

Global Thermostat

Social and Economic Impact of Climate Change

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Columbia University

CEO & Co-Founder of Global Thermostat

Earth Dialogues

Puerto Madryn, Argentina

October 22, 2018

Carbon Negative

Produced by Paul Atkins, Emmy Award winning filmmaker of National Geographic



<https://www.youtube.com/watch?v=wVQIYYpJrNI>

NEWS: February 2018 New Tax Incentive in Trump's Budget Zooms Adoption of Direct Air Capture of Carbon

- Presentation of Direct Air Capture of Carbon in RI & RI Senate January 2018
- Followed by our proposal, written at US Senate request - January 25th 2018
- Senator Sheldon Whitehouse (D-RI) on February 2018 introduces new Law, now part of Trump's Budget, with a unlimited tax credit (\$35 per ton) for removal of CO₂ from air

FUTURE ACT BIPARTISAN FEDERAL LAW (45Q)

Basic Needs

- In 1974 the Bariloche Model of the World Economy (with Mallman, Herrera, Gallopin and others)
- Based on my new concept of Basic Needs
- Basic Needs is the basis of Sustainable Development voted by 150 nations at the 1992 UN Earth Summit in Rio Brazil
- Adopted by the G – 20 in 2009 - as main concept of economic development

Sustainable Development

International Laws Achieved

1. 1992: **Basic Needs**: voted by 150 nations at UN Earth Summit Rio de Janeiro Brazil – cornerstone of **Sustainable Development** (G-20 2009)
2. 1997: **Kyoto Protocol - Global Carbon Market EU ETS**, voted by 160 nations in Kyoto COP, 1997 international law since 2005, trading \$175USBn in 2012
3. 2009: **Green Power Fund** Copenhagen COP 2009: now international law as Green Climate Fund
4. 2010: **Global Thermostat**: its **Carbon Negative Technology** can Reverse Climate Change (Forbes and KPMG, 2016)
5. 2015: **UN Paris Agreement** is voluntary only but contains **four articles we wrote on Carbon Removals that can Reverse Climate Change**
6. 2018: 1/2018 – our proposal to US Senate became the **US Future Act** – Bipartisan Federal Law (45Q) – practically Unlimited tax credits (\$35/ton) for removing CO₂ from atmosphere

Global Thermostat is the Sole US Company Qualifying For Tax Credits FUTURE ACT law (45Q)

Global Thermostat Meets The World's Needs: CARBON NEGATIVE TECHNOLOGY™

GT Removes Carbon Dioxide from ambient air while selling it profitably for: Water Desalination, Green Fertilizers, Clean Carbonated drinks, Dry Ice, Green Synthetic Fuels, Greenhouses, materials - Carbon Fibers and Plastics, Enhanced Oil Recovery, an enormous US \$1trillion market. GT's technology brings new capital to economy and can reverse climate change

Our revolutionary technology FARMS THE SKIES: low cost Direct Air Capture of 2 for commercial use; according to the UN IPCC Fifth Assessment Report & the 2015 Paris Agreement, Carbon Negative Technology™ is now the only way to avert catastrophic climate change:

Global Thermostat

Positive Business Impact while Reversing Climate Change

Meeting Requirements of US Byrd-Hagel Law 1997

- New Jobs
- Expanding Exports
- Economic Progress

GT TIMELINE



Incubation

Key author of the Kyoto protocol, Graciela Chichilnisky, establishes Global Thermostat (GT) with Peter Eisenberger, leading researchers and, at the time, professor at Columbia University.

Capitalization

Through 2015, GT successfully raises an aggregate of **\$29.5 million** anchored by Edgar Bronfman, NRG, and Vice Media

Technology Validation

GT collaborates with industry leaders Corning, Linde, NRG Haldor Topsoe, and BASF. Achieves **32 patents** to date, **protected in 147 countries**. GT proprietary modules achieve an unprecedented competitive advantage with industry-leading margins

Partnerships

GT proliferates the global CO₂ value chain with key partnerships including **NRG, Georgia Tech, Corning, SRI, and Linde** as strategic partners

Commercialization & Scale Up Deployment

GT starts exploring commercial contracts to address market demand

Funding and Commercial Construction

GT successfully closes investment round of **\$20 million** bringing the aggregate amount of funding to **\$42 million**. GT starts building first commercial plant for **major carbonated beverage producer**

First GT Commercial Plant (4,000/TPY)

Completed at Huntsville, AL For Global leading provider of carbonated beverages (Coca-Cola) and production of bio-degradable plastics

2010



Pilot Demo Plant

2013



Commercial Demo Plant

2015

Global Thermostat, LLC

2016

2017

2018



Commercial Plant

2018: GT Moving Ahead at Breakthrough Speed

GT's Competitive Advantage vs. Existing Supply

..Huge demand for CO₂ unmet..¹

Industrial Markets:

Over \$1tn, including: Food & Beverages, Enhanced Oil Recovery, Refrigeration & Greenhouses, Carbonates, Concrete/Cement, Polymers, Graphene, Crop Improvement

Oil & Gas:

Enhanced Oil Recovery (EOR), Clean up of Natural Gas Processing

Renewable Fuels:

Algae Biofuels, Synthetic Gasoline

..Due to three critical issues..

Limited, Stranded Supply:

Natural subterranean reserves are limited. Supply is depleting and geo-specific. Other sources are inadequate

High Capture Costs:

Competing carbon capture methods prohibitively expensive

Difficult to Transport:

CO₂ is difficult to transport economically. Trucking and pipelines require significant capital investment for an inefficient process

1. Appendix: CO₂ – A MARKET FLOODED BY DEMAND

2018

ENORMOUS UNMET DEMAND FOR CO₂

GT's Competitive Advantage vs. Existing Supply

Huge demand for CO₂ unmet..

Industrial Markets

Food & Beverages,
Refrigeration & Greenhouses,
Carbonates, Concrete/Cement,
Polymers, Crop Improvement

Renewable Fuels

Algae Biofuels, Synthetic
Gasoline

Emerging Technologies

Bio-plastics, Graphene,
Carbon Fibers

..due to three critical issues..



Limited, Stranded Supply

Natural subterranean reserves
are limited. Supply is
depleting and geo-specific.
Other sources are inadequate



High Capture Costs

Competing carbon capture
methods prohibitively
expensive



Difficult to Transport

CO₂s difficult to transport
economically. Trucking and
pipelines require significant capital
investment for an inefficient
process

.. GT addresses these issues

.. GT provides an unlimited
supply of CO₂

.. GT captures CO₂ at a
fraction of the cost of
traditional sources from
flue gas or ambient air

.. GT offers modular, "plug
and play" units that can be
located anywhere

For the first time in human history abundant, low cost CO₂ is available anywhere, anytime.

“CO₂ – A MARKET FLOODED BY DEMAND”

CryoGas International Magazine - May 2013 Page 28



CryoGas International

Carbon Dioxide — A Market Flooded by Demand

Carbon Dioxide — A Market Flooded by Demand

By Agnes H. Baker and Maura D. Garvey

The markets for carbon dioxide (CO₂) are among the most diverse and dynamic in the industrial gas industry. Applications for CO₂ range from carbonating beverages to recovering oil. Delivery methods include pipeline, bulk and microbulk trucks, cylinders, and as dry ice. The rapidly increasing use of carbon dioxide for Enhanced Oil Recovery (EOR) and for oil and gas field services, combined with the continued drive to limit CO₂ emissions into the atmosphere, is creating change in the CO₂ supply chain. In this review of the US CO₂ market in 2012, we look at how new oil field plays and new technology are opening up new business opportunities for industrial gas players and distributors.

solutions are sought. CO₂ for greenhouse growing and for commercial-scale, open-pond, algae-to-fuel cultivation systems continue to make the news. Read about an interesting new application for CO₂ capture and algae farming on page 46 of this issue. The effects of climate warming on crops are fueling research into the relationship of CO₂ and agriculture as well. See Linde's article on this topic on page 48.

“Shortages of carbon dioxide in Europe may get worse”

The Economist- July 15, 2018

7/13/2018

Shortages of carbon dioxide in Europe may get worse - In a fizz

The
Economist

In a fizz

Shortages of carbon dioxide in Europe may get worse

It has affected the production of beer, fizzy drinks and even crumpets



Print edition | Business

Jul 5th 2018

IN THEORY, the world has too much carbon dioxide. In 2015 the Paris climate agreement set limits on emissions of the gas to prevent global temperatures rising

“CO₂ shortage: Coca-Cola pauses production at some plants”

BBC News – June 25, 2018

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CO₂ shortage: Coca-Cola pauses production at some plants

June 25th 2018 by BBC News



Coca-Cola says it has “temporarily paused” some production because of the shortage of CO₂ gas.

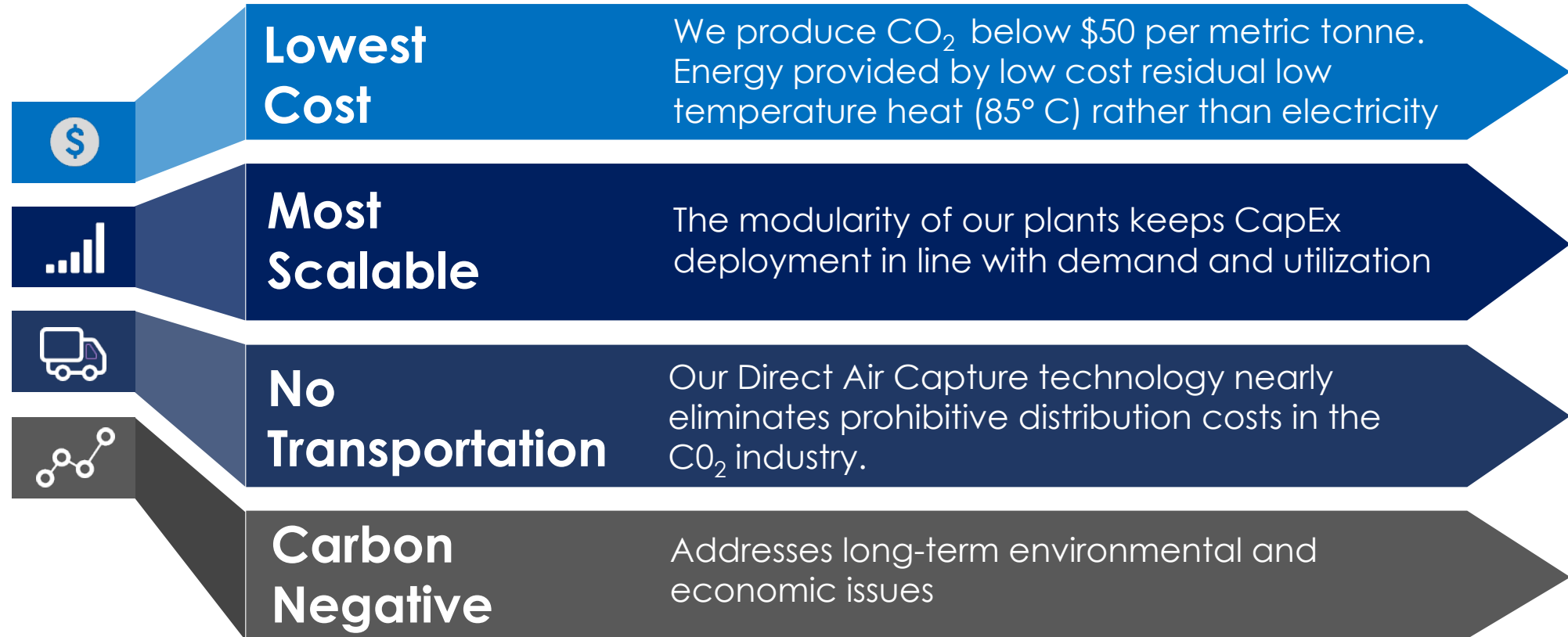
However, the soft drinks manufacturer says that so far the shortage has not affected supplies.

Last week, the makers of Heineken’s John Smith’s Extra Smooth and Amstel said supplies had been hit.

There are reports that the shortage is affecting deliveries of frozen foods, which are kept cool by dry ice, which is made by compressing CO₂.

GLOBAL THERMOSTAT COMMERCIAL VALUE PROPOSITION

A major and unprecedented CO₂ market disruptor



Reliable, lowest cost CO₂ available anytime, anywhere in the world

– Can Reverse Climate Change

Carbon Negative Power Plants

By Graciela Chichilnisky and Peter Eisenberger,
Global Thermostat LLC

Global Thermostat LLC (GT) (www.globalthermostat.com) was formed in 2006 to develop and commercialize a unique technology for the direct capture of carbon dioxide from the atmosphere and other sources. The GT process “co-generates” carbon capture with other industrial processes—such as power production—by using the process heat from those processes to drive its carbon capture technology. By combining CO₂ capture from air along with capture from the flue gas of an electrical power plant, and using the power plant’s low cost process heat to provide the energy needed for the air capture process, GT technology has the capability of transforming power plants into net carbon sinks. Global Thermostat technology also can work with renewable power plants, because it captures carbon directly from air using the plant’s process heat. For example, heat from a Concentrated Solar Plant (CSP) can be used by Global Thermostat to drive its capture process.

CO₂ capture from air is different from other

CO₂ air capture has gained momentum on the policy front and in the business community as a viable and economic solution for reducing carbon emissions and is now being introduced commercially with pilot demonstration plants. The first GT pilot plant erected at SRI International in Menlo Park, CA, captures 1,000 tpy (tons per year) of CO₂ and was co-developed with Corning and BASF. The CO₂ captured at plants like this is available for use in applications such as enhanced oil recovery, greenhouses, production of industrial grade formic acid, producing bio-fuels from algae, and, when combined with hydrogen, for producing hydrocarbons such as high octane gasoline.

According to the International Energy Agency, over 41 percent of all human based emissions of CO₂ are generated by power plants and 89 percent of electricity production around the world is powered by fossil fuels. This represents an energy infrastructure valued in excess of \$55 trillion dollars. As this cannot easily be replaced, CO₂ emissions



by GT’s process can be as high as 98–99 percent, and the stream can be further purified and/or liquefied using standard “compression” techniques.

Transportation costs for large volume gaseous CO₂ is significant and can run as high as \$1.5 million per mile for a pipeline, plus compression. With the GT process, these costs are drastically reduced or eliminated; a CO₂ air capture plant can be located anywhere, needing only air and heat to operate. A

2018: New US Law (45Q 2/9/18)

February 2018 New Tax Incentive in Trump's Budget Zooms Adoption of Direct Air Capture of Carbon

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- Followed by our proposal, written at US Senate request - January 25th 2018
- Senator Sheldon Whitehouse (D-RI) on February 2018 introduces New Law, Now Part of Trump's Budget, with a practically **unlimited tax credit** (\$35 per ton) for removal of CO₂ from air Adoption of Direct Air Capture
- **Global Thermostat is the only company that qualifies for the 2018 Future Act tax credit**

FUTURE ACT BIPARTISAN FEDERAL LAW (45Q)

Breakthrough

Carbon Negative Powerplants can Transform
US\$53 Trillion global power plant
infrastructure from emitters to sinks for CO₂

Cleaning the Atmosphere While Producing Electricity

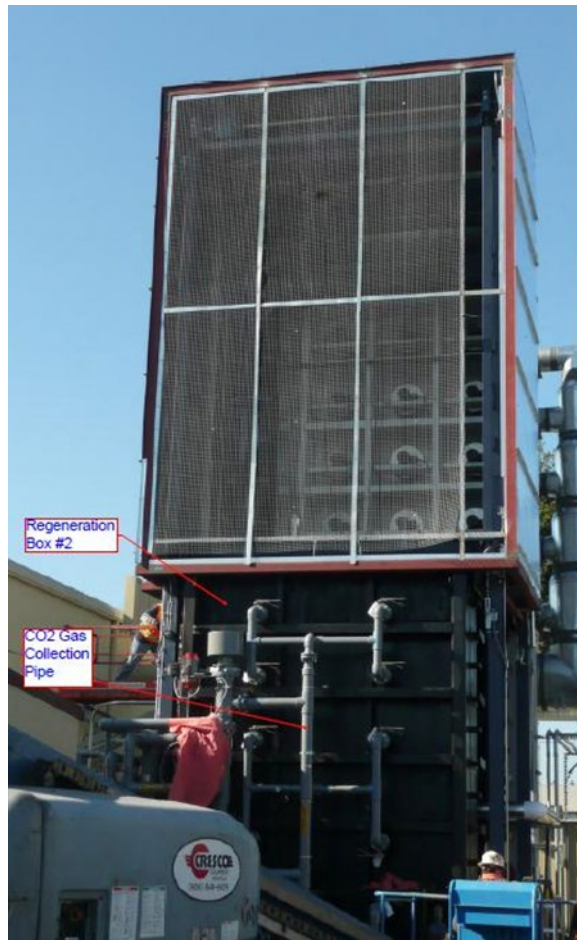
HOW IT WORKS

Our proprietary **Cyclic Adsorptive CO₂ Capture** method selectively captures high-purity CO₂ from free air at any location. The process also conserves energy in an efficient heat cycle



2010: 1st PILOT GT PLANT

Captures CO₂ directly from air



SRI International (formerly Stanford Research Institute), 333 Ravenswood Avenue, Menlo Park, CA 94025

2013 COMMERCIAL GT DEMO PLANT at SRI

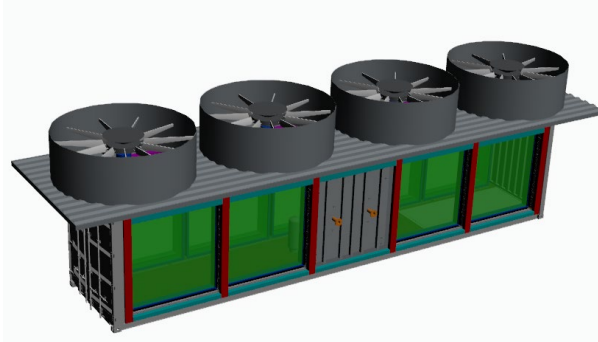
Captures CO₂ from SRI fossil fuel power plant and also directly from air
[GT achieves US DoD/DoE Technology Readiness Level-8 (TR8)]



333 Ravenswood Avenue, Menlo Park, CA 94025

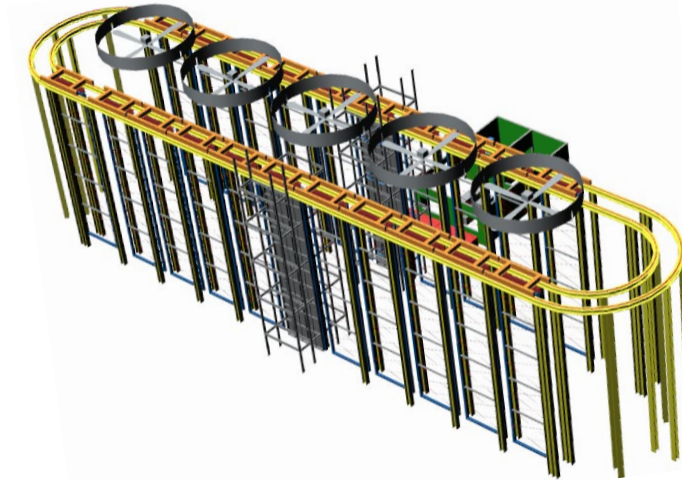
2018 GT COMMERCIAL PLANT in Huntsville, Alabama

First GT Commercial Plant (4,000/ TPY)

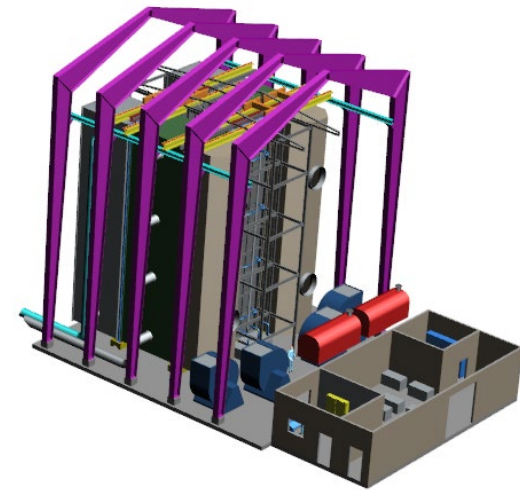


Containerized GT-Carburetor
40' ISO container
10,000 tonnes CO₂ / year

Conceptual design for Containerized Carburetor is complete. Next step is detailed engineering.



Full-scale GT-DAC
18m tall, 50m long, 6m wide
50,000 tonnes CO₂ / year

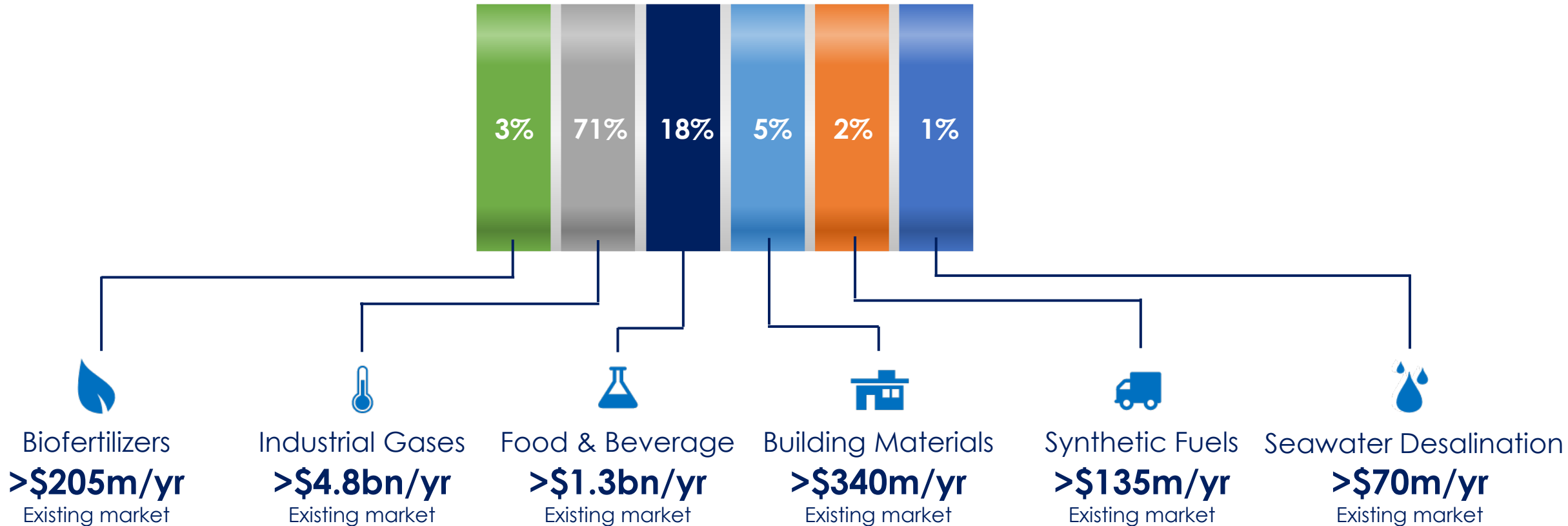


Basic design for Full-scale modules completed with NRG and Sargent & Lundy. Next step is detailed engineering.

Huntsville, Alabama

GLOBAL THERMOSTAT: INITIAL MARKET VERTICALS

\$6.7 billion annual CO₂ market in initial target segments



LEADERSHIP



Dr. Graciela Chichilnisky

CEO & Cofounder

- World leading economist and mathematician
- Two PhD's: Math, MIT; Economics, Berkeley
- Successful Entrepreneur: Founded & sold financial services tech companies FITEL, and Cross Border Exchange
- Authored Kyoto Protocol carbon market
- Tenured Professor at Columbia University, previously at Harvard and Stanford
- 2015 "CEO of the Year" Selected by IAIR, Yale Club NY April 2015



Dr. Peter Eisenberger

CTO & Cofounder

- Leader and technology innovator in global energy industry and CO₂ capture
- 20+ year career including global R&D head at Exxon and lead scientist at Bell Labs
- Tenured professor, former Vice Provost at Columbia University
- Founding Director Columbia University Earth Institute
- Founding Director Princeton University Materials Institute



Edgar Bronfman, Jr.

Executive Chairman

- Chairman, Endeavor Global
- General Partner at Accretive LLC
- Former Chairman and CEO of the Warner Music Group
- Recently successfully sold Warner for US\$3.3 billion
- Former President and CEO of the Seagram Company

GT AWARDS

“The 30 Most Innovative Companies to Watch 2018”
– Insights Success Magazine, March 2018

“World’s Top-10 Most Innovative Company in Energy”
– Fast Company, April 2015

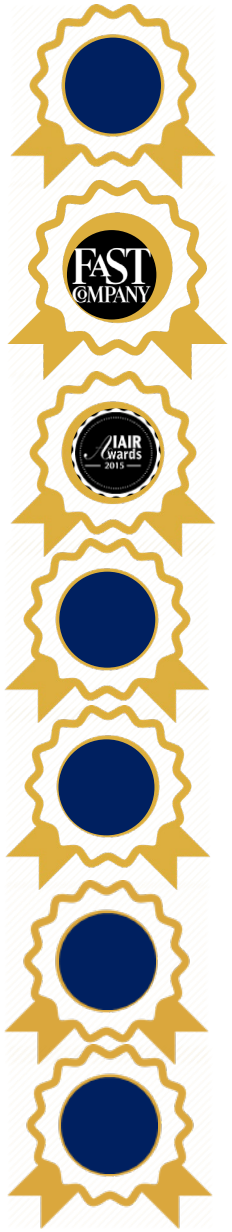
“2015 CEO of The Year: Graciela Chichilnisky”
– Yale Club of New York City IAIR Award, April 2015

“2016 Top 50 Most Innovative Company in Renewable Energy”
– Company Energy, May 2016

“Finalist and \$250k Grant Winner”
– NYSERDA, June 2016

“World’s Top 50 Innovators from the Industries of the Future: Graciela Chichilnisky ”
– Codex, July 2017

“The Companies with Most Disruptive Innovation”
– Insights Success, 2018



October 8, 2018

New UN IPCC Climate Report (Korea) Confirms Immediate Need For Carbon Removal – Like Global Thermostat's Technology

The latest report by the United Nations Intergovernmental Panel on Climate Change (IPCC) paints a gloomy picture of accelerating climate change and weakening global efforts to reduce carbon emissions.

Immediate Need for Massive Carbon Removal

A recent report by the World Resources Institute has identified three companies that have made significant progress on direct air carbon capture technologies, including 1 US company, the world leader: Global Thermostat.

Global Thermostat 2019

Dual Strategy

**Demonstrate commercial viability immediately –
with Coca Cola’s 950 bottlers, Air Liquid**

**Demonstrate ability to reverse climate change: Scale Up GT
technology to remove one gigaton of CO₂ - with EXXON, New
Fortress**

Monaco 2018

Chichilnisky serves as advisor/board member to H.S.H. Prince Albert II of Monaco – Transition Forum



Forbes & KPMG: GT Can Reverse Climate Change

The Great Rewrite: Reverse Engineering Global Warming



<https://www.youtube.com/watch?v=dPEQg63Te7g&feature=youtu.be>

- Atmospheric CO₂ levels continue to rise
- 20% increase in the last half century
- Hit 400ppm in 2013, for the first time

GT Answers This Critical Challenge by Profitably Capturing Atmospheric CO₂ for Productive Industrial Use – Creating Abundant, Reliable, Low Cost Supply Wherever Needed

GT FEATURE ON SCIENTIFIC AMERICAN

Sustainability: How to Profit from CO₂ Emissions



https://www.youtube.com/watch?v=xeaACs8_vpo&feature=youtu.be

CNBC Edgar Bronfman on Global Thermostat

Edgar Bronfman Jr., talks about creating value for companies, and explains how Global Thermostat works.



<https://www.youtube.com/watch?v=kzLgdPSZek8&feature=youtu.be>

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