Quantification of Carbon-Neutral Greenhouse Gas Emissions

Using ASTM D6866

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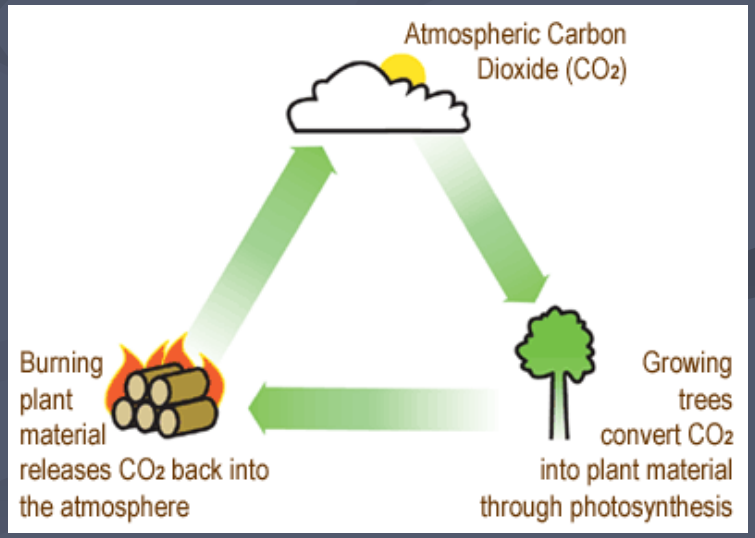
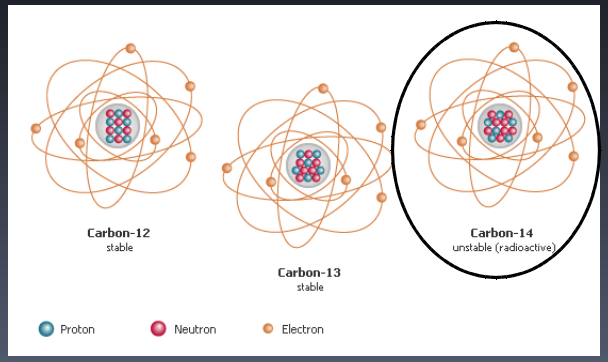
Carbon Neutral CO_2
(Biogenic CO_2)

- *Recently respired CO_2*
- *Plants recently removed it from the air*
- *A by-product of biomass incineration*
- *Can be subtracted from GHG inventories*
- *Has value in the trading markets*



Carbon-14



Naturally occurring

in <u>all</u> biomass,

<u>absent</u> in fossil fuels

ASTM D6866 measures it.

Carbon-14 is ubiquitous in all living things.

But it doesn't stick around.

It slowly and gradually decays away after death, so that by 50,000 years there's none left.

Coal and fossil-derived materials do not have any carbon-14 whereas biomass does.

Take a good look, Identical?

Carbon-14

- **Biomass CO2**

Coal CO2

No Carbon-14

They're NOT the same!

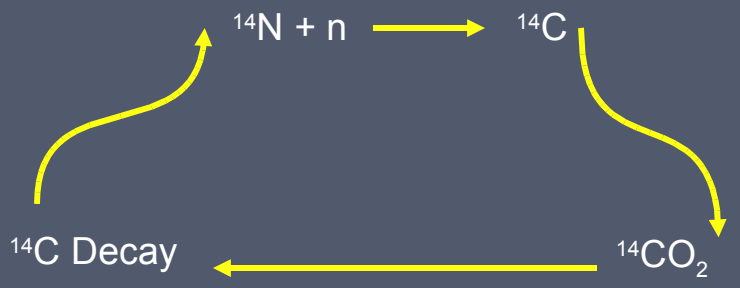
The Radiocarbon Cycle

STEP 1: Ongoing formation and decay of radiocarbon within the atmosphere

Nitrogen (^{14}N) + cosmic neutrons → Radiocarbon (^{14}C)

Radiocarbon immediately oxidizes → Carbon dioxide ($^{14}CO_2$)

The radiocarbon immediately starts to decay ($T^{1/2}$ = 5730 years)

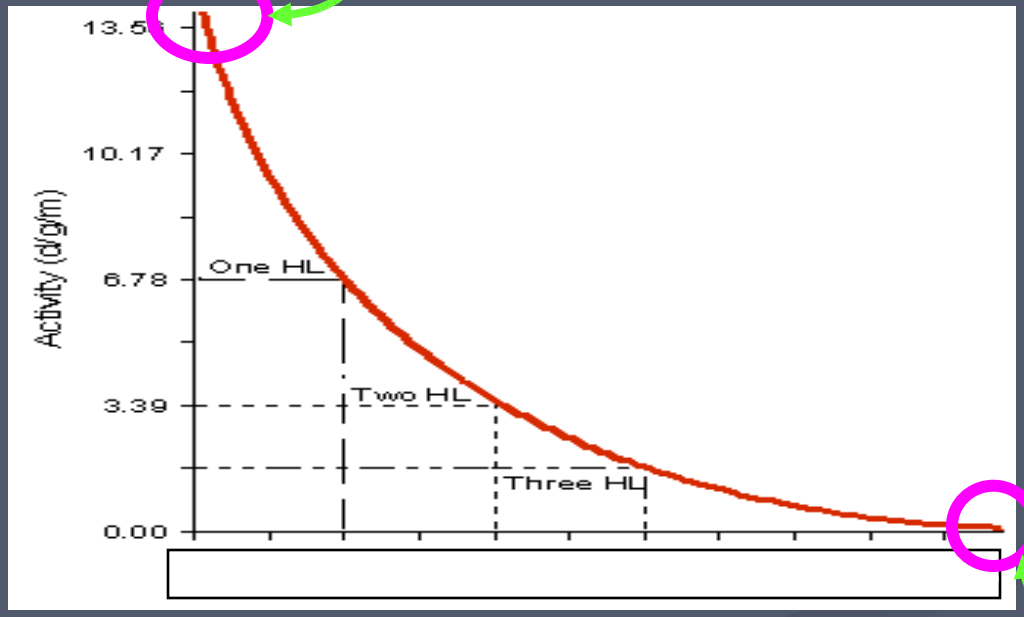


→ "Constant" amount of radiocarbon in the atmosphere as CO_2

STEP 2: Radiocarbon is removed from the atmosphere by plants

STEP 3: Disequilibrium begins upon "death"

100% renewable

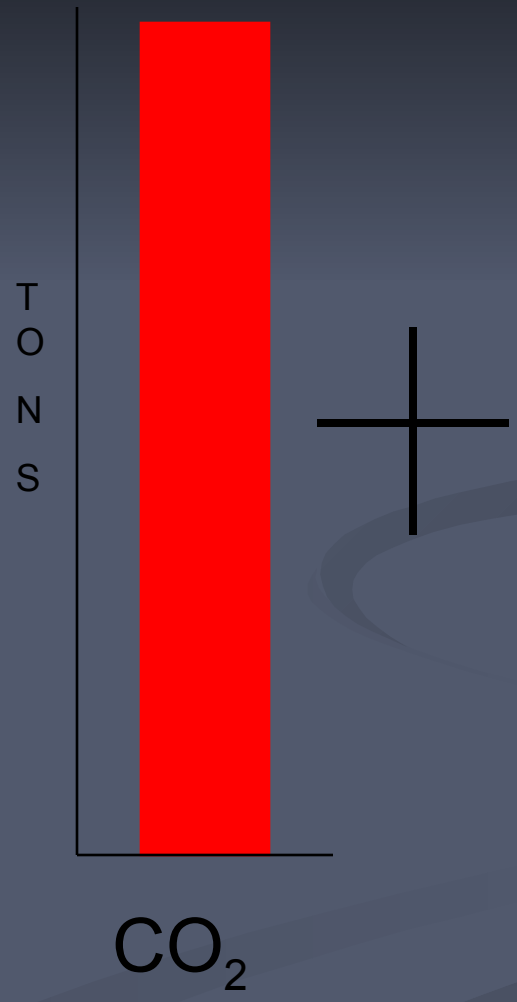


The Radiocarbon Decay Curve

0% renewable

Conventional biomass – CO_2 inventory accounting

(Stationary Combustion Sources – e.g. Cement, Co-firing, Biomass, Waste, etc.)



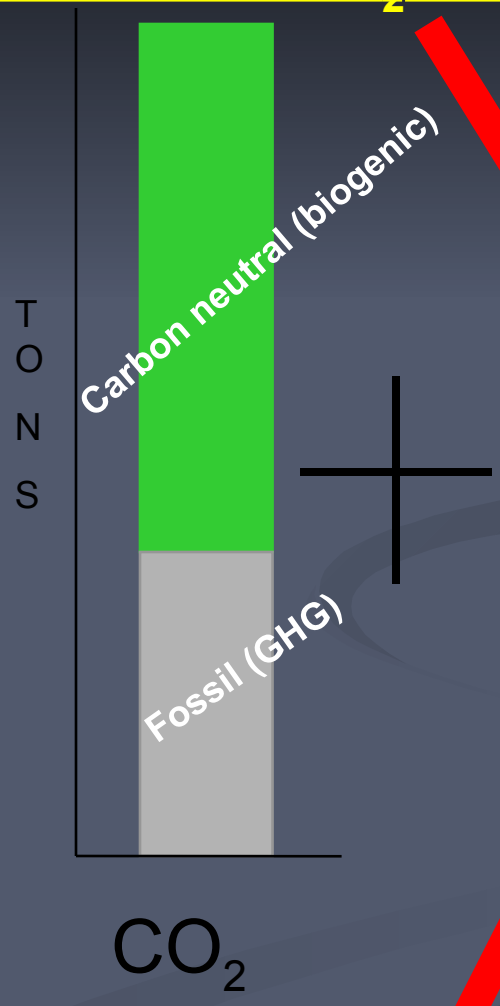
Complicated physical characterization of the feed stock

Sorting, cutting, sectioning, and weighing raw fuel

Labor intensive, expensive, burdensome

ASTM D6866 biomass – CO2 inventory accounting

Measure CO_2 in the stack effluent



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ASTM-D6866 is a standardization of radiocarbon dating methods used by archaeologists to determine the age of fossils.

Methods that have been in use for 60 years

(mature technology)

and being a mature industry . . .

- Expertise
- Laboratories
- Well known sources of error
- Supply Lines
- Venders
- Instrumentation
- Raw materials

Complete pre-existing infrastructure

Carbon-14 and Atmospheric Monitoring

Used for atmospheric monitoring for 3 decades

Nothing to invent

Nothing to test

Commercially available with results in 3-4 days

Gives the relative fossil CO_2 in gas sample

C14 Dating is an internationally recognized method for verification

ASTM (American Society for Testing and Materials)

CEN (European Committee for Standardization)

US EPA (Environmental Protection Agency)

ARB (California Air Resources Board)

TCR (The Climate Registry)

WCI (Western Climate Initiative)

Australia (National Greenhouse and Energy Reporting Protocol)

EU-ETS (European Union Emission Trading Scheme)

ROCs (Renewable Obligation program UK) *Currently being Approved

Status of ASTM-D6866 in the USA

California Air Resources Board (CARB) & AB 32

"Fuels like biomass and municipal solid waste (MSW) are so varied that fuel analysis is impractical."

"The proposed regulation requires emissions from biomass-derived fuels to be reported separately from fossil fuels."

"Municipal solid waste facilities are required to use ***ASTM Method D6866*** . . . "

All stationary combustion facilities which co-fire a fossil fuel with a biomass-derived fuel are recommended to use ***ASTM Method D6866.***

Status of ASTM-D6866 in the USA

California Air Resources Board (CARB) & AB 32

January 1, 2008 : Establish a statewide GHG emissions cap for 2020 based on 1990 emissions

January 1, 2009 : Adopt mandatory reporting rules for significant sources of GHG

January 1, 2010 : Adopt a plan indicating how emission reductions will be achieved

January 1, 2011 : Adopt regulations to achieve the maximum technologically feasible and cost-effective reductions in GHG

Status of ASTM-D6866 in the US

The Western Climate Initiative

Essential Requirements of Mandatory Reporting, Third Draft released January 6, 2009:

ASTM D6866 has been identified as the analytical method for biogenic CO2 emissions for general stationary fuel combustion sources.

The Climate Registry – North American GHG Protocol

Adoption of ASTM D6866 for biomass CO2 emissions monitoring

General Reporting Protocol Version 1.1 May 2008 identified ASTM D6866 as one of the methods to use when quantifying emissions from waste fuels and biomass.

Status of ASTM-D6866 in the USA

EPA Proposed Mandatory Greenhouse Gas Reporting Rule

"Carbon dioxide emissions from the combustion of biogenic fuels shall be excluded from the calculations."

"For a unit that combusts MSW, the owner or operator shall use, for each quarter, ASTM Methods D6866 and D7459 … to determine the relative proportions of biogenic and non-biogenic CO2 emissions when MSW is combusted.

"The owner or operator shall separate total CO2 emissions from MSW combustion into biogenic emissions and non-biogenic emissions, using the average proportion of biogenic emissions of all samples analyzed during the reporting year."

ASTM D6866 and CEN 15747

~ ASTM D6866 is part of the mandatory reporting requirements of California's AB 32, Western Climate Initiative, The Climate Registry and the EPA's GHG protocol.

~ The European Union allows the use of ASTM D6866 for monitoring various types of heterogeneous fuels.

~ The Australian government has recommended the use of ASTM D6866 for blended fuels.

~ The Renewable Obligation Certificate program in the United Kingdom is also considering this method for monitoring biomass energy production.

~ CEN 15747 is used to monitor refused derived fuels for the European Union's Emission Trading Scheme.

ASTM D7459

Standard Practice for Collection of Integrated Samples for the Speciation of Biomass (Biogenic) and Fossil-Derived Carbon Dioxide Emitted from Stationary Emissions Sources

Established for the EPA Proposed Mandatory Greenhouse Gas Reporting Rule

Written by stack testing community including The Avogadro Group

Used as basis for international ISO standard under development

Reporting

Simple Visual Report

Easy Inter-comparison

Instinctively Obvious

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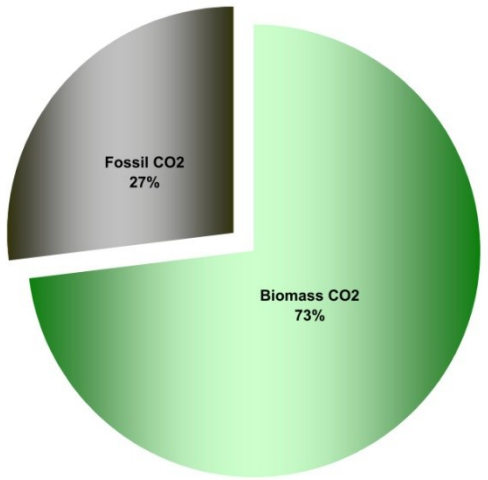
Report of Biomass CO2 Content Analysis using ASTM-D6866

Submitter:	ABC Company
Submitter Label:	Gas Bag 1
Laboratory Number:	Beta-00001
Material Analyzed:	CARBON DIOXIDE
Date Received:	October 13, 2006
Date Reported:	October 17, 2006

Biomass CO2: (carbon-neutral CO2) **73% *** (renewable carbon to total carbon)

Proportions Biomass CO2 vs. Fossil CO2 indicated by C14 content



* ASTM-D6866 cites precision on the mean Biomass CO2 Result as +/- 3% (absolute). This is the most conservative estimate of error in the measurement of complex biomass containing solids and liquids based on empirical results. Real precision for readily combustible and homogenous materials (e.g. gasoline) and especially samples recieved as CO2 (e.g. flue gas or CEMS exhaust) can be as low as +/- 0.5-2%. The result only applies to the analyzed material. Fluctuations in carbon content within a batch of product, gasoline or flue gas must be determined separately (e.g. averaged measurements of multiple solids or liquids, and single measurement of the combination of gas aliquots collected over time). The accuracy of the result as it applies to the analyzed product, fuel, or flue gas relies upon all the carbon in the analyzed material originating from either recently respired atmospheric carbon dioxide (within the last few decades) or fossil carbon (more than 50,000 years old). "Percent biomass" specifically relates % renewable (or fossil) carbon to total carbon, not to total mass or molecular weight. Mean Biomass CO2 estimates greater than 100% are assigned a value of 100% for simplification.

How much does it cost?

$595 per analysis

(Off-setting labor, liabilities and hazards associated with feedstock characterization)

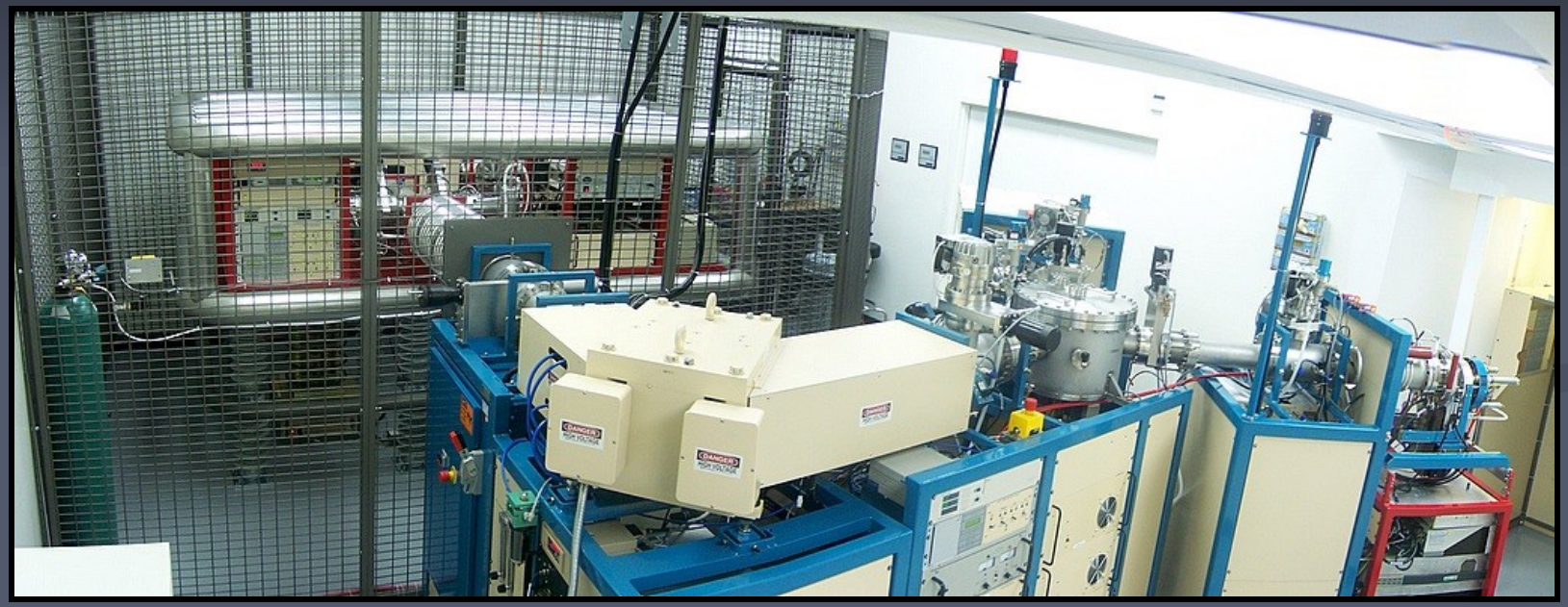
How long does it take to get a result?

One week, but as little as 2-3 days

LSC Counter Room

One of the Chemistry Line Rooms

Accelerator Mass Spectrometry Room



Company Background

- 30 years in business, considered the leader of our field

- Fast turn-around times (as little as 24 hours)

- Confidentiality of all results

- Large throughput operation [52 LSC counters, 2 mass spectrometers, 2 accelerator mass spectrometers (4 ions sources), 16 chemistry lines]

-18 dedicated full-time professionals, no part-time students learning on your samples

- ISO/IEC 17025:2005 accredited

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