

# MOVING FORWARD

## Law and Policy Panel, CMTc 2017

Mary Ellen Ternes, BEChE, JD, Earth & Water Law, LLC

Charles McConnell, BSChE, MBA, Rice University

Frederick Eames, JD, Hunton & Williams

Victor B. Flatt, JD, University of Houston

E. Dennis Griffith, BSChE, MSChE, Granherne

# OUTLINE

- Utilization should be the focus
- Many policy changes: Energy, Environmental, Economic
- What are the subjects of these current reversals and how will it work?
  - Paris Agreement – What is it?
    - Individual US Commitments
  - Regulatory Reform Realities –
    - Legislative Process:
      - New Rules: Congressional Review Act
      - Older Rules: Regulatory Process, with or without statutory revision
    - Regulatory Process:
      - How: Administrative Procedures Act
        - Notice and comment rulemaking
        - Judicial Review
      - What: 2-1; Best Available Science and Endangerment Finding >> CAA New Source Review?
    - Litigation and Market Response: States, NGO's, citizen suits, corporate governance and business reputation
- Impact on current projects
- Opportunities and challenges



BUT FIRST...

We've seen large scale swings before.

For calibration purposes:

President	Terms	Clean Air Act
Reagan	1981-1989	<b>1988 – EPA applies New Source Review (NSR) strictly to Electric Generating Units (EGUs) – WEPCO;</b> NSR recognized as not intended to allow significant life extension projects
Bush 1	1989-1993	<b>1990</b> - Clean Air Act Amendments (no specific NSR revisions) <b>1992</b> – EPA adopts WEPCO Rule for EGUs
Clinton	1993-2001	<b>1996</b> – EPA proposes NSR reform rules <b>1997</b> – NSR Enforcement Initiative – EGUs <b>1999</b> – <b>EPA sues 7 EGU companies for NSR violations</b>
Bush II	2001-2009	<b>2001 – EPA/DOE conduct 90-day review of NSR impact on energy industry; USAG reviews NSR enforcement actions for CAA consistency.</b> <b>2002</b> – EPA promulgates NSR reform rules: revised baseline actual; actual to projected actual; Plant-wide Applicability Limits (PALs); <b>Clean Units; and Pollution Control Projects (PCP).</b> <b>2002</b> – EPA proposes NSR reform for EGUs, including <b>Equipment Replacement Provision (ERP)</b> <b>2003</b> – EPA promulgates ERP <b>2005-2006</b> – <u><b>DC Circuit vacates Clean Unit, PCP and ERP revisions</b></u>



# OUTLINE

- Utilization should be the focus
- Many policy changes: Energy, Environmental, Economic
- What are the subjects of these current reversals and how will it work?
  - **Paris Agreement – What is it?**
    - **Individual US Commitments**
  - Regulatory Reform Realities –
    - Legislative Process:
      - New Rules: Congressional Review Act
      - Older Rules: Regulatory Process, with or without statutory revision
    - Regulatory Process:
      - How: Administrative Procedures Act
        - Notice and comment rulemaking
        - Judicial Review
      - What: 2-1; Best Available Science and Endangerment Finding >> CAA New Source Review?
    - Litigation and Market Response: States, NGO's, citizen suits, corporate governance and business reputation
- Impact on current projects
- Opportunities and challenges

# PARIS AGREEMENT

- Comes into force if nations representing 55% of global GHG emissions ratify – Came into Force October 2016
- Kyoto governs to 2020. Paris to govern post-2020.
- Pivots from top down multinational agreement with overarching targets to bottom up submission of national emissions reduction plans without global reduction target.
- Establishes commitments by all parties to make “indicated nationally determined contributions” (INDCs) based on voluntary domestic measures to reduce emissions – includes developing countries.
- New INDCs every five years, with expectation they will ratchet up targets every five years.
- National emission targets under INDCs are not “binding” and enforceable, transparency and the five year review cycle are intended to drive performance
- Cannot withdraw for 3 years – 1 year notice

*Use of markets:*

At this time, the United States does not intend to utilize international market mechanisms to implement its 2025 target.

*Domestic laws, regulations, and measures relevant to implementation:*

Several U.S. laws, as well as existing and proposed regulations thereunder, are relevant to the implementation of the U.S. target, including the Clean Air Act (42 U.S.C. §7401 et seq.), the Energy Policy Act (42 U.S.C. §13201 et seq.), and the Energy Independence and Security Act (42 U.S.C. § 17001 et seq.).

Since 2009, the United States has completed the following regulatory actions:

- Under the Clean Air Act, the United States Department of Transportation and the United States Environmental Protection Agency adopted fuel economy standards for light-duty vehicles for model years 2012-2025 and for heavy-duty vehicles for model years 2014-2018.
- Under the Energy Policy Act and the Energy Independence and Security Act, the United States Department of Energy has finalized multiple measures addressing buildings sector emissions including energy conservation standards for 29 categories

of appliances and equipment as well as a building code determination for commercial buildings.

- Under the Clean Air Act, the United States Environmental Protection Agency has approved the use of specific alternatives to high-GWP HFCs in certain applications through the Significant New Alternatives Policy program.

At this time:

- Under the Clean Air Act, the United States Environmental Protection Agency is moving to finalize by summer 2015 regulations to cut carbon pollution from new and existing power plants.
- Under the Clean Air Act, the United States Department of Transportation and the United States Environmental Protection Agency are moving to promulgate post-2018 fuel economy standards for heavy-duty vehicles.
- Under the Clean Air Act, the United States Environmental Protection Agency is developing standards to address methane emissions from landfills and the oil and gas sector.
- Under the Clean Air Act, the United States Environmental Protection Agency is moving to reduce the use and emissions of high-GWP HFCs through the Significant New Alternatives Policy program.
- Under the Energy Policy Act and the Energy Independence and Security Act, the United States Department of Energy is continuing to reduce buildings sector emissions including by promulgating energy conservation standards for a broad range of appliances and equipment, as well as a building code determination for residential buildings.

In addition, since 2008 the United States has reduced greenhouse gas emissions from Federal Government operations by 17 percent and, under Executive Order 13693 issued on March 25<sup>th</sup> 2015, has set a new target to reduce these emissions 40 percent below 2005 levels by 2025.

# OUTLINE

- Utilization should be the focus
- Many policy changes: Energy, Environmental, Economic
- What are the subjects of these current reversals and how will it work?
  - Paris Agreement – What is it?
    - Individual US Commitments
  - **Regulatory Reform Realities –**
    - **Legislative Process:**
      - **New Rules: Congressional Review Act**
      - **Older Rules: Regulatory Process, with or without statutory revision**
    - Regulatory Process:
      - How: Administrative Procedures Act
        - Notice and comment rulemaking
        - Judicial Review
      - What: 2-1; Best Available Science and Endangerment Finding >> CAA New Source Review?
    - Litigation and Market Response: States, NGO's, citizen suits, corporate governance and business reputation
- Impact on current projects
- Opportunities and challenges



28. Congressional Review of Agency Rulemaking  
[5 U.S.C. 801, 802, 804]

The following excerpts of chapter 8 of title 5, United States Code, do not contain privileged procedures for the consideration of a measure in the House. They are depicted here because they constitute Rules of the House and potentially affect the legislative process. Detailed procedures for the consideration in the Senate of a joint resolution disapproving an agency rule may be found in the statute (5 U.S.C. 802).

SEC. 801. CONGRESSIONAL REVIEW.

(a)(1)(A) Before a rule can take effect, the Federal agency promulgating such rule shall submit to each House of the Congress and to the Comptroller General a report containing—

- (i) a copy of the rule;
- (ii) a concise general statement relating to the rule, including whether it is a major rule; and
- (iii) the proposed effective date of the rule.

(B) On the date of the submission of the report under subparagraph (A), the Federal agency promulgating the rule shall submit to the Comptroller General and make available to each House of Congress—

[1247]

# CONGRESSIONAL REVIEW ACT UP TO 2001 (1); 2017 (14)

SEC. 802. CONGRESSIONAL DISAPPROVAL PROCEDURE.

(a) For purposes of this section, the term “joint resolution” means only a joint resolution introduced in the period beginning on the date on which the report referred to in section 801(a)(1)(A) is received by Congress and ending 60 days thereafter (excluding days either House of Congress is adjourned for more than 3 days during a session of Congress), the matter after the resolving clause of which is as follows: “That Congress disapproves the rule submitted by the \_\_\_\_\_ relating to \_\_\_\_\_, and such rule shall have no force or effect.” (The blank spaces being appropriately filled in).

[1250]

(4) Except for a major rule, a rule shall take effect as otherwise provided by law after submission to Congress under paragraph (1).

(5) Notwithstanding paragraph (3), the effective date of a rule shall not be delayed by operation of this chapter beyond the date on which either House of Congress votes to reject a joint resolution of disapproval under section 802.

(b)(1) A rule shall not take effect (or continue), if the Congress enacts a joint resolution of disapproval, described under section 802, of the rule.

(2) A rule that does not take effect (or does not continue) under paragraph (1) may not be reissued in substantially the same form, and a new rule that is substantially the same as such a rule may not be issued, unless the reissued or new rule is specifically authorized by a law enacted after the date of the joint resolution disapproving the original rule.



# OUTLINE

- Utilization should be the focus
- Many policy changes: Energy, Environmental, Economic
- What are the subjects of these current reversals and how will it work?
  - Paris Agreement – What is it?
    - Individual US Commitments
  - **Regulatory Reform Realities –**
    - Legislative Process:
      - New Rules: Congressional Review Act
      - Older Rules: Regulatory Process, with or without statutory revision
    - **Regulatory Process:**
      - **How: Administrative Procedures Act**
        - **Notice and comment rulemaking**
        - **Judicial Review**
      - **What: 2-1; Best Available Science and Endangerment Finding >> CAA New Source Review?**
    - Litigation and Market Response: States, NGO's, citizen suits, corporate governance and business reputation
- Impact on current projects
- Opportunities and challenges

# ADMINISTRATIVE PROCEDURES ACT

## § 706. Scope of review

To the extent necessary to decision and when presented, the reviewing court shall decide all relevant questions of law, interpret constitutional and statutory provisions, and determine the meaning or applicability of the terms of an agency action. The reviewing court shall—

(1) compel agency action unlawfully withheld or unreasonably delayed; and

(2) hold unlawful and set aside agency action, findings, and conclusions found to be—

(A) arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law;

(B) contrary to constitutional right, power, privilege, or immunity;

(C) in excess of statutory jurisdiction, authority, or limitations, or short of statutory right;

(D) without observance of procedure required by law;

(E) unsupported by substantial evidence in a case subject to sections 556 and 557 of this title or otherwise reviewed on the record of an agency hearing provided by statute; or

(F) unwarranted by the facts to the extent that the facts are subject to trial de novo by the reviewing court.

In making the foregoing determinations, the court shall review the whole record or those parts of it cited by a party, and due account shall be taken of the rule of prejudicial error.

(Pub. L. 89-554, Sept. 6, 1966, 80 Stat. 393.)

# CCUS?

All regulatory changes must comply with the **Administrative Procedures Act**:

- General:
  - Regulatory Reform Task Forces
  - Removing Two Rules for every new One Rule
  - Imposing new “Best Available Science” requirements
- Revising Clean Air Act Regulation
  - Clean Power Plan and NSPS 111(b)
  - Oil and Gas Methane Rules
  - ***Endangerment Finding? Supports Application of New Source Review***
  - ***New Source Review? Provides authority for imposing CCS requirements as Best Available Control Technology (BACT) for major stationary GHG “Anyway” Sources***

# OUTLINE

- Utilization should be the focus
- Many policy changes: Energy, Environmental, Economic
- What are the subjects of these current reversals?
  - Paris Agreement – What is it?
    - Individual US Commitments re CCUS forcing
  - Regulatory Reform Realities –
    - Legislative Process:
      - New Rules: Congressional Review Act
      - Older Rules: Regulatory Process, with or without statutory revision
    - Regulatory Process:
      - How: Administrative Procedures Act
        - Notice and comment rulemaking
        - Judicial Review
      - What: 2-1; Best Available Science and Endangerment Finding >> CAA New Source Review?
    - **Litigation and Market Response: States, NGO's, citizen suits, corporate governance and business reputation**
- Impact on current projects
- Opportunities and challenges

# CCUS?

- Litigation in rulemaking, enforcement and innovative common law claims
  - California and other state activism
  - Delegated States
  - Non-Governmental Organizations (NGO) environmental advocacy
  - Industry Groups
  - Citizen suits

URL: [www.climatecasechart.com](http://www.climatecasechart.com)

To receive e-mail updates to this chart,  
send a request to

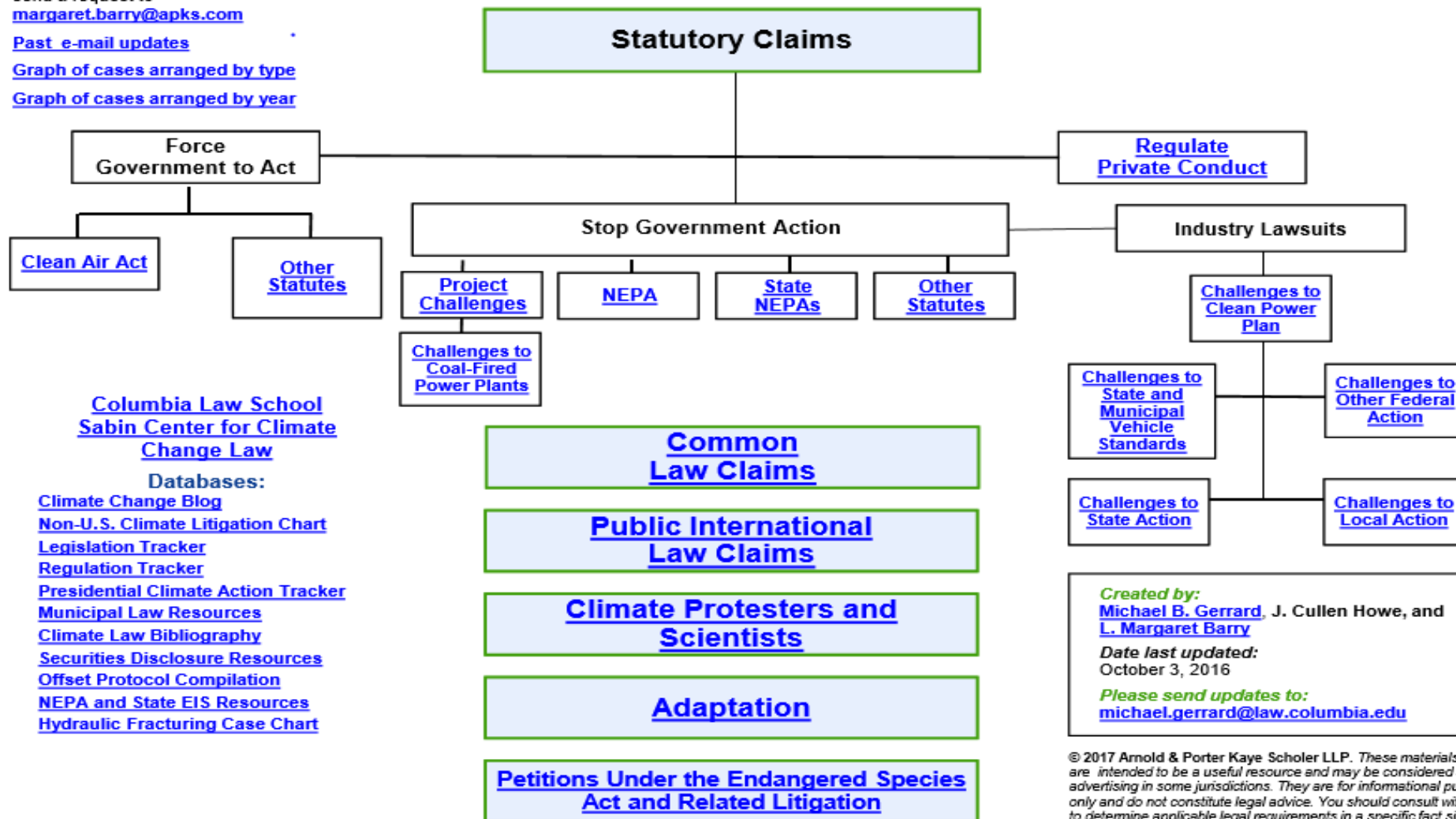
[margaret.barry@apks.com](mailto:margaret.barry@apks.com)

[Past e-mail updates](#)

[Graph of cases arranged by type](#)

[Graph of cases arranged by year](#)

## CLIMATE CHANGE LITIGATION IN THE U.S.



[Case Index](#)

© 2017 Arnold & Porter Kaye Scholer LLP. These materials are intended to be a useful resource and may be considered attorney advertising in some jurisdictions. They are for informational purposes only and do not constitute legal advice. You should consult with counsel to determine applicable legal requirements in a specific fact situation.



# CCUS?

- Corporate Governance
  - Disclosure requirements?
    - Materiality regardless of SEC enforcement
    - AG Lawsuits
  - Shareholder initiatives: petitions, lawsuits
  - Market driven global sustainability initiatives and business reputation
    - Financial Stability Board (FSB) Task Force on Climate-Related Financial Disclosures (TCFD),
    - Power Forward 3.0,
    - Annual Sustainable Innovation Forums,
    - Global Reporting Initiative,
    - Carbon Disclosure Project,
    - ISO 20400 Sustainable Procurement Guidance

# OUTLINE

- Utilization should be the focus
- Many policy changes: Energy, Environmental, Economic
- What are the subjects of these current reversals?
  - Paris Agreement – What is it?
    - Individual US Commitments re CCUS forcing
  - Regulatory Reform Realities –
    - Legislative Process:
      - New Rules: Congressional Review Act
      - Older Rules: Regulatory Process, with or without statutory revision
    - Regulatory Process:
      - How: Administrative Procedures Act
        - Notice and comment rulemaking
        - Judicial Review
      - What: 2-1; Best Available Science and Endangerment Finding >> CAA New Source Review?
    - Litigation and Market Response: States, NGO's, citizen suits, corporate governance and business reputation
- **Impact on current projects**
- **Opportunities and challenges**



# LanzaTech

The Road to Awesome  
Jennifer Holmgren  
CEO LanzaTech



LanzaTech  
capturing carbon. fueling growth.



# A Few Predictions

1876 “This ‘telephone’ has too many shortcomings to be seriously considered as a means of communication” *Western Union Memo*

1895 “Heavier-than-air flying machines are impossible”  
*Lord Kelvin, President Royal Society*

1920 “The wireless music box (radio) has no imaginable commercial value”  
*David Sarnoffs Associates in response to his urgings for investments in the radio*

1943 “I think there’s a world market for maybe five computers”  
*Thomas Watson, Chairman IBM*

1949 “Computer in the future may weigh no more than 1.5 tons”  
*Popular Mechanics forecasting the relentless march of science*

1977 “There is no reason anyone would want a computer in their home”  
*Ken Olson, President, Chairman and Founder of Digital Equipment*

1981 “640K ought to be enough computer memory for anyone”  
*Bill Gates*



**Predictions are simply extrapolations  
of the past...**

*...innovation expands  
the 'art of the possible'*

**...today's 'unimaginable' is  
tomorrow's 'conventional wisdom.'**





1998: \$12/Watt  
2016: ~ 2.50/Watt

1.9M in Energy Efficiency  
~414,000 Americans  
Renewables  
170,000 Advanced  
Vehicles

2016 new electricity  
generation  
**9564 MW Renewable**  
(wind, hydro, solar)  
**8187 MW Fossil**  
(NG, oil, coal)

**That'll Never Work**

**That'll Never Work**



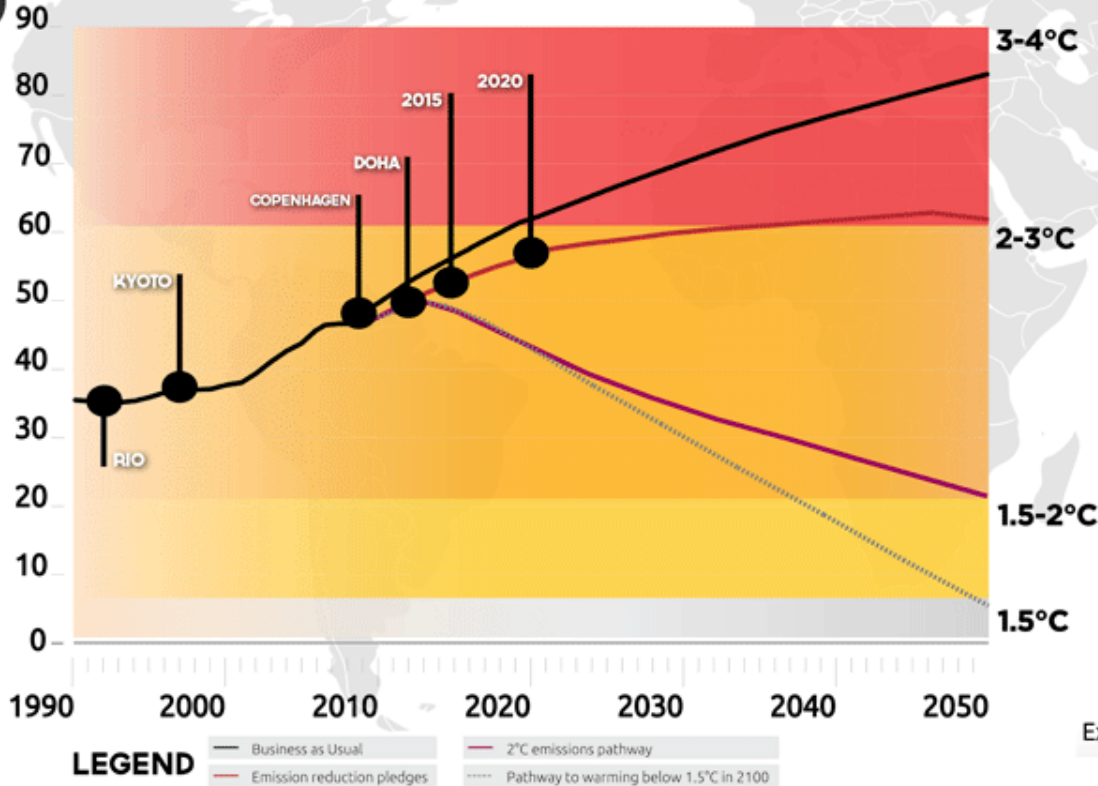
\$2.05/gallon  
At-scale  
Domestically-produced  
2<sup>nd</sup> generation



# STAYING BELOW 2°C: THE CHOICES WE FACE

With current pledges on the table to cut emissions, we are heading to a 3.3°C warming future. No further action before 2020 will limit society's choices. As temperatures rise, so do the impacts.

Global greenhouse gas emissions (GtCO<sub>2</sub>e)

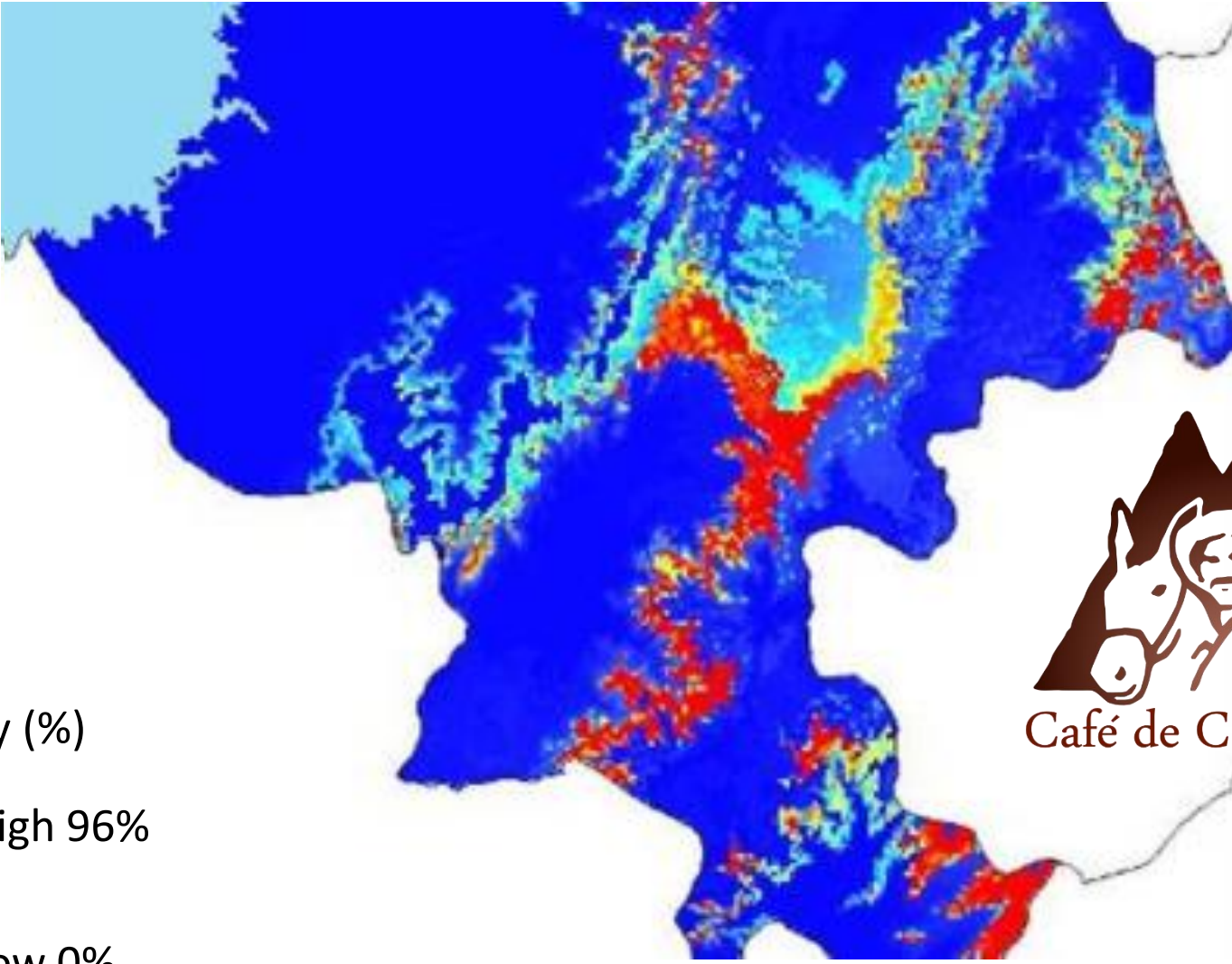


- Adaptation highly questionable
- Unprecedented heat waves
- 20-30% increase extreme precipitation
- Risk of global mass extinctions
- Global crop decline
- Significant Amazon dieback
- Millions risk displacement by sea level rise
- Tipping point for Greenland Ice Sheet
- High risks for regional food security
- Major risk to most coral reefs
- Food production losses
- Extreme heat waves with severe societal impacts

©www.climateactiontracker.org  
Ecofys | Climate Analytics | PIK

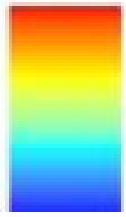


# Department's Coffee Growing Regions Colombia



2050

Suitability (%)



High 96%

Low 0%



Source: Jarvis, CIAT (2012)







**Energy can be Carbon Free**





**Aviation Fuel needs Carbon**



**Chemicals for Everyday Products need Carbon**



# Carbon: Problematic When Combusted

## Outdoor Air Pollution Impact

CHINA: 1.2M premature deaths in China in 2010  
Or 25M healthy years of life from the population.

USA: 200,000 early deaths every year  
(Equal to those who die from diabetes each year. )

*The New York Times*, April 1, 2013, sec. World / Asia Pacific,  
quoting from the *Global Burden of Disease Study 2010*, *The Lancet*, December 2012.  
Shindell, D. T. et al. (2016) Climate and health impacts of US emissions reductions consistent with 2C, *Nature Climate Change*, [doi:10.1038/nclimate2935](https://doi.org/10.1038/nclimate2935).



Sources:

IEA Oil Market report 2015 <https://www.iea.org/oilmarketreport/>  
APF <http://aliciapatterson.org/stories/china%E2%80%99s-rise-creates-clouds-us-pollution>

IEA World Energy Outlook 2011: [http://www.iea.org/publications/freepublications/publication/weo2011\\_web.pdf](http://www.iea.org/publications/freepublications/publication/weo2011_web.pdf) capturing carbon. fueling growth.  
EIA International Energy Outlook 2013: <http://www.eia.gov/forecasts/ieo/pdf/0484%282013%29.pdf>

**LanzaTech**

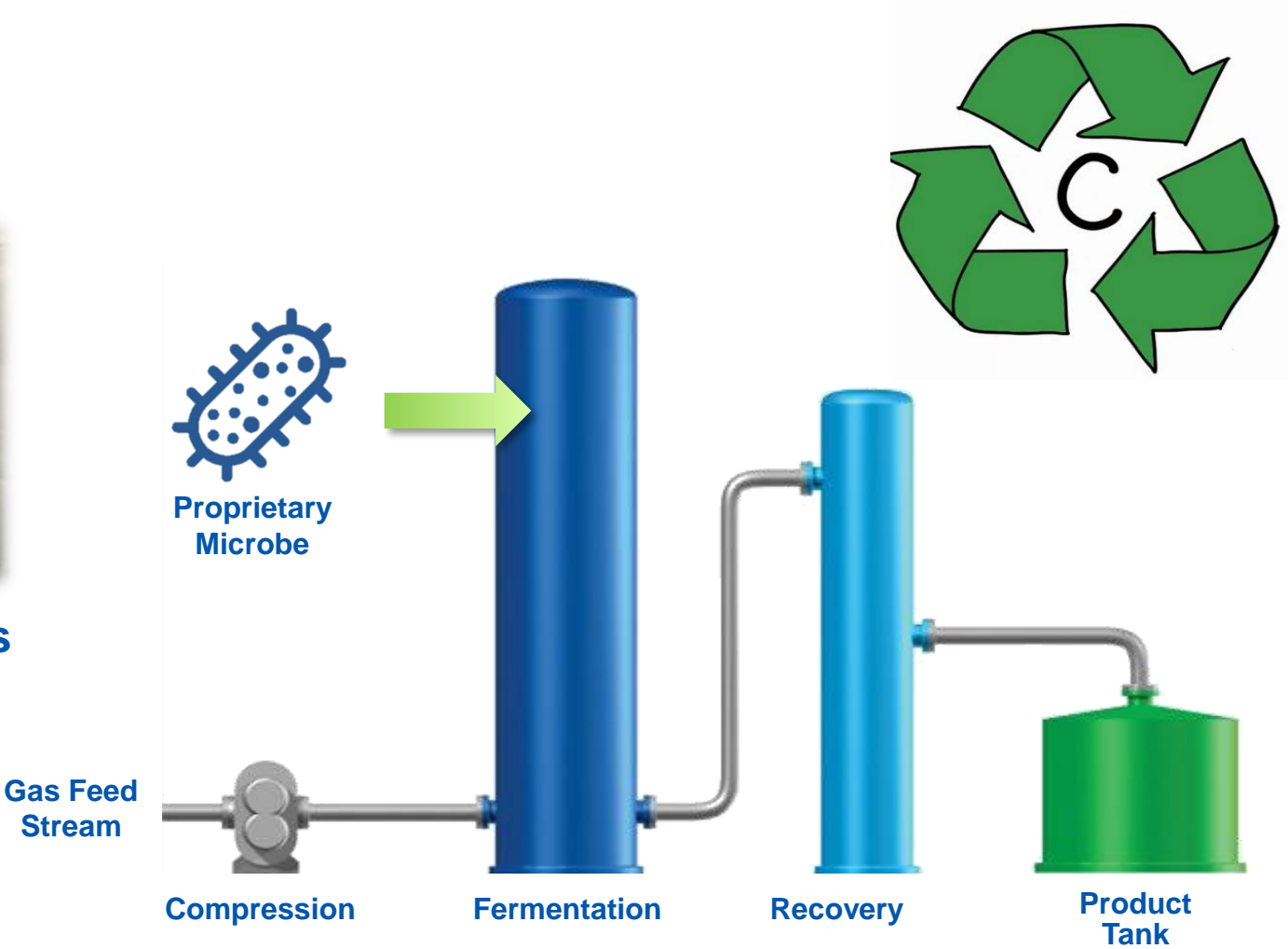




# Recycling Carbon



**Industrial Off Gas**  
✓ Steel  
✓ Refining  
✓ Ferroalloy



LanzaTech





# Commercial Scale Facilities



首钢朗泽

Shougang LanzaTech

**Caofeidian, China**  
**16M gallons/year**  
**2017**



ArcelorMittal



**Gent, Belgium**  
**21M gallons/year**  
**2018**



# Commercial Scale Beyond Steel



IndianOil



**Haryana, India**  
**13M gallons/year**  
**Refinery offgas**  
**2019**

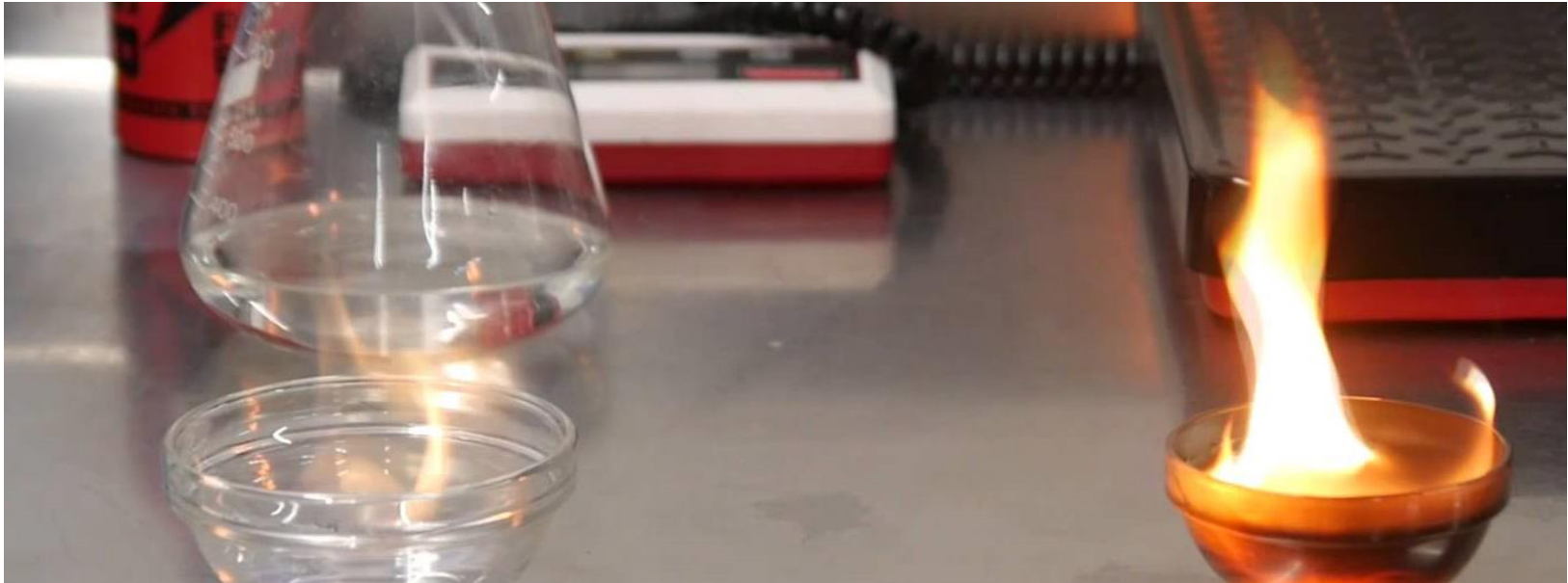


**Modesto, California**  
**8M gallons/year**  
**Biomass Syngas**  
**2018**





# Ethanol-blend Fuels Reduce Particulate Emissions

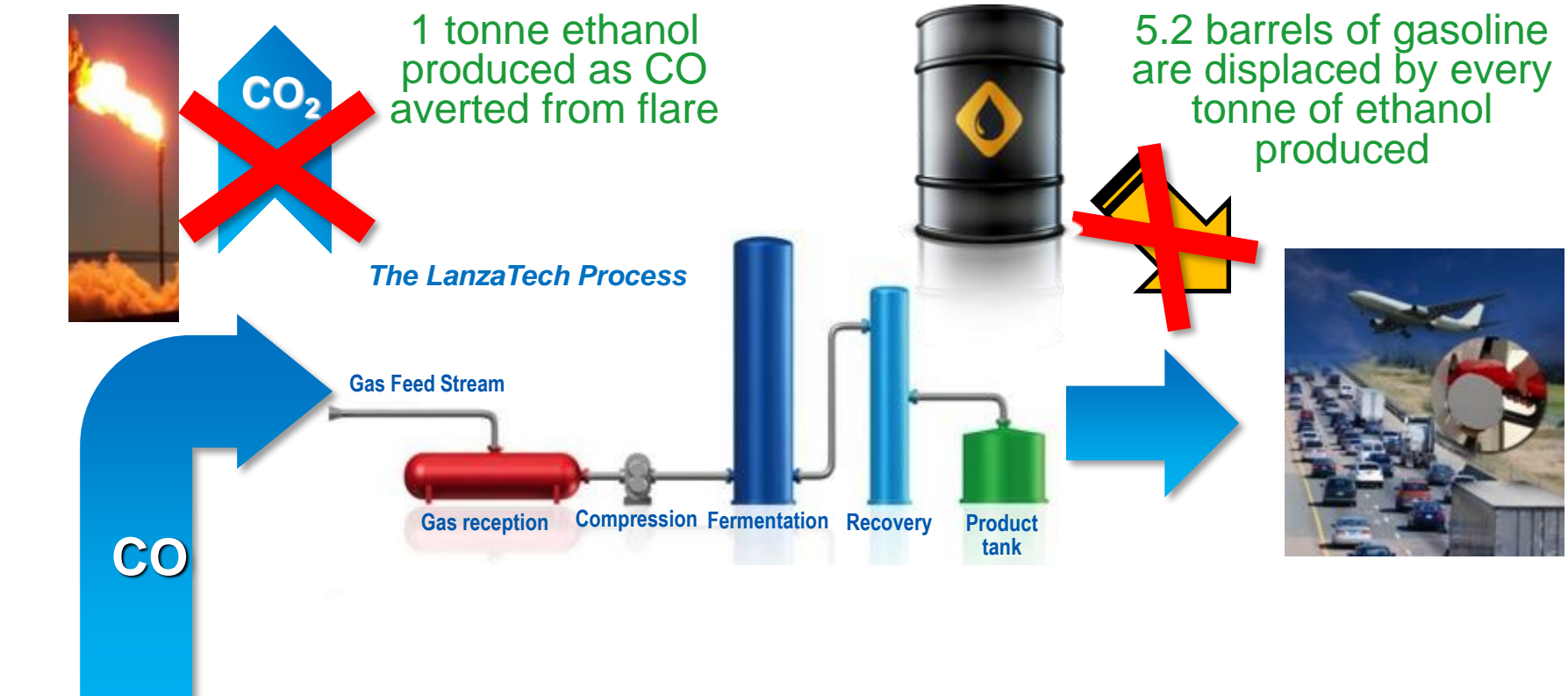


**30-40% reduction PM**  
**E0:E20 fuel blends**

Storey et al., SAE Int. J. Fuels Lubr. 3(2):2010



# Environmental Impact: LanzaTech Example



***Steel mill gases from the Steelanol project can be used to fuel 100,000 cars per year... While saving the emissions of 80,000***



# Electric Mobility for Road Transport

Transition is underway for road transport



\$35,000 USD  
200miles/charge

**Current LanzaTech Commercial Projects  
Equivalent ~300k EVs on Road/Year**

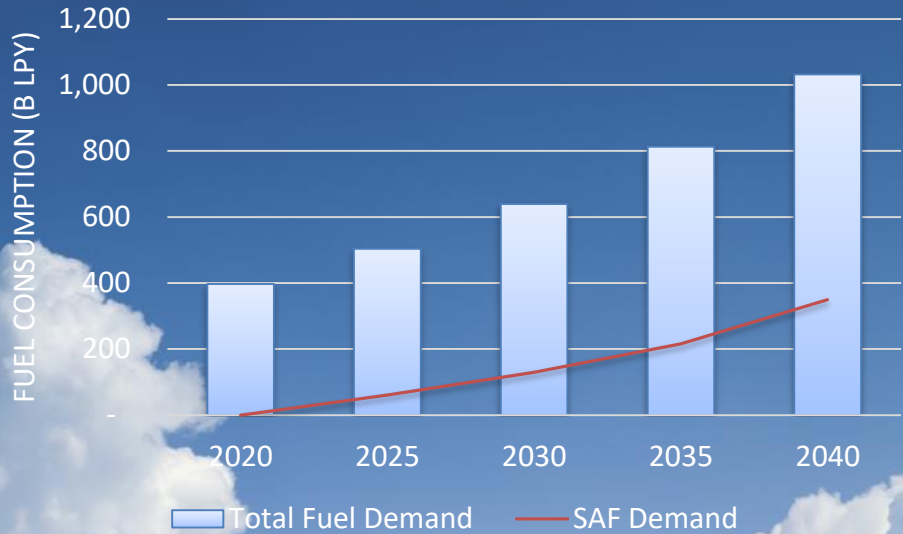




**Aviation Fuel needs Carbon**



# Sustainable Aviation Fuel will Play a Key Role



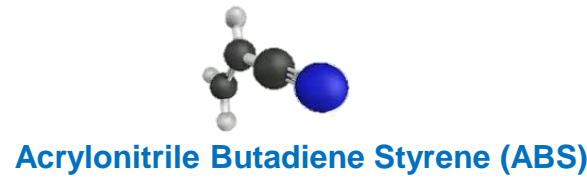
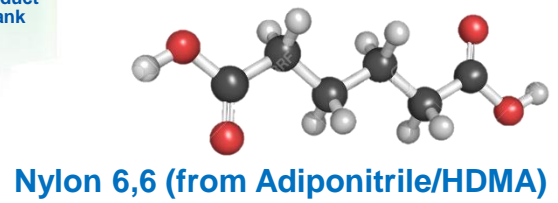
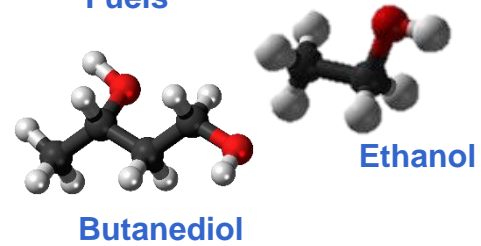
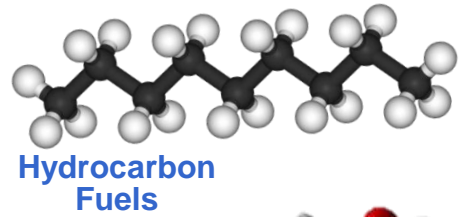
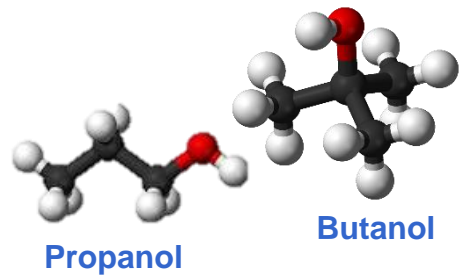
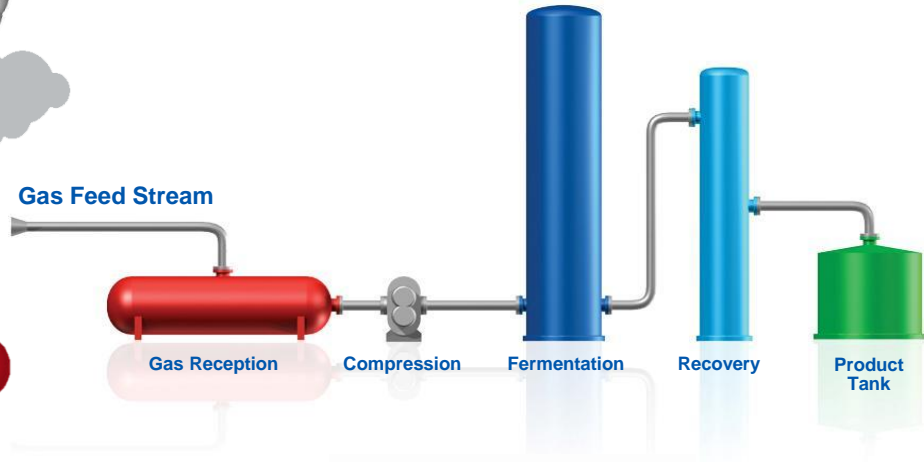
*SAJF will need to rise to 34% of total jet fuel consumption by 2040 to meet ICAO commitments*

Carbon neutral growth post 2020

50% emissions reduction by 2050: 2005 levels

Limited substitution options for aviation sector

# Building a Technology Platform



# Building Experience...

## Steel (CO)

*Field experience since 2008*

- 4 pilot/demo units; 2 @ 400k lpy capacity
- Over 70,000 combined hours on stream
- Multiple runs exceeding 2000 hours
- 3 commercial projects past basic engineering design; 2 permitted; 1 LLE ordered

ArcelorMittal



CHINASTEEL



首钢朗泽  
Shougang Lanza Tech



BAOSTEEL



BLUESCOPE



## Syngas (CO+H<sub>2</sub>)

*Field experience since 2014*

- MSW Pilot facility in operation
- 2 commercial plants in basic engineering design
- **Over 15,000 combined hours on stream since 2015**



AEMETIS

## Refinery Gas (CO+H<sub>2</sub>+CO<sub>2</sub>)

*Lab and engineering/design experience since 2015*

- Continuous, stable ethanol production from low CO streams in lab
- High CO<sub>2</sub> utilization (>50% of carbon fixed from CO<sub>2</sub>)



IndianOil



LanzaTech  
capturing carbon. fueling growth.



# Stoichiometry of Ethanol Production with Different Gas Compositions

CO:H<sub>2</sub> ratio

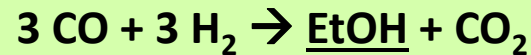
CO



1:0

**Steel Mill Gas**  
Demonstrated at scale

CO + H<sub>2</sub>



1:1

**Syngas (e.g. MSW)**  
Demonstrated at scale

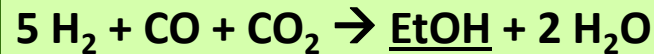
CO + H<sub>2</sub>



1:2

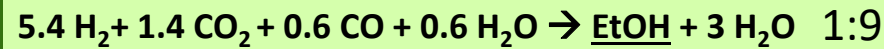
**High H<sub>2</sub> Syngas**  
Demonstrated at pilot, allows  
CO<sub>2</sub> fixing in products

CO + H<sub>2</sub> + CO<sub>2</sub>



1:5

CO + H<sub>2</sub> + CO<sub>2</sub>



1:9

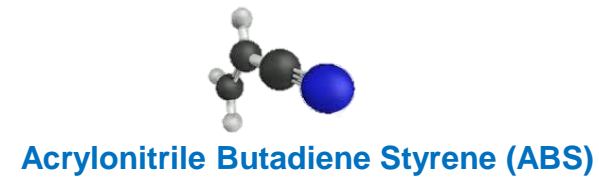
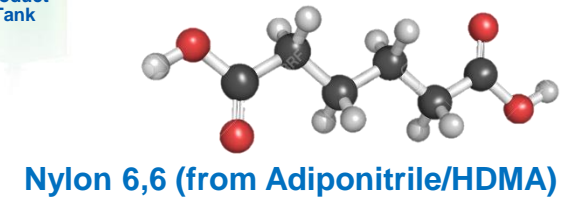
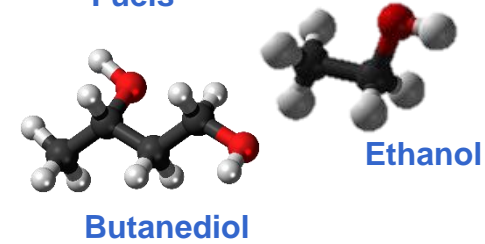
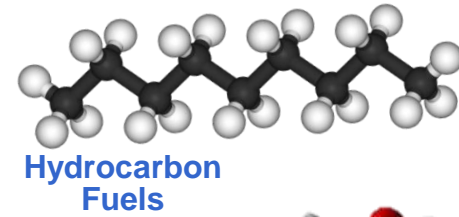
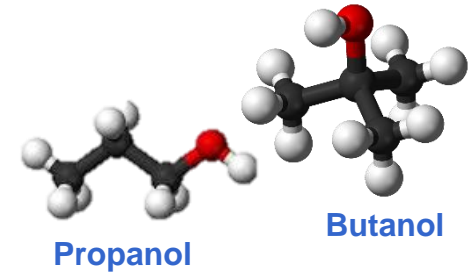
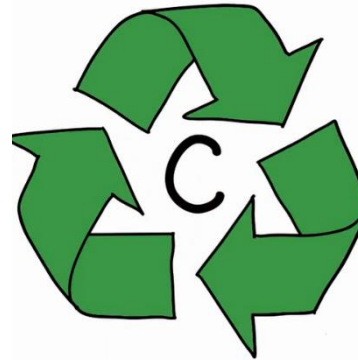
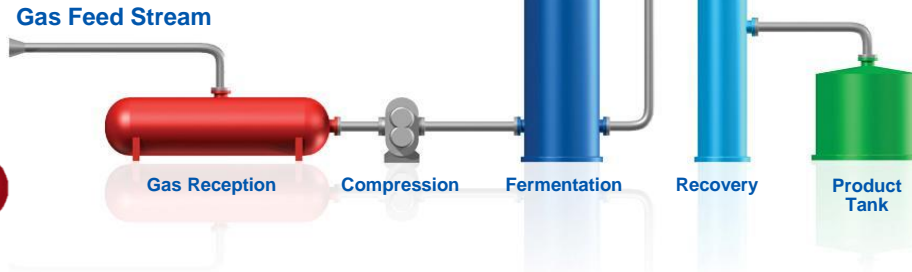
Primarily **Acetate** production

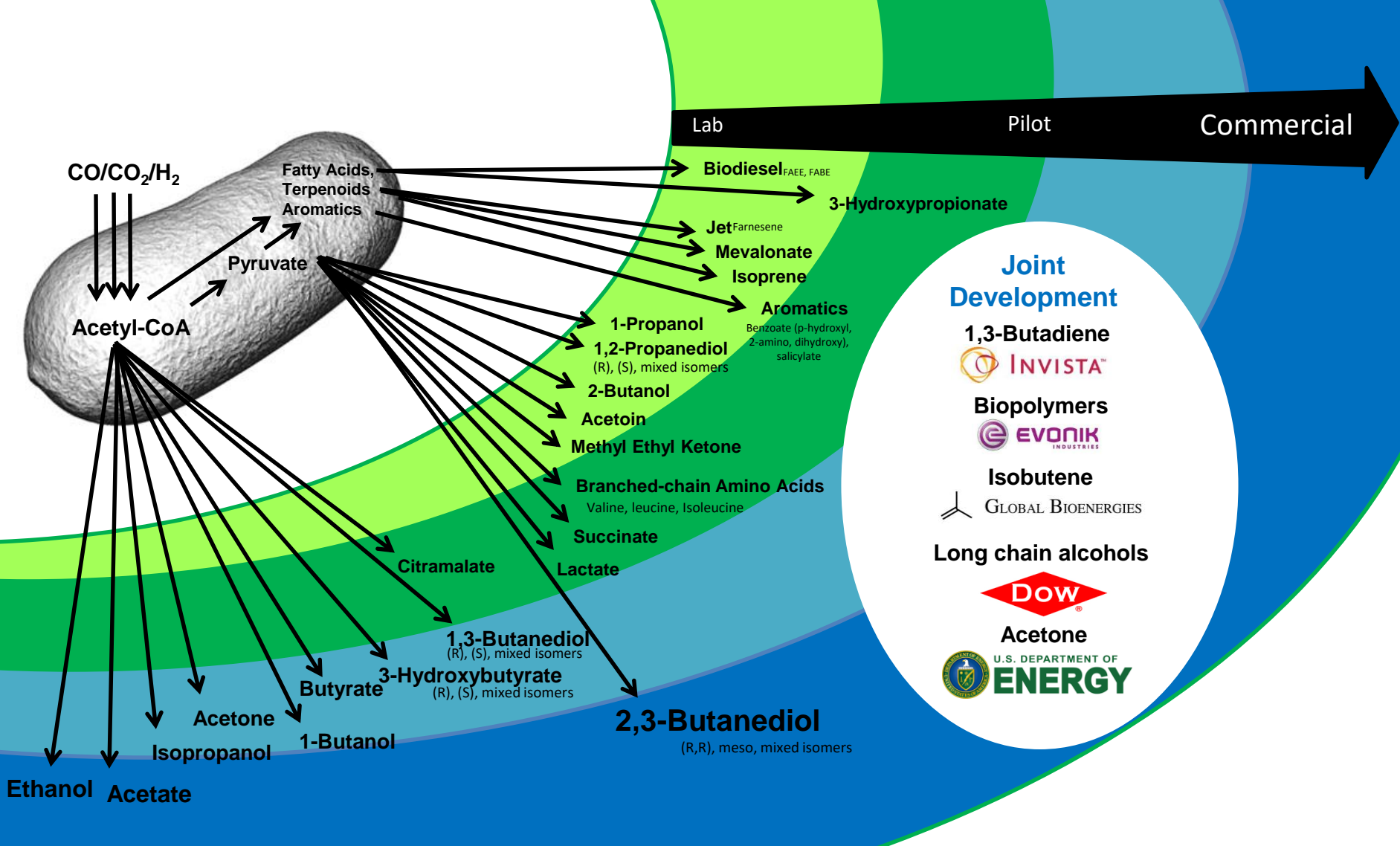
CO<sub>2</sub> + H<sub>2</sub>





# Building a Technology Platform





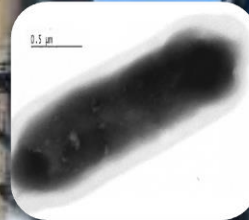
**Demonstrated Over 30 New Products Directly from Gas**





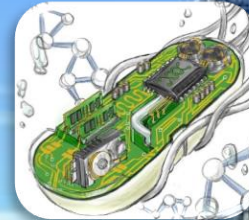


Microbe 1.0



✓ Ethanol

Microbe 2.0

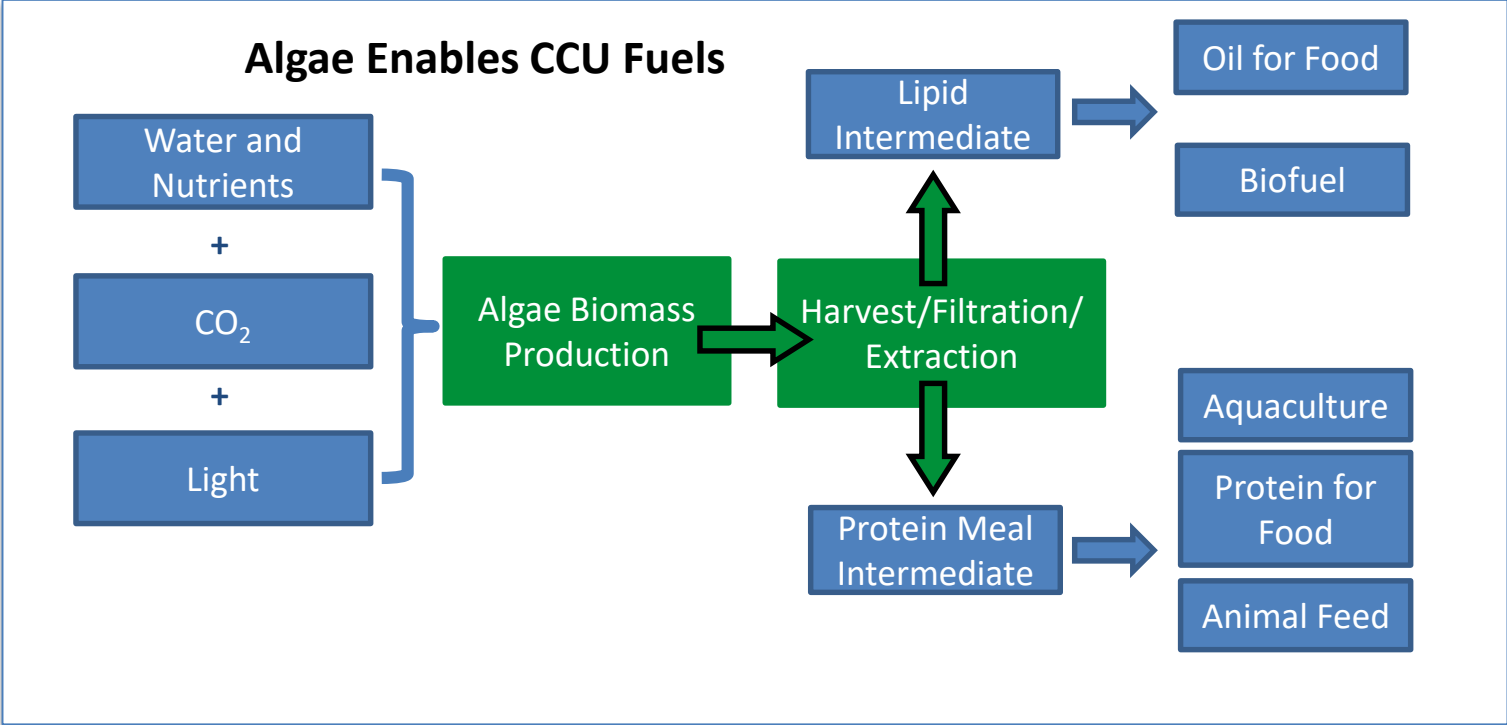


✓ new product molecule

- ✓ Same reactor
- ✓ Same operating conditions
- ✓ Same feedstock

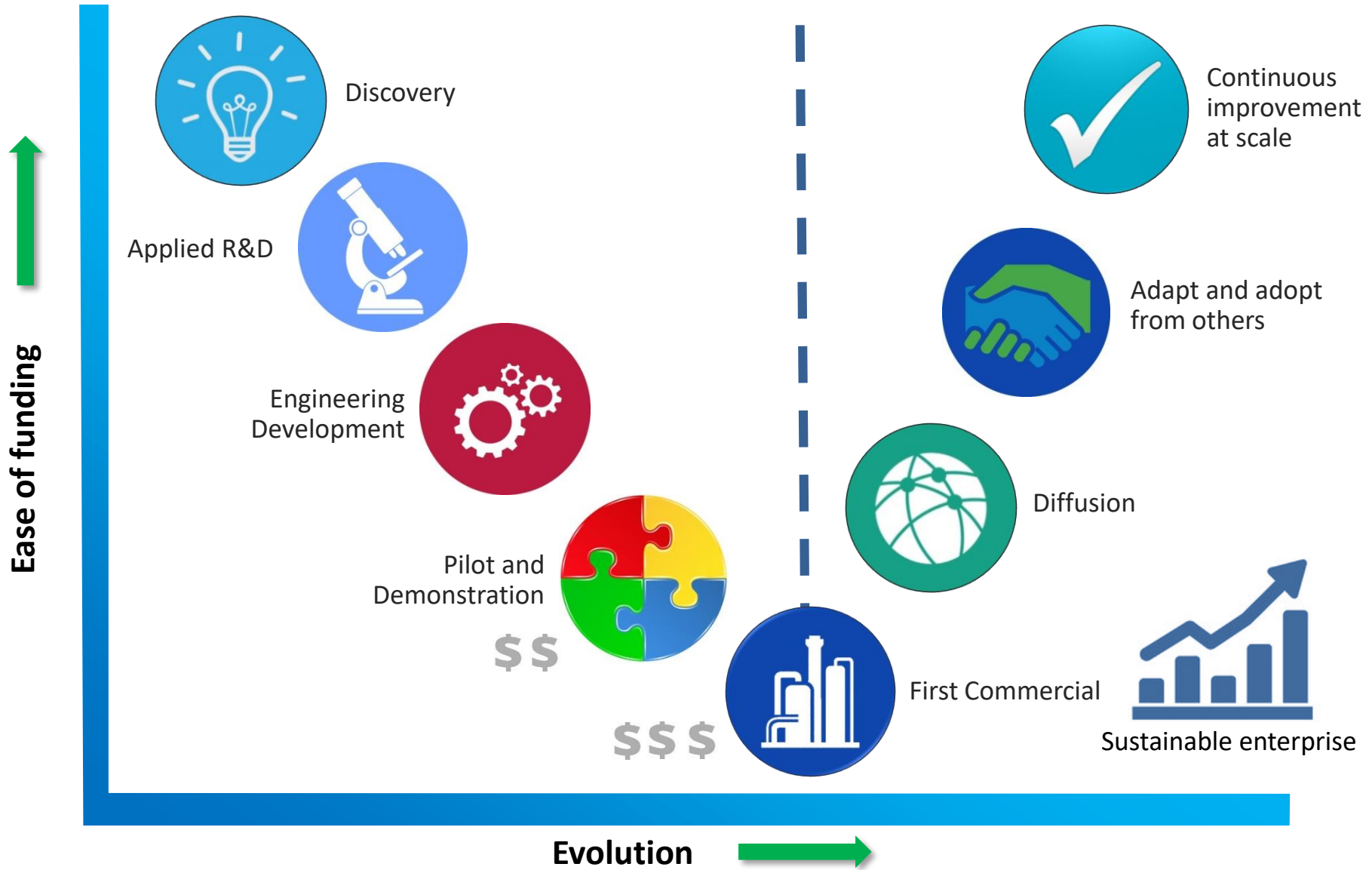
***DISRUPTION = 1) Rapid Reaction to Market Fluctuations 2) Feedstock ≠ Commodity***

# Carbon: Opportunities Today





# Crossing the Valley of Death



**“I run in the darkness long before  
I ever dance under the lights”**

*-Muhammad Ali*





CO<sub>2</sub>

Carbon (CCU)



Liquid Fuels



Polyethylene



PET



Nylon



CO<sub>2</sub>

Carbon (CCS)

CO<sub>2</sub>

CO<sub>2</sub>

CO<sub>2</sub>

Capturing Carbon. Generating Revenue. Reducing Emissions. **NOW**





**Carbon Management Technology Conference  
Houston, Texas  
July 18, 2017**

Robert M. Sturtz

VP of Business Development

World Fuel Services

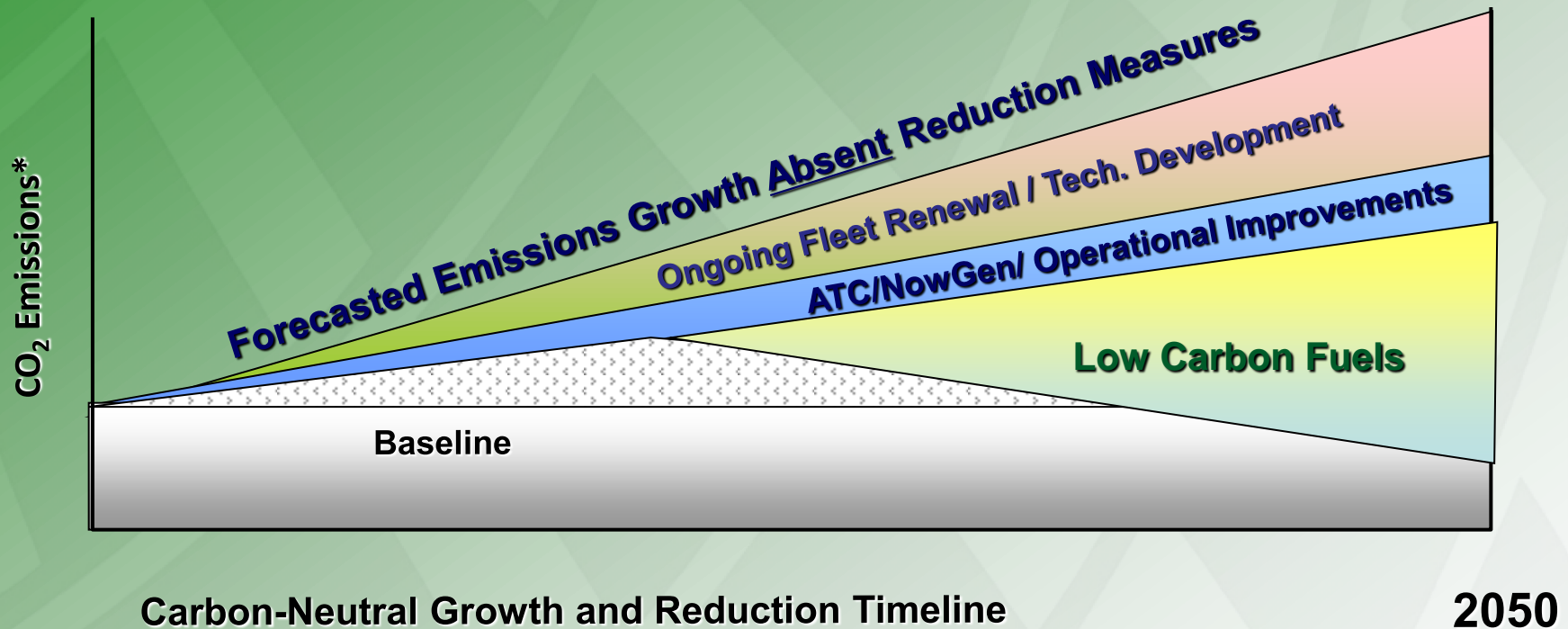


# Aviation is a Ready Made Market for Bio-Fuels.

- **Highly concentrated demand nodes**
- **Highly concentrated users**
- **Aviation has no alternative source of energy**
- **Economic benefits**
- **No changes needed for airplanes/airports/pipelines**
- **Environmental benefits**



# Aviation Taking Action on CO<sub>2</sub>



- United worldwide – global sectoral approach
- Sustainable bio-fuels a key part of the solution

# Low-Carbon Fuels Critical to Voluntary Environmental Commitments of Worldwide Aviation Industry

1. Improve fuel efficiency by 1.5% p.a. in 2009-2020
2. Achieve carbon-neutral growth (“CNG”) from 2020
3. Reduce sector emissions by 50% from 2005 to 2050





# Airlines Take Their Environmental Responsibility Seriously

---

- Committed to Action on four Pillars
  - Technology including cleaner Fuels
  - Operations
  - Infrastructure
  - Basket of measures
    - Includes recent Agreements under ICAO that will lead to a cost for Carbon





# Airline Criteria for Alternative Fuels

- Reliable (Must meet ASTM Fuel Specifications)
- “Drop-In” Fuel
- Cost Competitive
- Environmentally better than conventional jet on an LCA basis



# Airline Off-take Agreements

• AltAir	10 MG	United, WFS
• Fulcrum BioEnergy	46.5 MG	United, Cathay
• Red Rocks	6 MG	FedEx, SW
• SG Preston	10MG	Jet Blue
• Gevo	8 MG	Luthansa
• Amyris/Total	1 MG	Cathay, Airbus

# AltAir Project

- Off-take Agreements executed in 2012
- Repurposed the Paramount, CA Refinery
- Converts Beef Tallow to RD and SAJF
- Began Production in March 2016
- 1<sup>st</sup> Commercial production of SAJF in the World
- 1<sup>st</sup> commercial production of RD in CA
- Supplies united, Gulfstream, KLM, UPS, US Navy, and LAX ground vehicles.

# CAAFI Sponsors

## From across the industry





# How CAAFI works

Bringing interested parties together\*

15 Aircraft,  
Engine, Subsystem  
OEM's



20 Airlines,  
Military,  
Airport orgs.



15 U.S. States /  
State Univ's



19 Countries /  
5 Continents



30 U.S.  
Government  
Offices

54 fuel  
producers

***300 Global Sponsor/Stakeholder Attendees  
180 Different Organizations, 32 EXPO Participants***

# CAAFI Work Teams

Building the foundation to enable commercialization

## **Research & Development**

*Enabling  
Multiple “Drop-in”  
Solutions*

## **Certification / Qualification**

*Fostering  
ASTM D7566  
Approval*

## **Environmental**

*GHG LCA, PM2.5  
Quantification,  
Sustainability*

## **Business**

*Facilitating  
Deployment,  
Investment*

# The Great Green Fleet Exercise





# CCU: Part II

## How Advances in Biological and Other Recycling Technologies are Changing the Carbon Equation



Carbon Management Technology Conference

July 18, 2017

**Matt Carr**

Executive Director

[mcarr@algaebiomass.org](mailto:mcarr@algaebiomass.org)







# PLATINUM MEMBERS



# GOLD MEMBERS



KELLER AND HECKMAN LLP  
SERVING BUSINESS THROUGH LAW AND SCIENCE®



# SILVER MEMBERS



# SILVER MEMBERS



The World Leader  
in Process Equipment Design



# The Challenge

- Reduce GHG emissions from fossil power generation and other industrial sources...

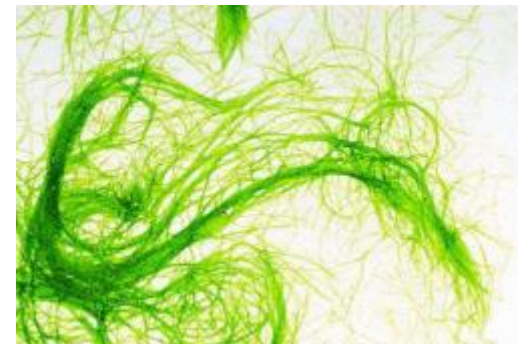
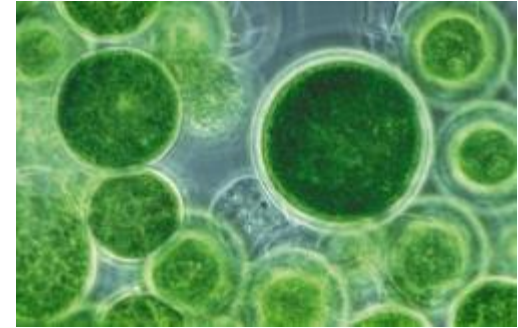
**Economically**



# The Biological Capture and Utilization Opportunity

## Algae & Other Autotrophs

- Earth's original carbon mitigation strategy
- CO<sub>2</sub> eating machines:
  - 100 acres of algae consume as much CO<sub>2</sub> as 2,000,000 trees
- Exceptionally fast-growing
  - Mature in days vs. months/years
- Factory for production of oils, proteins, other high-value products





# The Biological Capture and Utilization Opportunity



- Can produce ...  
**50-100 gallons biofuel per ton CO<sub>2</sub>**
- Product value from algae conversion:  
**> \$100 / ton CO<sub>2</sub>**
- Today: Algae developers buy CO<sub>2</sub>  
(at \$40+ / ton) as a feedstock
- Industrial CO<sub>2</sub> Challenge + **Algae** =  
**Opportunity**



# Co-Location Potential



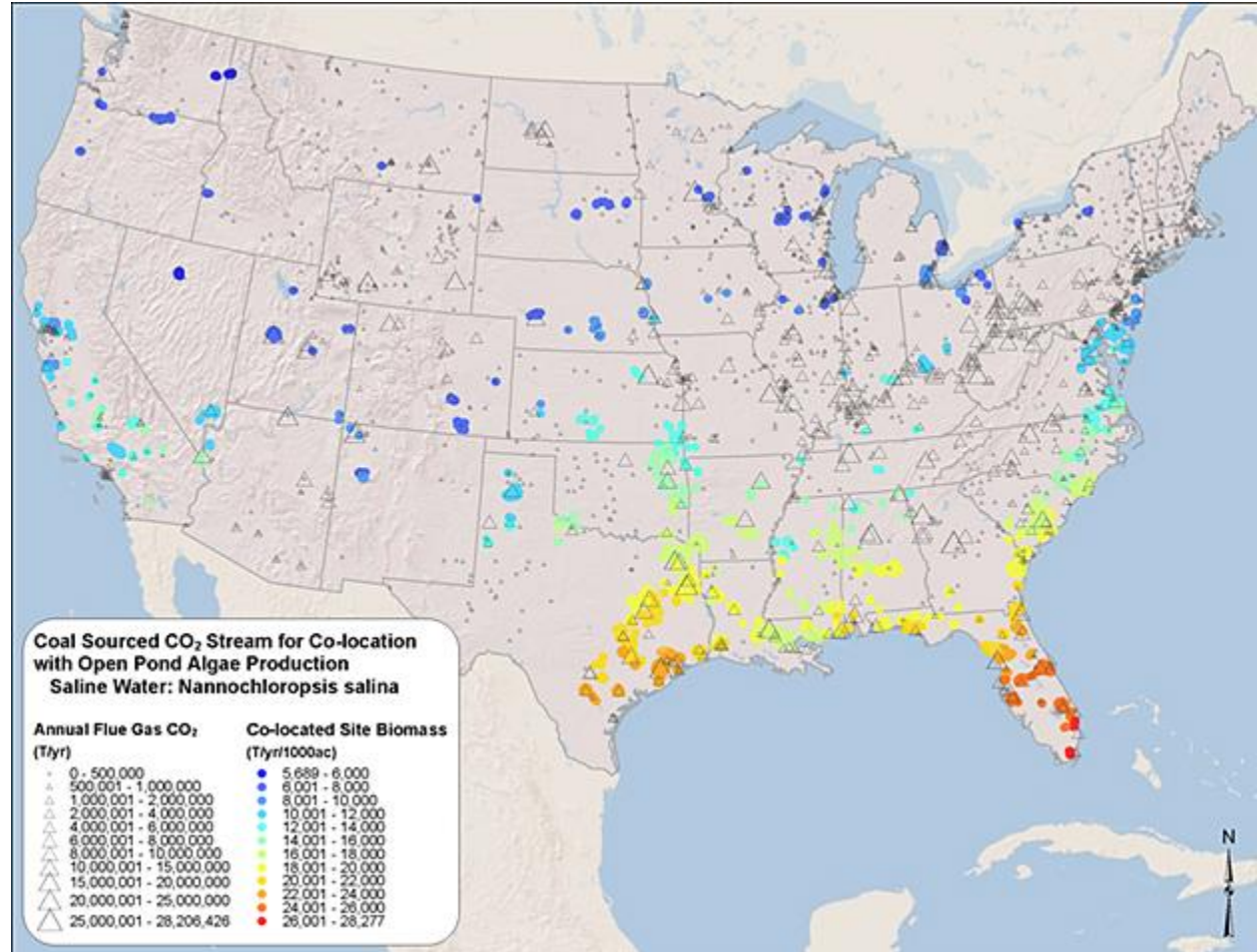
➤ **2016 DOE/ORNL Analysis\*:**  
**Substantial U.S. Potential for Algae CCU:**

- ❖ 140,000 sq. miles suitable for open pond production (**≈75,000 farms**)
- ❖ Even with highly conservative assumptions, using existing technology:
  - More than 500 viable point sources
  - Potential to use **>200 million tons CO<sub>2</sub> / year**
- ❖ Much larger quantities possible beyond 2030, especially with CO<sub>2</sub> price/regulation

\*2016 Billion-Ton Report <https://bioenergykdf.net/billionton2016/overview>

# Algae Chapter Highlights

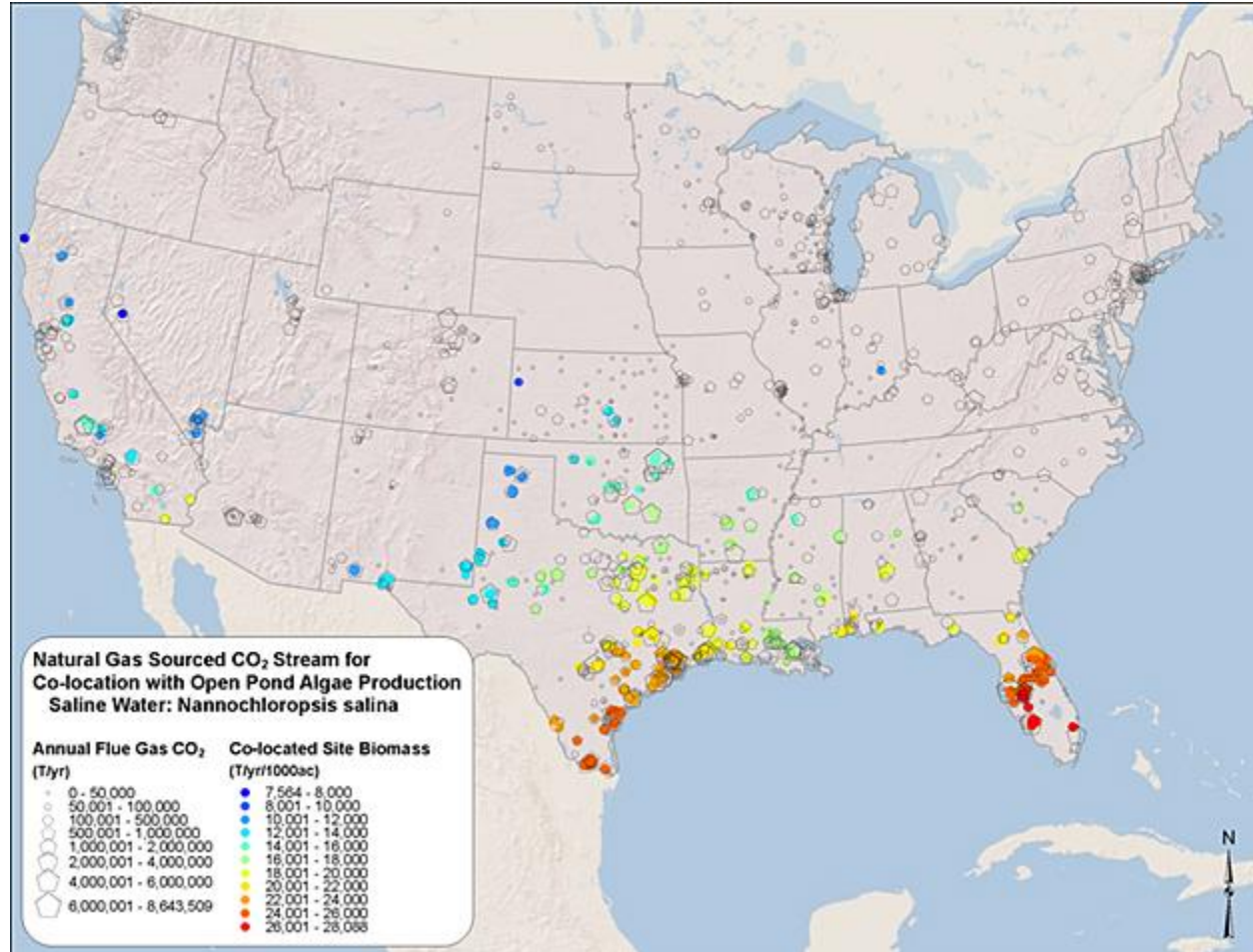
## COAL - Saline Strain, Current Productivity





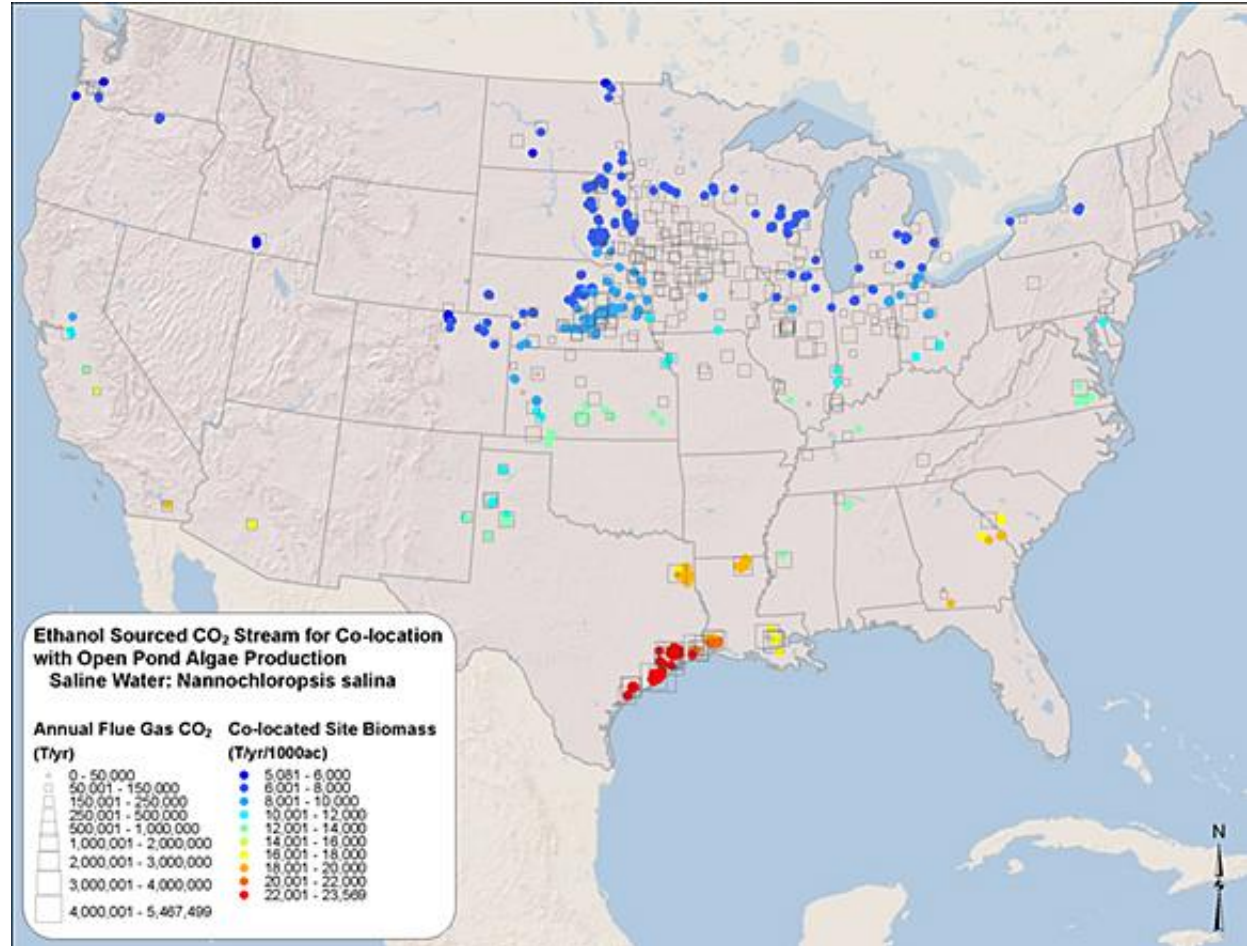
# Algae Chapter Highlights

## NATURAL GAS - Saline Strain, Current Productivity



# Algae Chapter Highlights

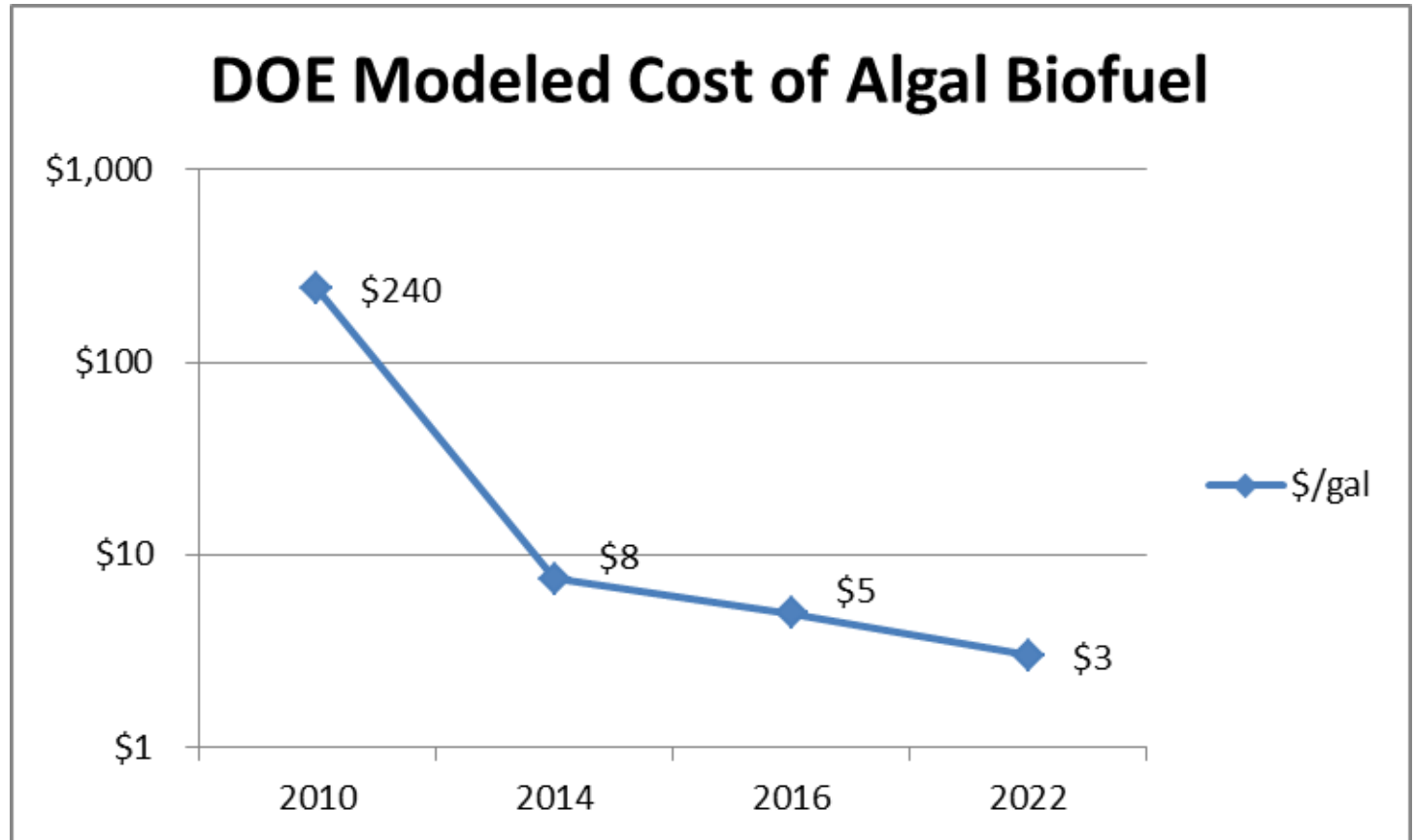
## ETHANOL - Saline Strain, Current Productivity





# Technology Progress

## ➤ Cost of Production



# Technology Progress



## ➤ DOE-funded integrated algae biorefinery commercial demonstration projects in:

- Florida (Algenol)
- New Mexico (Sapphire)
- Iowa (BioProcess Algae)



## ➤ Pilot / demonstrations with flue gas from variety of industrial sources:

- Coal, other power plants
- Cement, steel
- Ethanol



# Beneficial Re-use of Carbon Using Microalgae

## University of Kentucky / Duke Energy



- **Pilot project at Duke's East Bend Coal-powered Generating Station**
- **Recently awarded \$1 million DOE Fossil Energy Grant**





# 33-Acre Kauai Algae Facility

Co-located with naphtha / fuel oil-powered steam-injected combustion turbine power plant



# State of Algae Carbon Utilization Technology

## ➤ BioProcess Algae

- 5-acre commercial demonstration in Shenandoah, IA, co-located with Green Plains **corn ethanol plant**
- Continuous operation since 2009 utilizing waste CO<sub>2</sub>, waste heat, waste nutrients
- Markets: Fuel, fish/animal feed





### 3 Commercial Projects Underway



**Strong Pipeline and Committed Partners**

*Commercial Production  
2017*



*1 M barrels/year  
in the ground*

**LanzaTech**  
capturing carbon. fueling growth.





# Big Market Opportunities



## ➤ Aquaculture Feed

❖ 130 million tons, \$9B / yr



## ➤ Livestock Feed

❖ 1B tons, \$370B / yr

## ➤ Fertilizer

❖ 180 million tons, \$90B / yr



Source: Bloomberg New Energy Finance Research Note 5 June 2015

## ➤ Soil Amendments and Biofertilizers

200 Acre Algae Biofertilizer Demonstration – Arizona Farm



- Algae cultivated in simple PBR's adjacent to the melon field
- Algae distributed through drip irrigation system



12 Weeks to harvest and a week sooner to market



Yosemite Melons	
Germination	2X
Early Growth	2.5X
Plant Size & Density	3X
Early Melon Maturity	2X
Mature Melon Size	1.4X
Mature Melon Weight	1.5X
Taste (blind panel test)	14:1



# Globalization



## ➤ Strategic Partnerships / Globalization

- ❖ TerraVia / Bunge / BioMar – Aquaculture Feed



- ❖ LanzaTech / ArcelorMittal / Virgin Atlantic – Steel Emissions to Aviation Biofuel





# Other CCU Markets & Technologies



## ❖ Concrete

- **Blue Planet** - Biomimetic mineralization into aggregates (43 billion ton / \$350 billion global market) and other materials
- **CarbonCure** – Sequestration in cement

## ❖ Transportation Fuels

- 2 billion ton market

## ❖ Performance Materials

- Graphene

# Policy Imperative: Parity with CCS



## ➤ Federal CCU Tax Credit

- New Senate bill (FUTURE Act) provides \$35 / ton for carbon captured and *utilized via photosynthetic, chemosynthetic or other conversion pathways.*
- House bill of record limited to CCS



## ➤ Carbon Utilization R&D

- Increased from \$2 million in FY2015 to \$10 million in FY2016-17
- Still 1/10 funding level for capture, storage



# Policy Outlook

## ➤ CCU Well Aligned with Trump Priorities

- ❖ Manufacturing
- ❖ Infrastructure
- ❖ Rural Revitalization

**JOBS!**

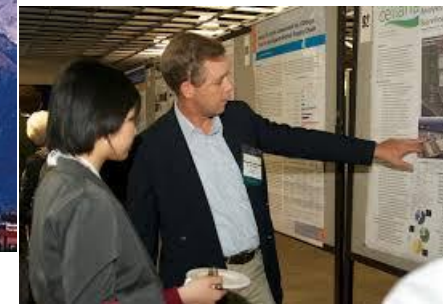




# 2017 Algae Biomass Summit



**Salt Lake City, Utah**  
October 29 – November 1, 2017







*Your Journey, Our Passion*

**Greer Tidwell**  
**Carbon Management Technology**  
**July 18, 2017**  
**Houston, Texas**

**Copyright 2016 Bridgestone Americas**







# Successful factory life

REQUIRES TURNING

# NEIGHBORS INTO FANS



## Environmental Mission Statement

To help ensure a healthy environment for current and future generations...

We, the Bridgestone group, are committed to continually working toward a sustainable society with integrity and in unity with our customers, partners, communities and the world around us.

Therefore, we are focused on three objectives.



**In harmony with nature**

To contribute to biodiversity through habitat enhancement, and through environmental education and research.



**Value natural resources**

To continually improve natural resource conservation through operational improvements and product design.



**Reduce CO<sub>2</sub> emissions**

To continually reduce emissions of Greenhouse Gases, including CO<sub>2</sub> from our products' complete life cycle.

The Bridgestone group's environmental mission covers all aspects of our business.



TEAMS: Total Environmental Advanced Management System  
TEAMS unites the group under a progressive management system to help ensure a healthy environment.

One Team,  One Planet.

**BRIDGESTONE**



# Environmental Mission: Reducing CO2 Emissions

## Global goals – by 2020



CO2  
EMISSION  
REDUCTION

Reduce CO2 from entire products lifecycle by **35%** per sales



ROLL  
EFFICIENCY

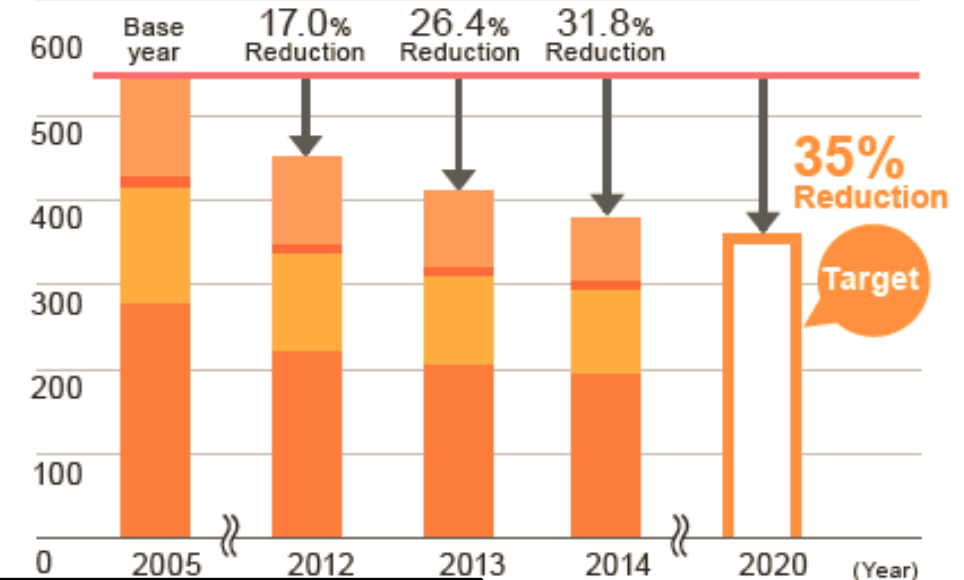
Improve **tire rolling efficiency** by **25%**, resulting in less fuel use and CO2 emissions while driving

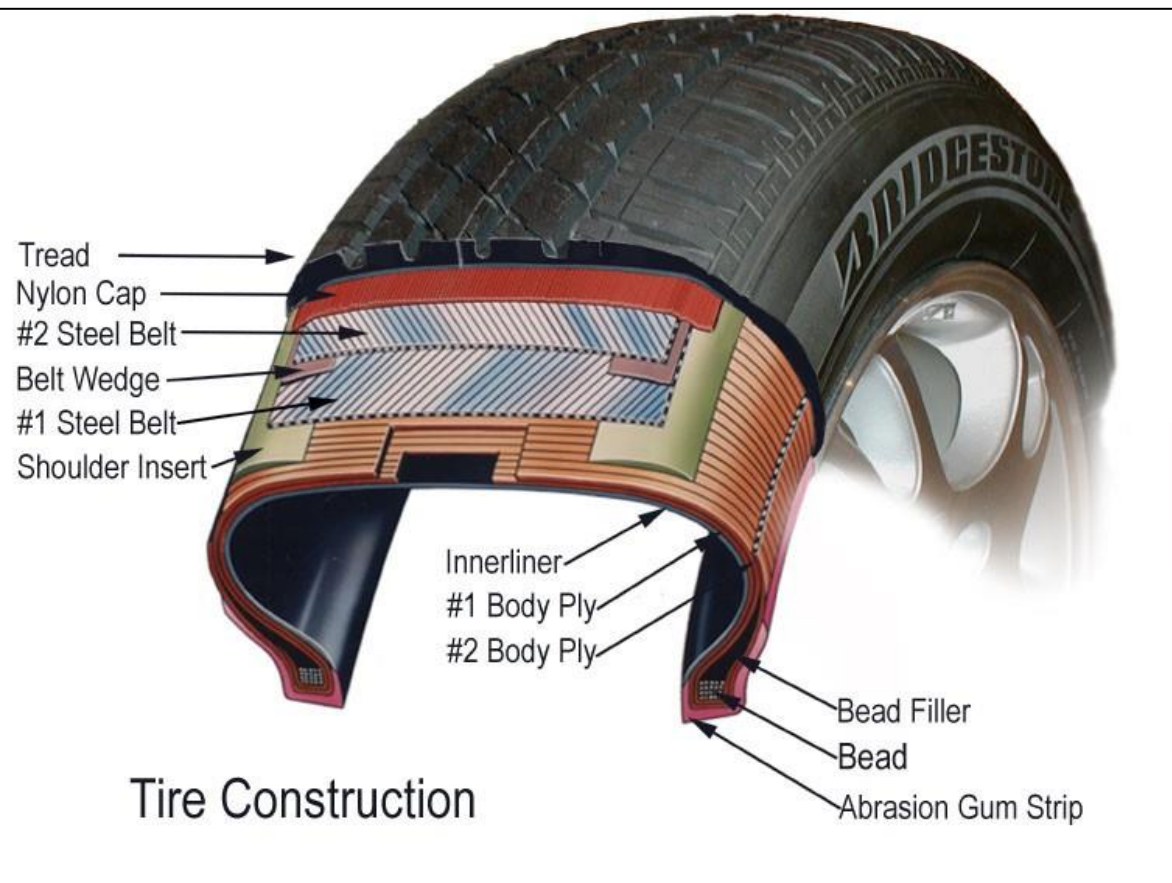
## Bridgestone's Global CO2 Progress

CO2 Emissions Per Unit of Sales from Lifecycle Stages Other Than Use\*3

(t/100 million yen)

Raw materials Manufacturing Distribution After-use












# 100% Sustainable Material Concept Tire 2012 Paris Auto Show



Tire Constructio

Today	Sustainable Materials	
Natural Rubber from Para Rubber Tree	Expand the range of renewable resources	Conventional Natural Rubber + <b>Guayule</b>  Guayule grown in arid region will diversify the source of natural rubber.
Rayon (Reinforcing Fiber)		Rayon + <b>New Cellulosic Fiber</b>  General grade pulp can produce the new fibers, resulting in more suppliability.
Synthetic Rubber from Petroleum	Replace fossil resources with renewable materials	<b>Synthetic Rubber from Biomass</b>  Butadiene from bioethanol
Rubber Materials from Petroleum		<b>Rubber Materials from Biomass</b>  Curing agent and anti-aging chemical from biomass
Filler from Petroleum and Coal		<b>Filler from Biomass</b>  Reinforcing carbon black from vegetable fats and oils





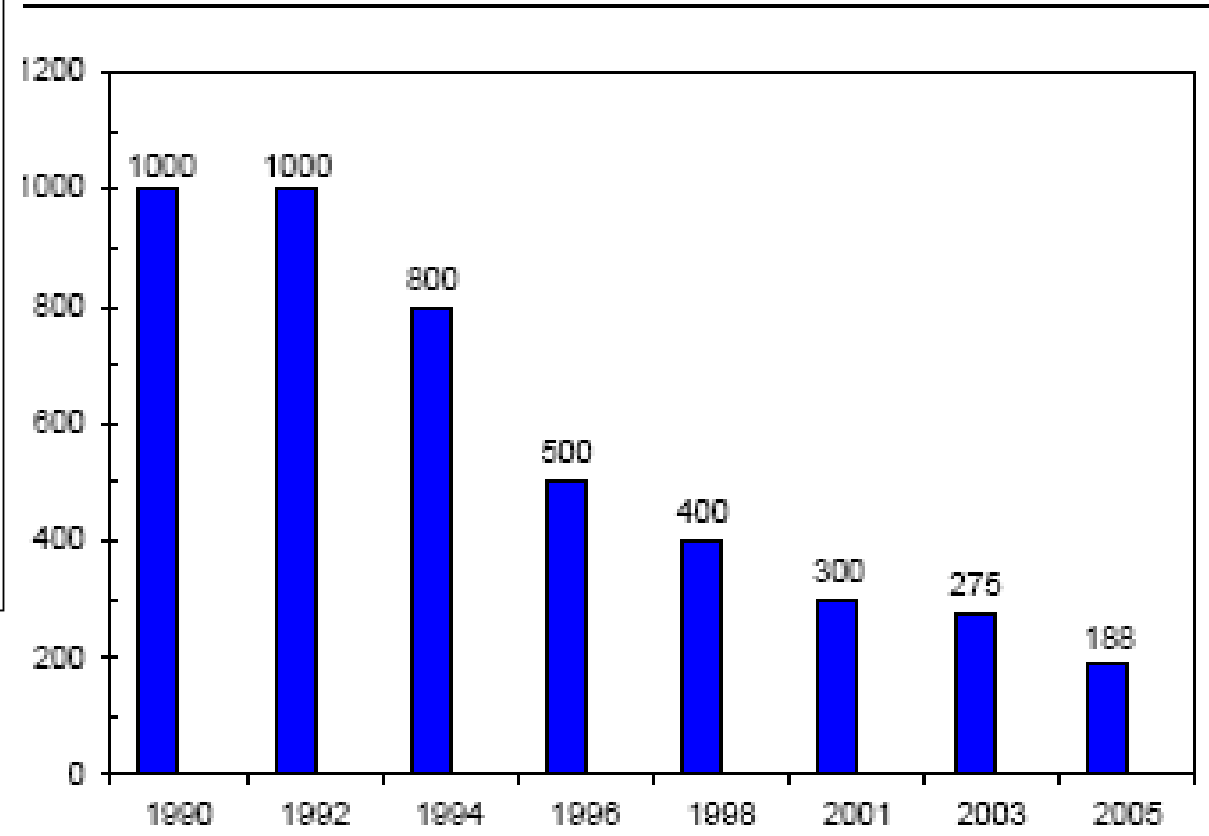
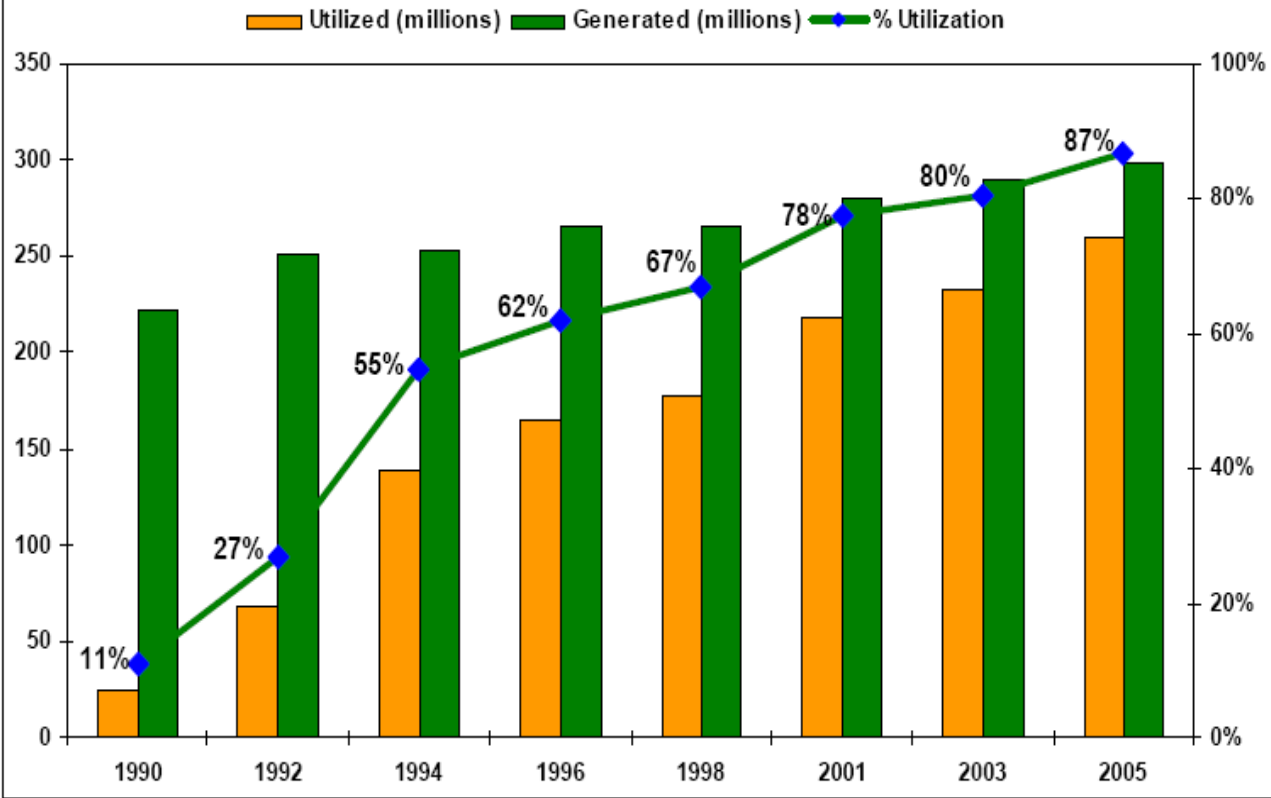
# Bridgestone GUAYULE R&D MESA, ARIZONA



Current source  
*Hevea brasiliensis*



# Nationwide: PROGRESS Tire Recycling and Stockpile Reduction



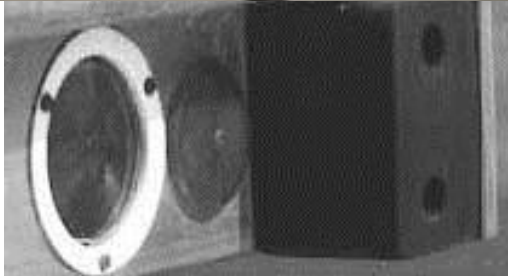
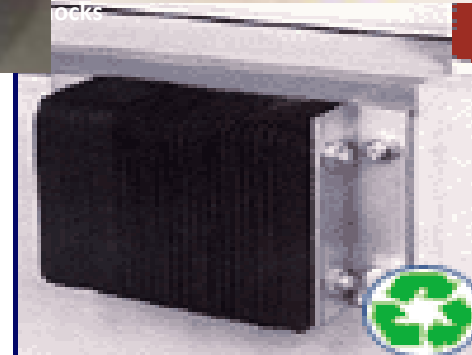
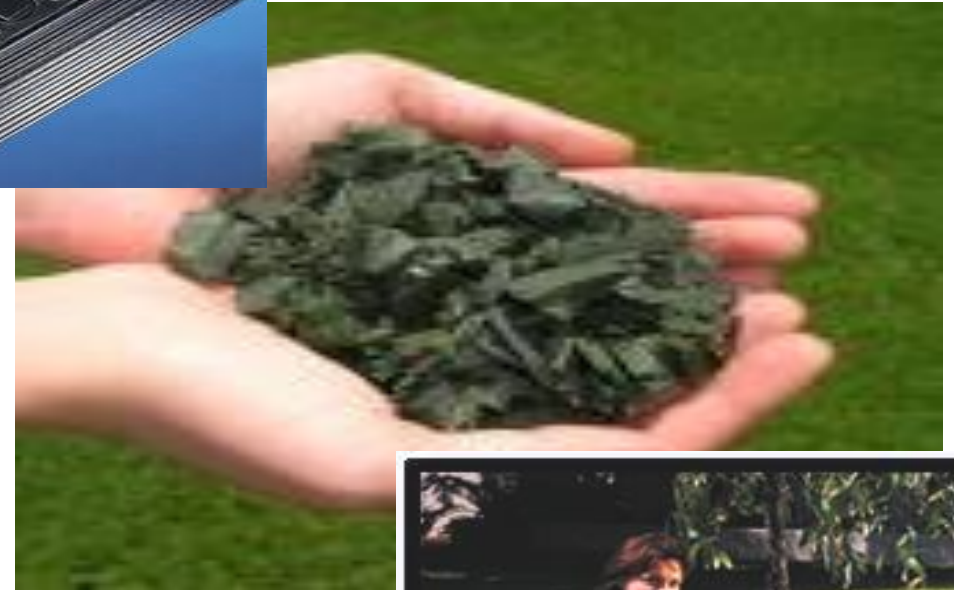
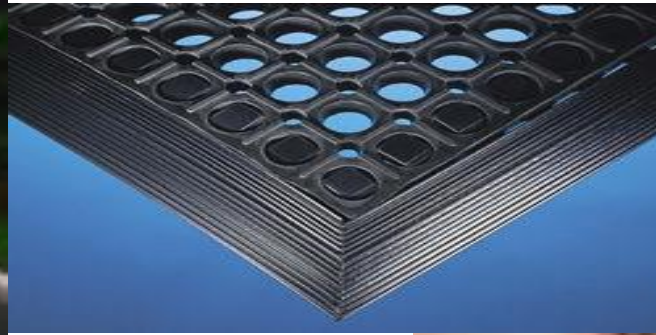
**Recycling U. S. Used Tires  
THEN 10% NOW >90%**

**Cleaning up U. S.  
Used Tire Stockpiles, Now <75M**

Source: Rubber Manufacturers Association



# “What do you do with all those scrap tires?”





**Vision: WASTE FREE Tire Industry**

- ✓ 100% of used tires returned to our stores get a beneficial next use.
- ✓ Provide Free scrap tire recycling for river cleanups

✓ <http://www.bridgestoneamericas.com/en/corporate-social-responsibility/environment-and-sustainability/tires4ward-request>

**>150,000 Tires recycled  
from 600+ events**

***Your Journey, Our Passion***