Massachusetts Forest Biomass Sustainability and Carbon Policy Study

Presentation to:
Connecticut SIPRAC

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Forest Biomass Carbon Accounting
What's the Issue?

- What is the greenhouse gas (GHG) impact of substituting renewable forest biomass for fossil fuels in the Massachusetts energy sector?

- Why interesting?

  – From a GHG perspective, forests provide a number of potential mitigation benefits.
    - Growing trees remove GHGs from the atmosphere.
    - Using woody biomass can displace fossil fuels.

  – Tradeoffs: is it better to let the trees continue to grow and sequester carbon or harvest them and displace fossil fuels?

  – Historically, it has generally been assumed that biomass energy is 'carbon neutral' but the story is more complex and better represented by a 'debt-then-dividend' model.

Biomass Carbon Accounting
How do you analyze the GHG problem?

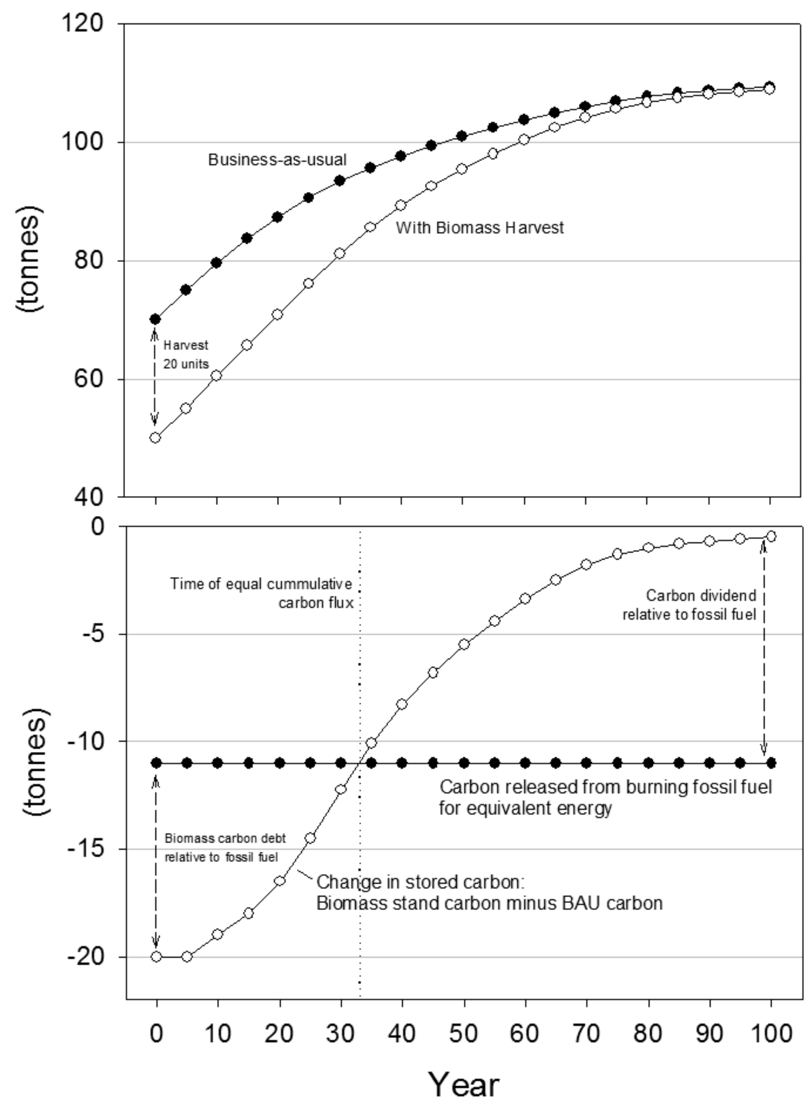
- Manomet ‘Debt-then-Dividend’ Framework: Compare a ‘Business as Usual’ Baseline with Biomass Energy Scenario.
  - BAU assumes continued burning of fossil fuels and continued sequestration in forests harvested for timber but not biomass.
  - Biomass scenario assumes GHG emissions from energy generation and BAU forest management plus additional biomass removals (logging residues and live whole trees).
- What’s different about Manomet’s approach?
  - Focus on atmospheric rather than forest carbon levels—just because carbon inventories continue to increase in forests does not mean the atmosphere can’t be worse off.
  - Manomet framework does not allow credit for carbon sequestration that would have occurred anyway under a business as usual scenario.
  - Consequently considers incremental carbon sequestration occurring only acres that have been harvested for biomass.

Biomass Carbon Modeling Framework

Exhibit 6-6 Carbon Emission Factors by Technology* Kilograms per Unit of Energy**					
Scenarios	**Biomass**	**Coal**	**Oil (#6)**	**Oil (#2)**	**Natural Gas**
Utility-Scale Electric	Kilograms/MWh				
Fuel Prod & Transport	7	14			34
Fuel Combustion	399	270			102
Total	406	284			136
Thermal	Kilograms/MMBtu				
Fuel Prod & Transport	1		6	6	6
Fuel Combustion	35		27	25	17
Total	36		33	31	23
CHP	Kilograms/MMBtu				
Fuel Prod & Transport	1		7	6	6
Fuel Combustion	35		29	27	18
Total	36		35	33	24

* As discussed below, emissions factors for pellets are characterized relative to the thermal technology using green chips which is shown in this table.

** Sources and calculations for these data are described in the text.



Carbon Emissions by Technology & Fuel

Exhibit 6-6
Carbon Emission Factors by Technology*
Kilograms per Unit of Energy**

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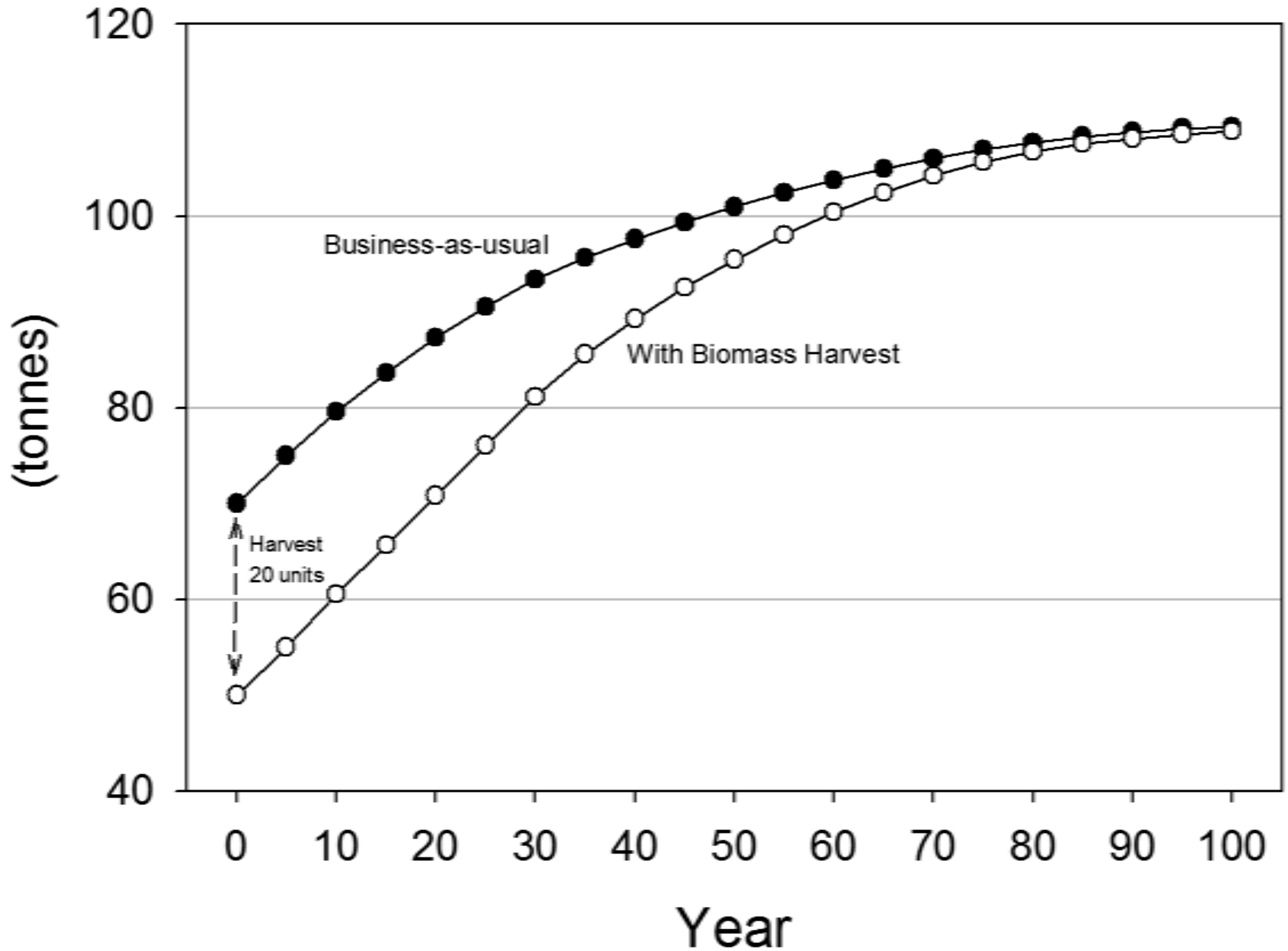
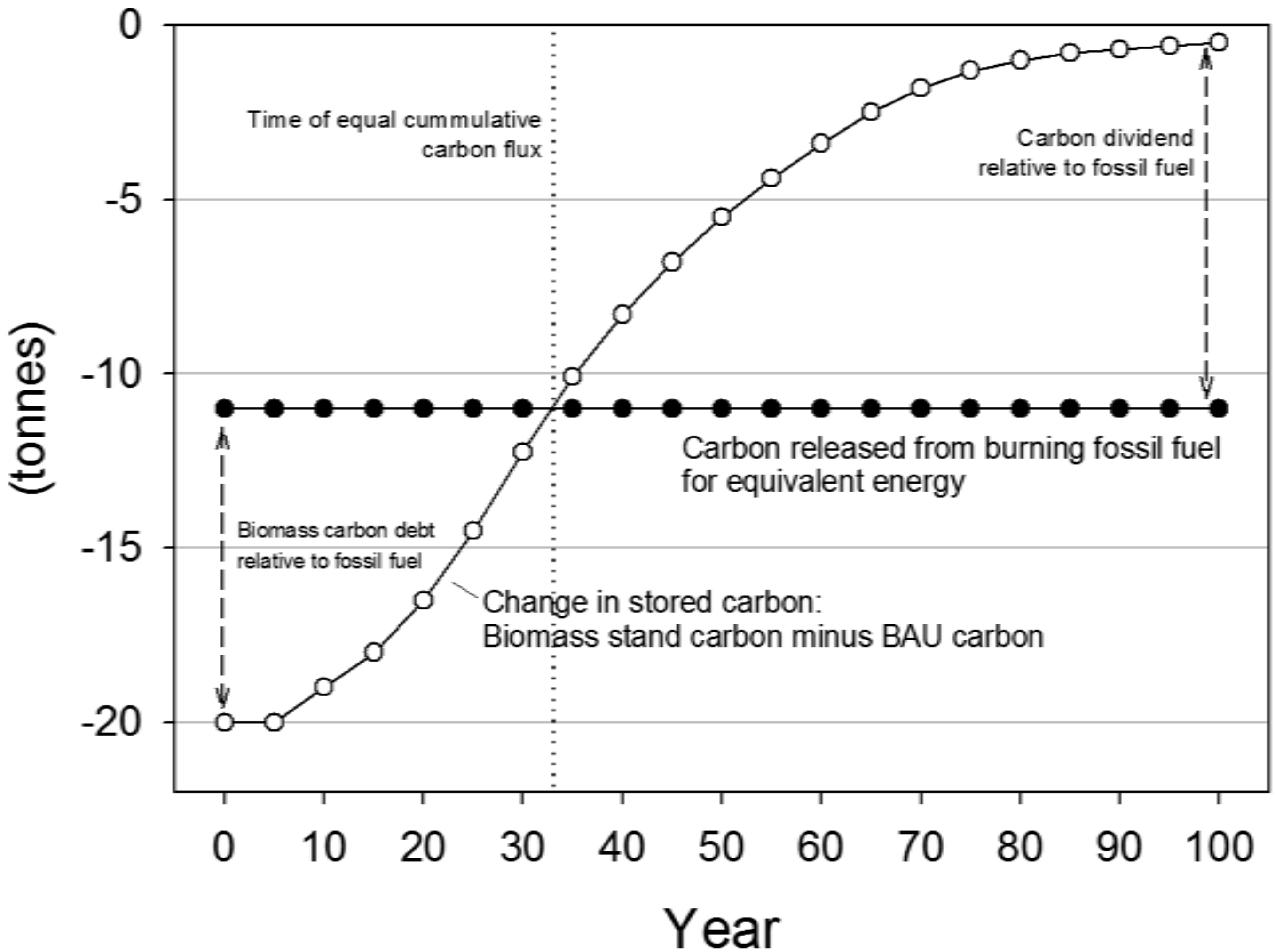
Forest Stand Dynamics



Biomass Carbon Recovery Profile

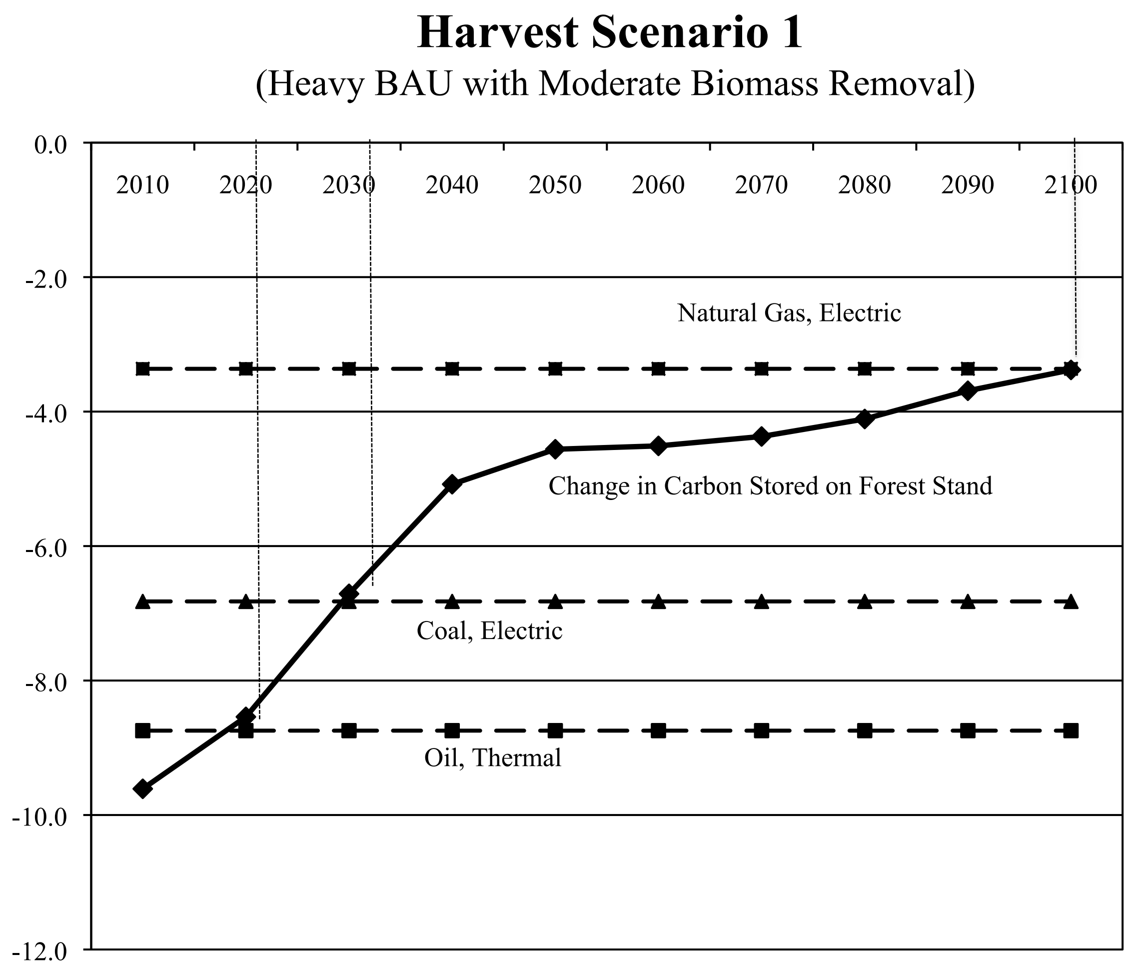


Modeling Scenarios

- **Harvest Scenarios**
  - Scenario 1: Heavy BAU, moderate biomass
  - Scenario 2: Heavy BAU, light biomass
  - Scenario 3: Heavy BAU, heavy biomass
  - Scenario 4: Average BAU, light biomass
  - Scenario 5: Average BAU, moderate biomass
  - Scenario 6: Average BAU, heavy biomass

- **Technologies**
  - Biomass Electricity
  - Biomass Thermal
  - Coal Electricity
  - Natural Gas Electricity
  - Oil Thermal
  - Natural Gas Thermal

Carbon Recovery Rate Results

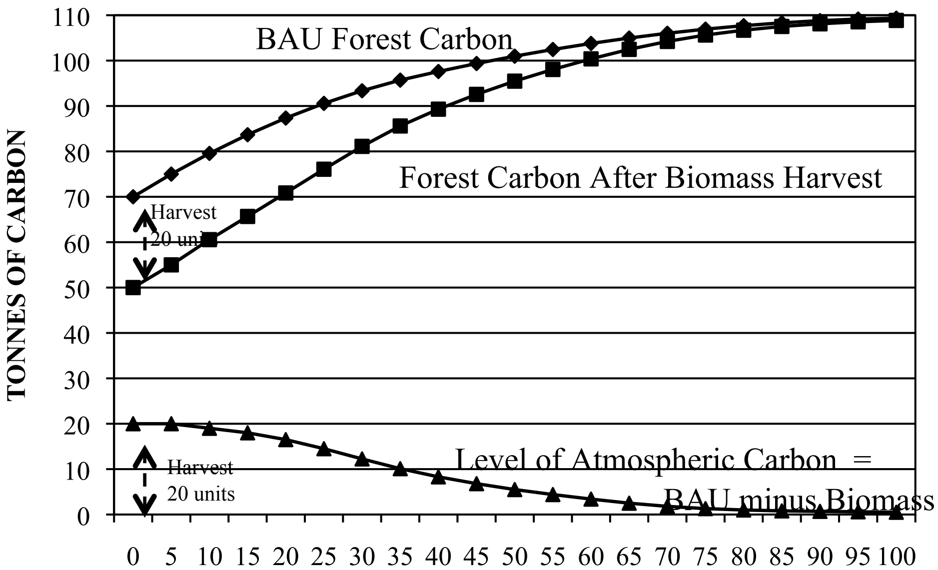


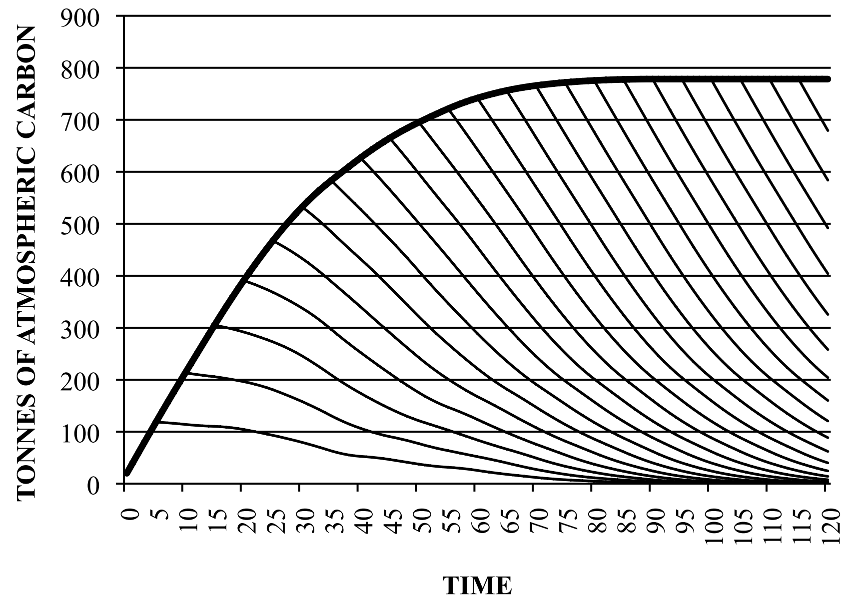
Carbon Recovery Summary
Single Year Emissions

Exhibit 6-13
Carbon Debt and Dividends

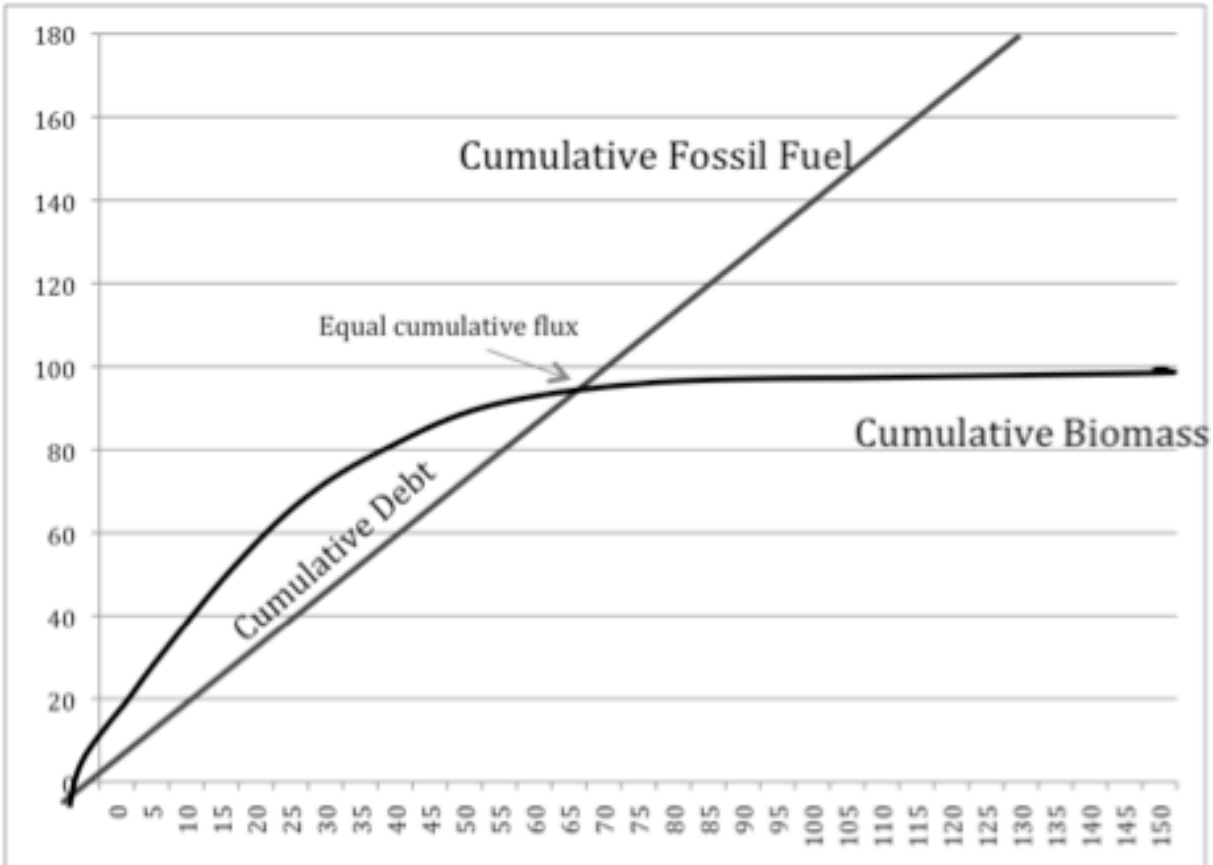
Harvest Scenario	Fossil Fuel Technology	Carbon Debt Payoff (yr)	Carbon Dividend 2050	Carbon Dividend 2100
1	Oil (#6), Thermal	7	47%	60%
	Coal, Electric	21	32%	49%
	Gas, Thermal	24	26%	44%
	Gas, Electric	>90	-38%	-3%
2	Oil (#6), Thermal	3	64%	85%
	Coal, Electric	12	54%	80%
	Gas, Thermal	17	50%	78%
	Gas, Electric	45	7%	60%
3	Oil (#6), Thermal	14	38%	62%
	Coal, Electric	30	21%	52%
	Gas, Thermal	36	13%	47%
	Gas, Electric	89	-61%	2%
4	Oil (#6), Thermal	10	53%	78%
	Coal, Electric	27	40%	72%
	Gas, Thermal	31	34%	69%
	Gas, Electric	59	-22%	43%
5	Oil (#6), Thermal	15	46%	63%
	Coal, Electric	25	31%	53%
	Gas, Thermal	28	24%	48%
	Gas, Electric	86	-41%	4%
6	Oil (#6), Thermal	15	39%	64%
	Coal, Electric	32	22%	54%
	Gas, Thermal	37	14%	50%
	Gas, Electric	85	-59%	7%

Aggregation of Stand-Level Plots





Landscape Scale Cumulative Carbon Debts & Dividends



Massachusetts Carbon Recovery Summary
Emissions from Continuous Operation

Years to Achieve Equal Flux with Fossil Fuels				
Harvest Scenario	Fossil Fuel Technology			
	Oil (#6), Thermal	Coal, Electric	Gas, Thermal	Gas, Electric
Mixed Wood	15-30	45-75	60-90	>90
Logging Residues Only	<5	10	10	30

What's it all mean?

- Projected forest biomass harvesting from MA forests would not be immediately carbon neutral – generally GHGs will be higher for a time before the benefits of biomass begin to accrue. Policy makers will need to weigh these short-term increases against longer term gains.
- For waste material (logging residues) carbon recovery can be relatively rapid regardless of the harvest or technology assumptions.
- Where live trees are harvested, carbon recovery profiles are longer – at least a couple of decades and potentially much longer.
- Scenarios sensitive to many factors—multiple harvests will slow recovery, low thinnings that don't accelerate growth can delay recovery.
- To the extent feasible, use of biomass with technologies with the lowest carbon debts is most 'climate friendly' (e.g., thermal or thermally-led CHP).

Broader Policy Implications?

- More generally, each state or region's situation is likely unique.
  - Baselines will be different – Maine is not Massachusetts.
  - Different sources of biomass have different GHG profiles.
  - Biomass technology choices affect carbon recovery times.
  - Fossil fuel replaced is a key determinant of the timing of carbon recovery.
  - Forest management choices by landowners can either accelerate or decelerate carbon recovery.
- To assess the 'carbon friendliness' of biomass policies and projects, stakeholders should consider the implications of these various factors within the context of their own forest and energy situations.

Carbon Recovery Summary
Emissions from Multiple Years

Cumulative Carbon Dividends: 2010 to 2050

Harvest	Fossil Fuel Technology			
Scenario	Oil (#6), Thermal	Coal, Electric	Gas, Thermal	Gas, Electric
1	22%	-3%	-13%	-110%
2	34%	11%	3%	-80%
3	8%	-22%	-34%	-148%
4	15%	-13%	-24%	-129%
5	16%	-11%	-22%	-126%
6	7%	-25%	-36%	-153%

Cumulative Carbon Dividends: 2010 to 2100

Harvest	Fossil Fuel Technology			
Scenario	Oil (#6), Thermal	Coal, Electric	Gas, Thermal	Gas, Electric
1	40%	19%	12%	-63%
2	56%	42%	36%	-18%
3	31%	8%	0%	-86%
4	43%	24%	17%	-54%
5	37%	16%	9%	-69%
6	31%	8%	-1%	-86%