

Institutional Wood Heating in Vermont: Emissions, Regulations & Control technologies

APCAS Emission Control and Clean Air Conference

Quebec City, Canada

February 9th, 2012

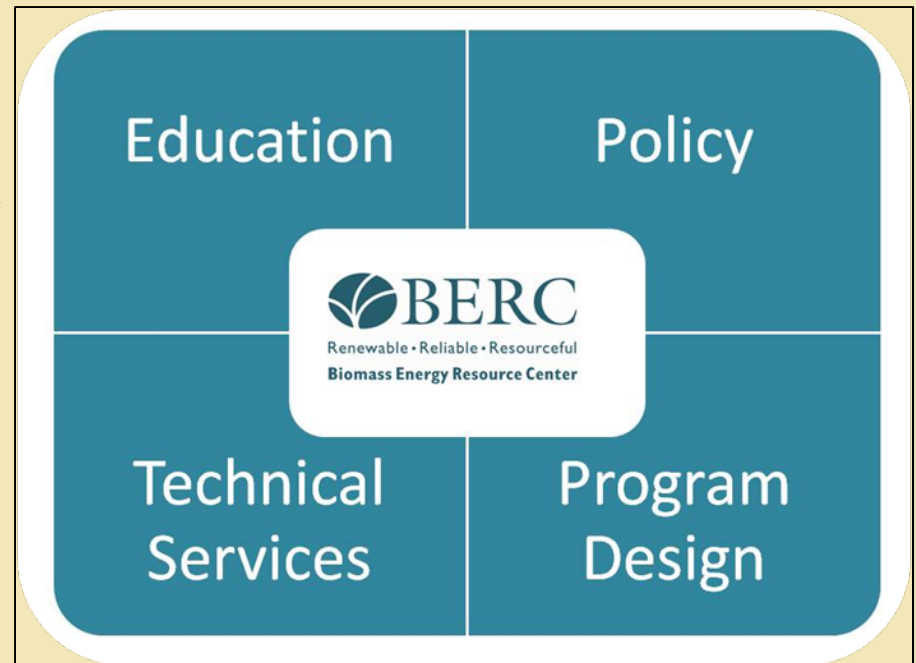
*Adam Sherman, Program Director
Biomass Energy Resource Center*

Biomass Energy Resource Center (BERC)

BERC is a national not-for-profit organization working to advance the responsible use of biomass for energy.

BERC's mission is to achieve a healthier environment, strengthen local economies, and increase energy security across the United States by developing sustainable biomass systems at the community level.

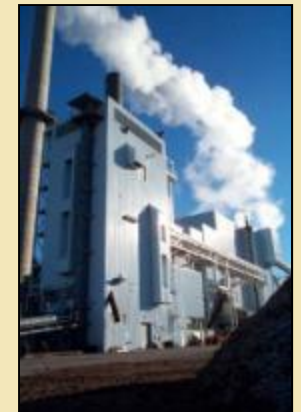
BERC has offices in Vermont and Wisconsin but works throughout the US and Canada.



Presentation Overview

- The Vermont story
- Technology overview
- Air emissions regulations
- Control technology
- Questions and Answers

The Vermont Wood Energy Experience



Introduction

STATS

- 2 Power Plants
- 41 Public Schools
- 1 Hospital
- 5 State Office Complexes
- 3 Housing Complexes
- 3 College Campuses
- Dozens of Businesses

Success Factors

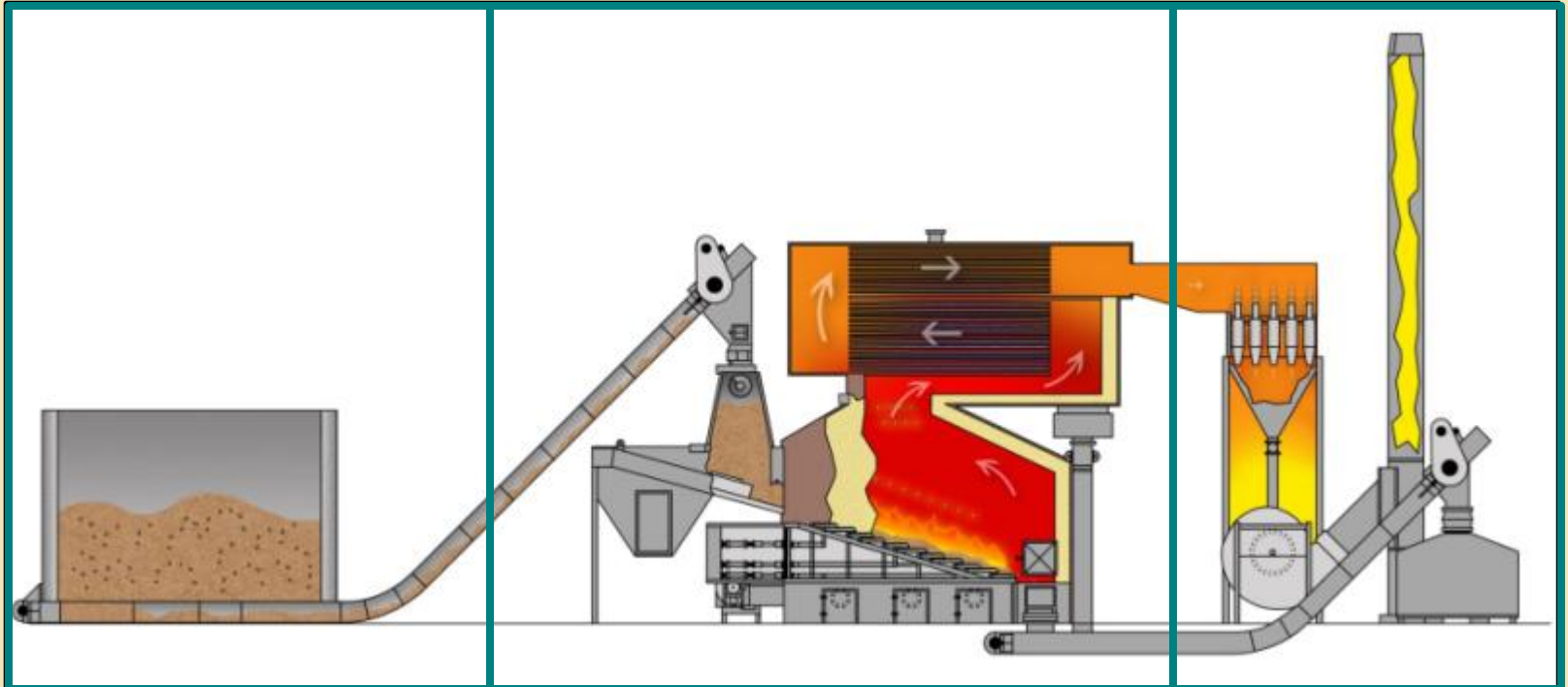
- 25 + years
- Strong political and public support
- High oil prices and volatility
- VT Fuels for Schools Program (partnerships of agencies and orgs)
- Relatively little natural gas infrastructure
- Transition to commodity fuel supply

Biomass Heating System Configuration Options

Fuel Storage

Combustion Equipment










Emissions Control Equipment & Stack



Pellet Silos
Slab chip bins
Below grade chip
bins

Stoker/fixed grate
Stoker/moving grate
Pneumatic/suspension
Fluidized bed

Single cyclone
Multi-cyclone
Baghouse
ESP

Technology	Cordwood Boilers	Pellet Boilers	Single Facility Woodchip Heating	District Heating w/Woodchip Boilers	Industrial CHP
					
Typical heat output capacity	20,000 – 100,000 Btu/hr	100,000 Btu – 5MMBtu/hr	2 – 30 MMBtu/hr	10 – 100 MMBtu/hr	10 -1,000 MMBtu/hr
Applications	Home heating and farm buildings	Home heating & small commercial buildings	Schools, hospitals, office buildings, etc.	College campuses and downtown communities	Industrial manufacturing facilities
Fuel Type					
Annual Fuel Use	2-15 cords	2-20 tons	100 – 10,000 tons	500- 50,000 tons	1,000 – 1,000,000 tons
Fuel Sourcing	Locally harvested firewood	Premium Pellets	Paper grade and screened bole chips	Bole chips and whole-tree chips	Whole-tree chips and hog fuel
Typical Emissions Control	none	none	Single cyclone	Multi-cyclone or bag house	ESP

Fuel Quality

Technology Overview



Urban Wood

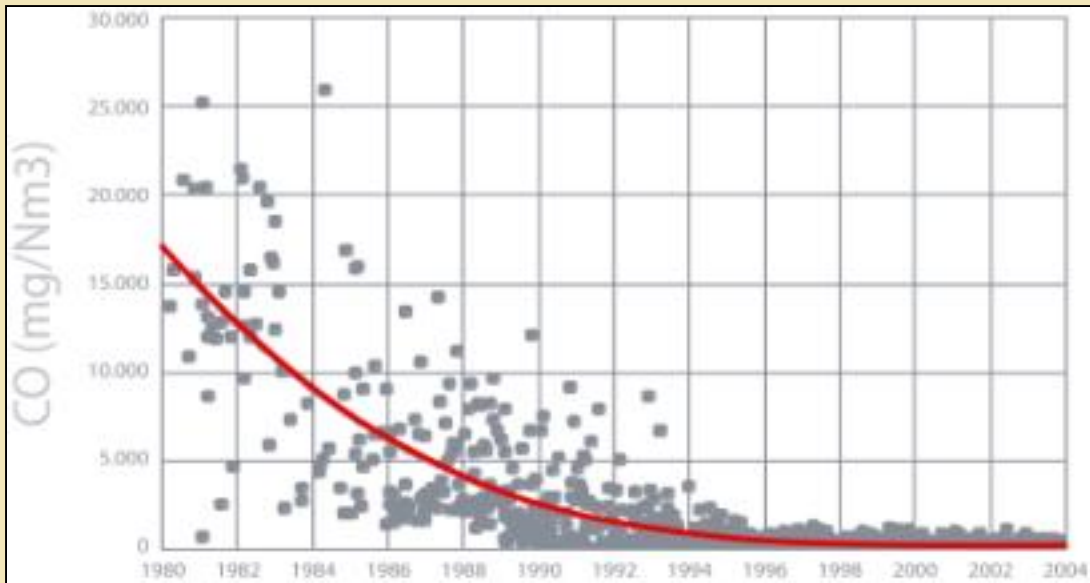
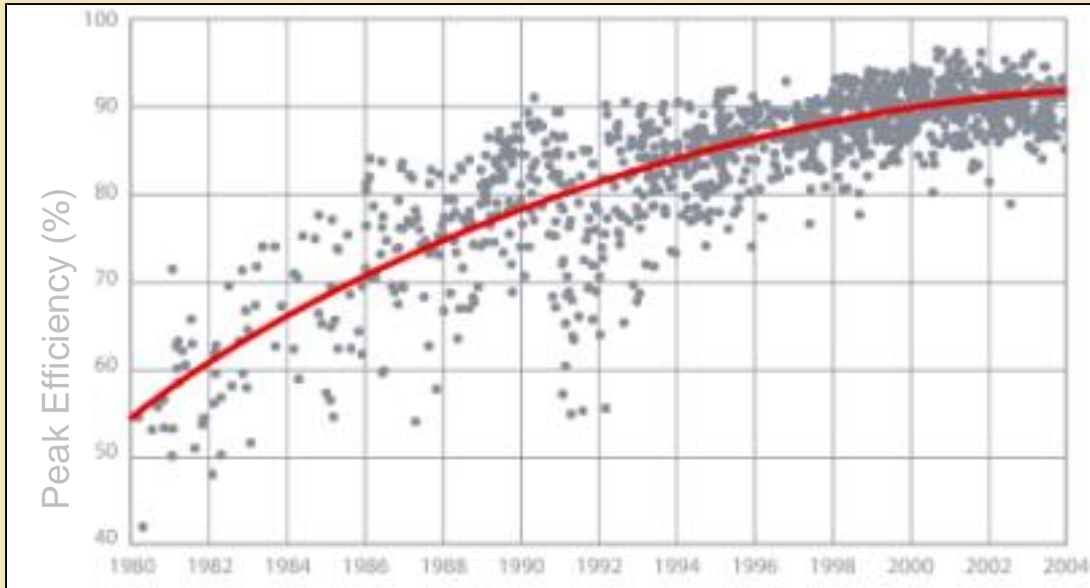
Whole-tree Chips

Bole Chips

Paper-grade Chips

Chip Shape Size and Uniformity	Moisture Content	Btu/Value	Ash Content	Alkali Content	Contaminants
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Air Emissions



Air Emissions

Regional State Emissions Limits for PM

- Vermont = 0.20 lb/MMBtu
- New Hampshire = 0.30 lb/MMBtu
- Massachusetts = 0.1 lb/MMBtu
- Maine = 0.25 lb/MMBtu
- Rhode Island = 0.10 lb/MMBtu
- Connecticut = 0.10 lb/MMBtu



Air Emissions

New EPA MACT Rules for "Area Source" (<10 ton per year for a single HAP)

Status	BTU Capacity	Boiler Technology	PM (lbs/MMBtu)	CO (ppm @7% O ₂)
Existing	>10MMBtu/hr	All technologies	N/A – Biannual Tune-up required	
	< 10MMBtu/hr	All technologies	N/A – Biannual Tune-up required	
New	>30MMBtu/hr	All technologies	0.03	N/A
	10-30MMBtu/hr	All technologies	0.07	N/A
	< 10MMBtu/hr	All technologies	N/A –Biannual Tune-up required	

ADD-ON POLLUTION CONTROLS

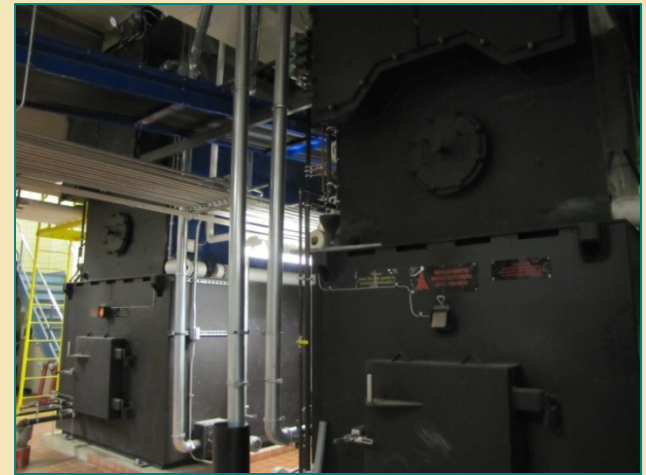
Control Technology	Control Efficiency for PM10	Control Efficiency for PM2.5
SINGLE CYCLONES	50%	5%
HIGH EFFICIENCY MULTICYCLONES	75%	10%
CORE SEPARATOR™	30-55%	70-90%
BAG HOUSE WITH CYCLONE	99%	99%
DRY ELECTROSTATIC PRECIPITATORS	95%	90%

Electro-static Precipitators

- Originally only cost effective at power plant scale
- Widely used on systems in Europe
- Now ESP use in smaller applications in US
- Far greater fine particulate emission control effectiveness than cyclones
- Lower fire hazard and maintenance than fabric filters
- Very encouraging results from a few recent installations

National Life - 0.008 lbs/MMBtu of PM

Weeks Medical Center – 0.027 lbs/MMBtu



Thank You!

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Further Information

http://www.biomasscenter.org/images/stories/emissions_rpt.pdf

http://www.anr.state.vt.us/air/docs/VTDEC%20Small%20Wood%20Boiler%20PM%20Study_Final%20Report_June%202009.pdf

Comparison of Boiler Emissions Fired by Wood and Distillate Oil

	Wood	Distillate Oil
	lb/MM Btu	lb/MM Btu
PM 10	0.1	0.014
NOx	0.165	0.143
CO	0.73	0.035
SO2	0.0082	0.5
TOC	0.0242	0.0039
CO2	gross 220 (net 0)	159

- All emission rates are without additional controls except the wood PM10 is controlled to BACT as discussed.
- The sulfur content of number 2 distillate oil is assumed to be at 0.5% by weight which is common. Other grades of oil are rarely used in boilers below 14 MM Btu heat input. Number 2 oil with a sulfur content as low as 0.025% is available but is rarely used.

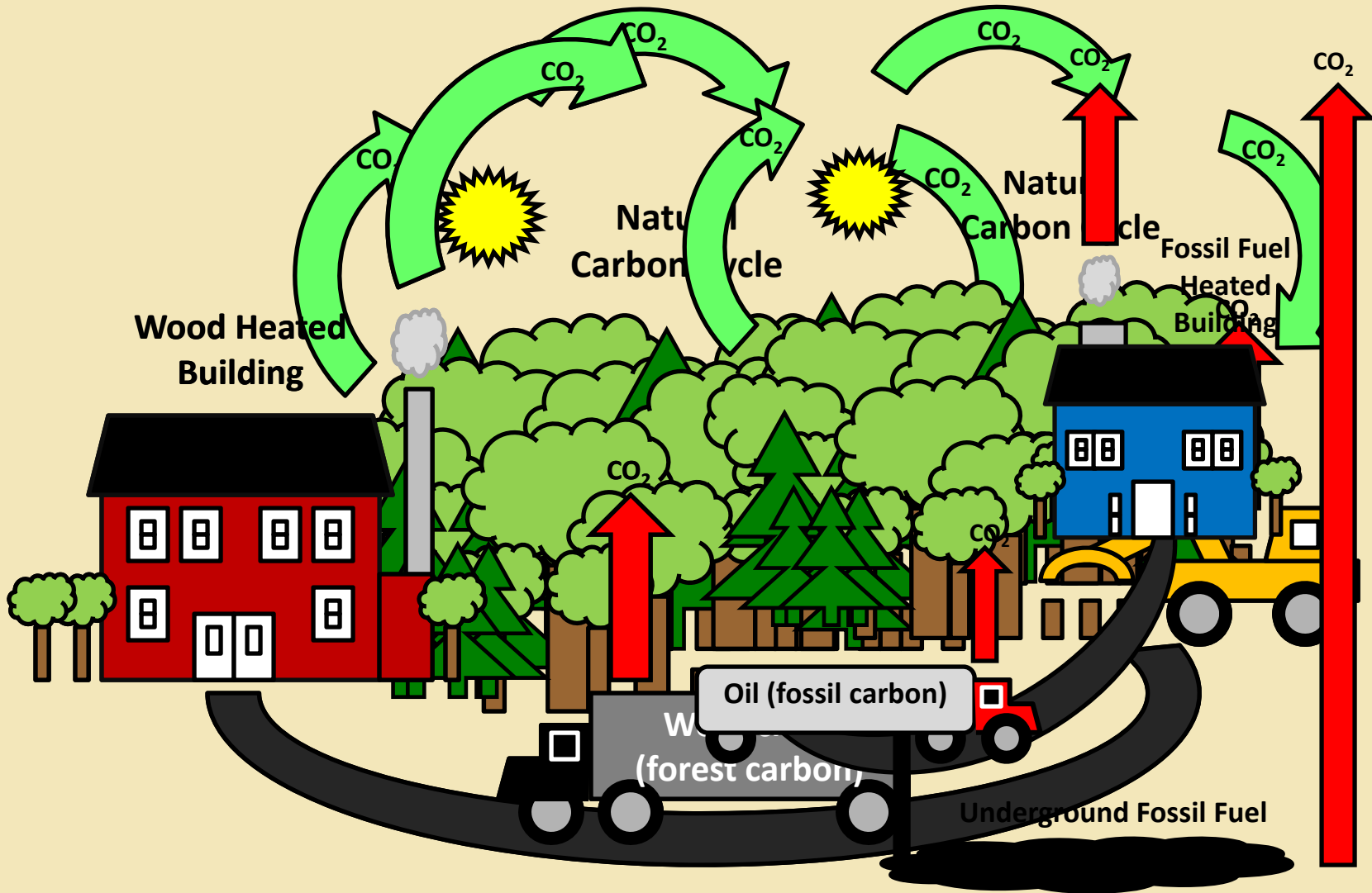
Stack Test Summary for Heat Input Less Than or Equal to 5 MMBtu/hour

Category	PM10 Emissions (lb/MMBtu)	PM2.5 Emissions (lb/MMBtu)	Condensable PM Emissions (lb/MMBtu)
Average	0.231	0.114	0.025
Median	0.161	0.110	0.026
Maximum	0.506	0.179	0.039
Minimum	0.016	0.014	0.009

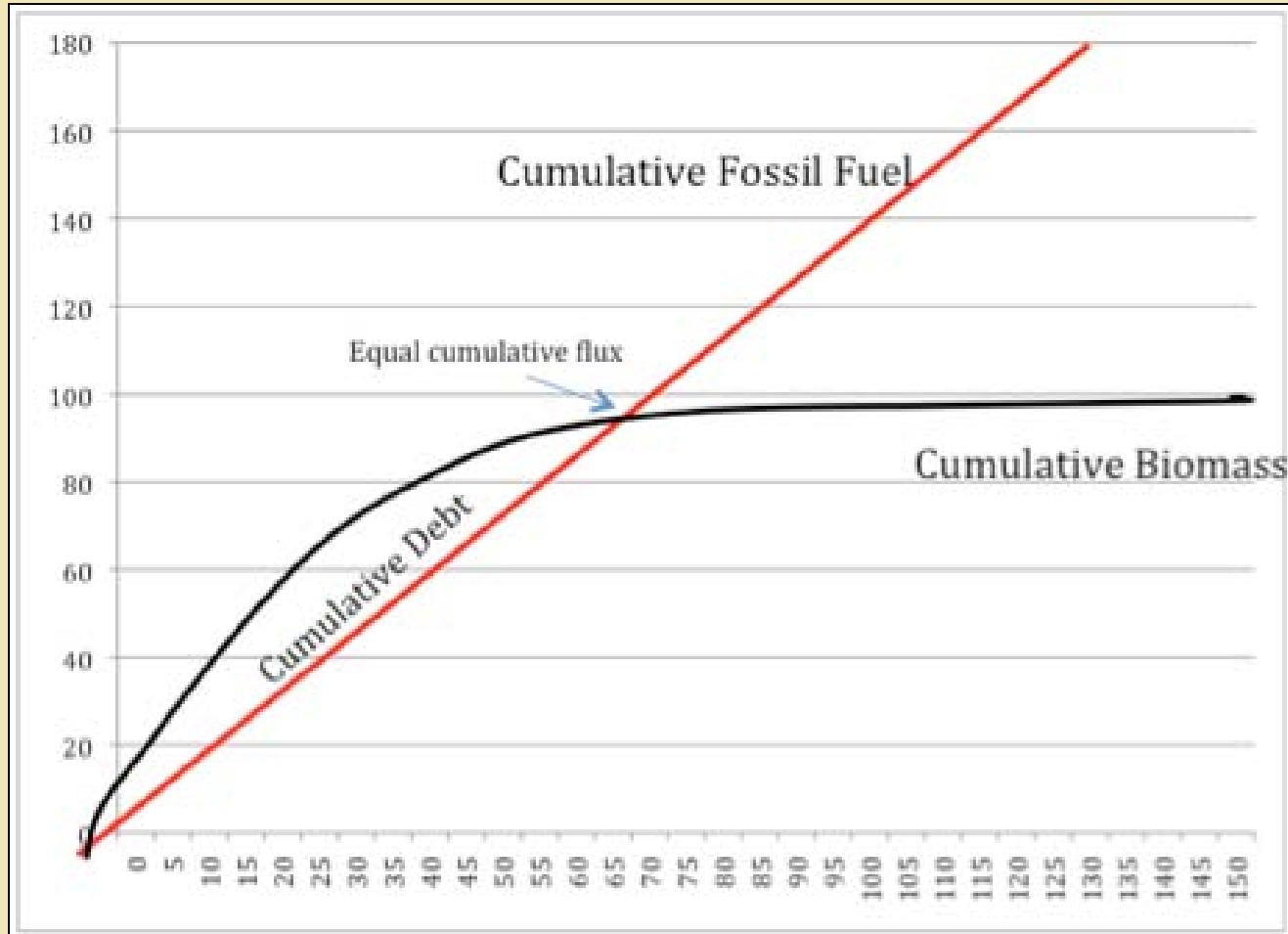
(Source: RSG report at <http://www.rsginc.com/assets/Emission-Controls-for-Small-Wood-Fired-Boilers-Appendix-A-Reports-14/RSG-BERC-Emission-Control-Report-5.6.2010.pdf>)

The Carbon Cycle

Biomass Heated Buildings vs. Fossil Fuel Heated Buildings



Cumulative Carbon Debts and Dividends Over Time



Source: Manomet Center