$24,900
● Concretes	\$800,000
● Asphalts	\$77,200
● Aggregates	\$466,000
WOOD-BASED PANELS	\$96,513
FUELS	\$3,821,316
● Gasoline	\$1,261,000
● Jet Fuel	\$216,318
● Diesel	\$1,510,080
● Natural Gas	\$773,242
● Ethanol	\$36,720
● Biodiesel	\$23,956
PLASTICS	\$412,448
● High density polyethylene	\$128,250
● Linear Low density polyethylene	\$103,546
● Low density polyethylene	\$58,311
● Polypropylene	\$122,342
CHEMICALS	\$20,217
AGRICULTURE AND AQUACULTURE	\$169,450
CONSUMER GOODS	\$24,360
TOTAL	\$5,912,404

BUILDING MATERIALS

This market includes sub-segments such as cement, concrete, paving asphalt, and aggregates. We estimate the total market values for these products to be \$100 billion and \$1.4 trillion for U.S. and global markets, respectively. In the building materials market, several companies (such as Blue Planet, CarbonCure, and Solidia Technologies) have established methods to produce concrete and aggregates with sequestered CO₂ to create products with parallel or improved functioning relative to incumbent materials. CO₂ may be sequestered in building materials through injection into concrete or biomineralization to produce aggregates.

WOOD-BASED PANELS

To evaluate the market for low-value wood-based products, we analyzed the markets for oriented strand board (OSB), high-density fiberboard (HDF), medium-density fiberboard (MDF), hardboard, and plywood (coniferous and nonconiferous). The total value for these markets is \$12 billion in the U.S. and nearly \$100 billion globally. There is a clear precedent to replace these engineered wood panels with low-value waste wood and wood scraps to reduce dependence on noncomposite timber.

FUELS

To evaluate the total potential market for the conversion of waste carbon feedstocks to fuels, we considered the existing markets for biofuels, such as ethanol and biodiesel, and petroleum fuels, including gasoline, jet fuel, and diesel. We also included the natural gas market, given the potential to cost-effectively convert CO₂ and other waste feedstocks into biogas and natural gas. We estimated the total available market for fuels in the U.S. and globally to be nearly \$900 billion and \$3.8 trillion, respectively. This market is dominated by three fuels—gasoline, diesel, and natural gas—which comprise roughly 93% of the U.S. and global fuels markets. Companies, such as Carbon Engineering, have demonstrated proof of concept by converting atmospheric CO₂ into diesel fuel, jet fuel, and gasoline, while fuels such as ethanol and biodiesel are already sourced from biomass feedstocks that capture atmospheric CO₂ through photosynthesis.

PLASTICS

For the plastics market, we cite existing proof of concept for converting carbon dioxide and methane into ethylene and propylene, respectively, as building blocks for polyethylene and polypropylene. We assume that these polymers can be used to create high-density polyethylene (HDPE), low-density polyethylene (LDPE), linear low-density polyethylene (LLDPE), and polypropylene (PP). We estimate the total market value for these plastics is \$72 billion in the U.S. and roughly \$413 billion globally.

CHEMICALS

For chemical markets, we analyzed applications of carbon-based feedstocks for the production of potash (exclusively K₂CO₃), formic acid (CH₂O₂), soda ash (Na₂CO₃), and carbon monoxide. In the United States, the value of these markets is negligible given the order of magnitude of other markets, but globally, we estimated the total market value for these chemicals to be \$20 billion.

AGRICULTURE AND AQUACULTURE

In the agricultural and aquacultural industry, we considered existing products that could be replaced by additives or biomass from algae production. This included algal fertilizers, aqua feed (high-protein fish feed), livestock feed, and nutraceuticals. We consider the existing market for algae in these applications, and also consider the total markets for livestock and aquafeed. Collectively, these markets are worth \$170 billion globally.

CONSUMER GOODS

While carbontech has the potential to dominate the world's largest commodity markets, including fuels and building materials, there are also a variety of consumer goods being produced with waste carbon feedstocks. We evaluated the total available markets for a few products already being produced with carbontech materials, such as diamonds, vodka, and guitars. Collectively, we found the total available global market for these consumer products to be \$24 billion in 2017.



For questions, please reach out to
rory@carbon180.org