"Barriers" to Biopower

TVA Renewable Energy Information Exchange
Biomass Energy
April 24, 2013
Knoxville, Tennessee

Mary S. Booth, PhD
Partnership for Policy Integrity

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TVA: Why renewable energy?

"*Renewable energy has the potential to greatly reduce overall greenhouse gas emissions and could help reduce global warming. It could also reduce other pollutants released into the air during conventional power generation. TVA is committed to using more renewable energy sources for generating power*."

- http://www.tva.gov/environment/technology/biomass_direct.htm

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Impacts of biomass energy are incompatible with renewables mission

- Forest impacts
- Greenhouse gas emissions
- Conventional pollutant emissions (PM, NOx, CO, hazardous air pollutants)
- Water impacts
- Biomass keeps old coal plants operating – Dominion

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Photo: Chris Matera, Massachusetts Forest Watch

FOREST IMPACTS

TVA's statements on biopower – imply "waste" used as fuel

"Biomass is less expensive than other renewable energy sources; increased use of biomass as fuel could benefit the local agricultural economy; and the more biomass is used as fuel, the less certain kinds of biomass, such as wood waste, will have to go to landfill. "

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But any meaningful amount of biopower would require substantial increase in harvesting

Foresty "waste" (residues) limited:

At collection rate of 37.5% (recover residues at 75% of logged sites; leave 50% onsite), ~910,000 green tons of residues available in TN.

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And residues don't work anyway

Duke Energy testimony to NC Utilities Commission,

Forestry residues:

"Most are left at the harvest site because they are considered uneconomic to transport and have low quality for utilization due to size, dirt, and bark content".

First Energy, Ohio Biomass Energy Working Group:

Wood products means no limbs, no bark, no leaves - only "white wood" used, to meet emissions requirements.

Wood mix required; can't co-fire 100% agricultural products due to burner damage and emissions requirements.

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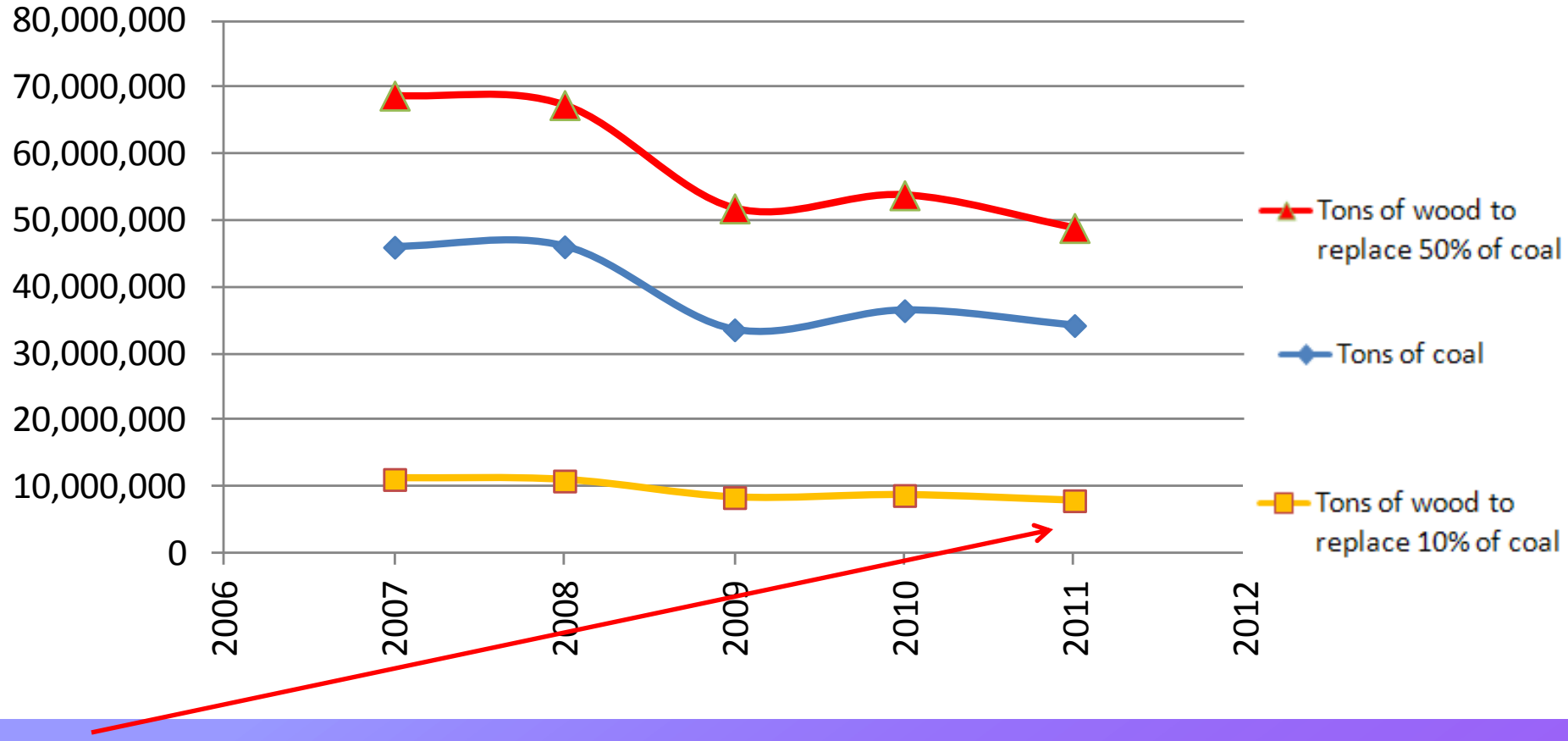
Replacing just 10% of TVA's 2011 coal use with biomass would require substantial increase in TN's forest harvest



7.8 million green tons of wood to replace 10% of 2011 coal; **49 million tons** to replace 50% of coal

USDA: TN total harvest **22.7 million** green tons

TVA coal use:
2007: 46 million tons
2011: 34 million tons
25% decrease

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Biomass harvesting threatens forests and biodiversity

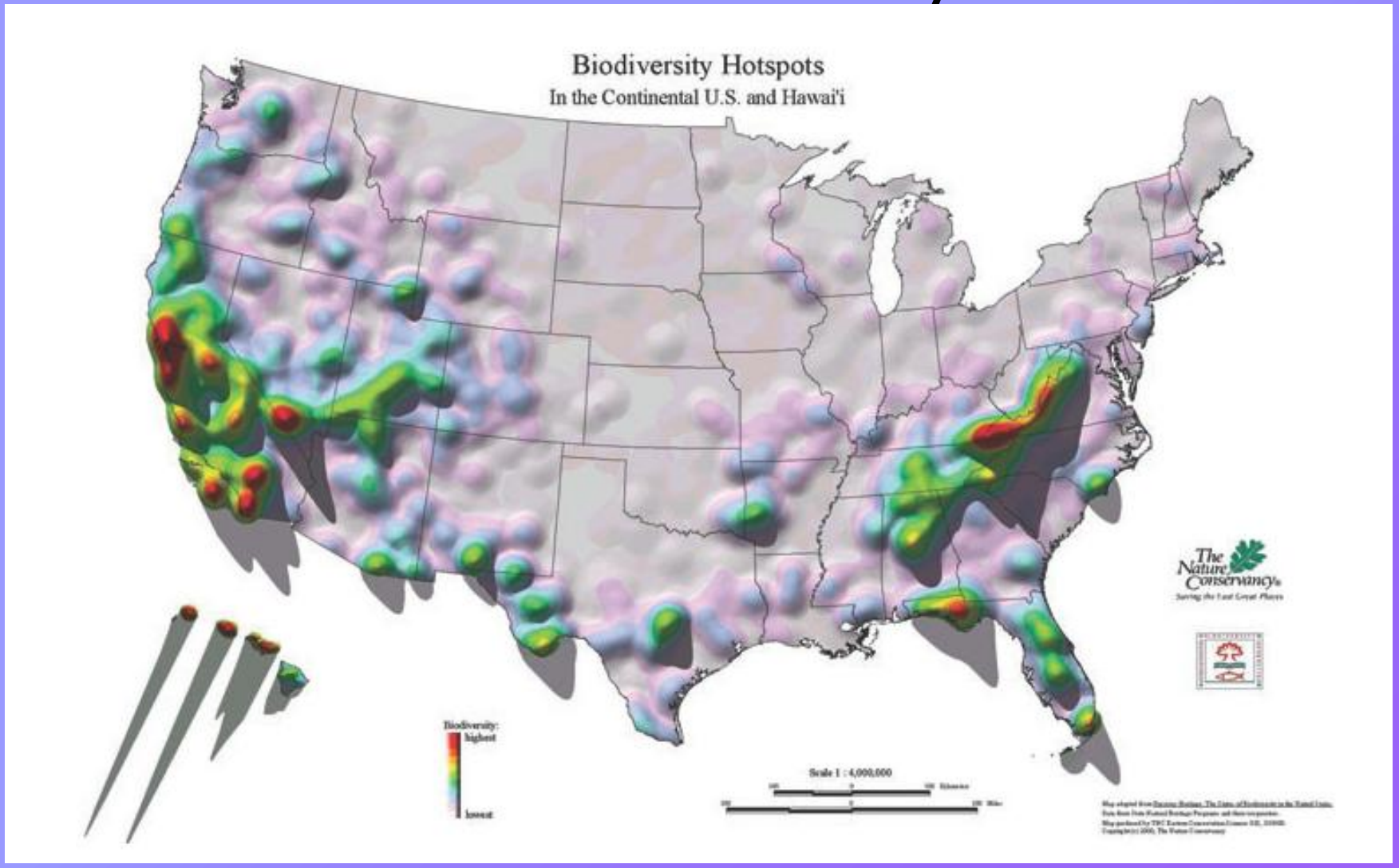

Photo: Dogwood Alliance

GREENHOUSE GAS EMISSIONS

TVA's statements on biopower – CO_2 emissions

"Biomass could reduce pollutants emitted in power production. Burning biomass is generally carbon neutral; net carbon emissions would be zero, and that would help control global warming."

Zero?

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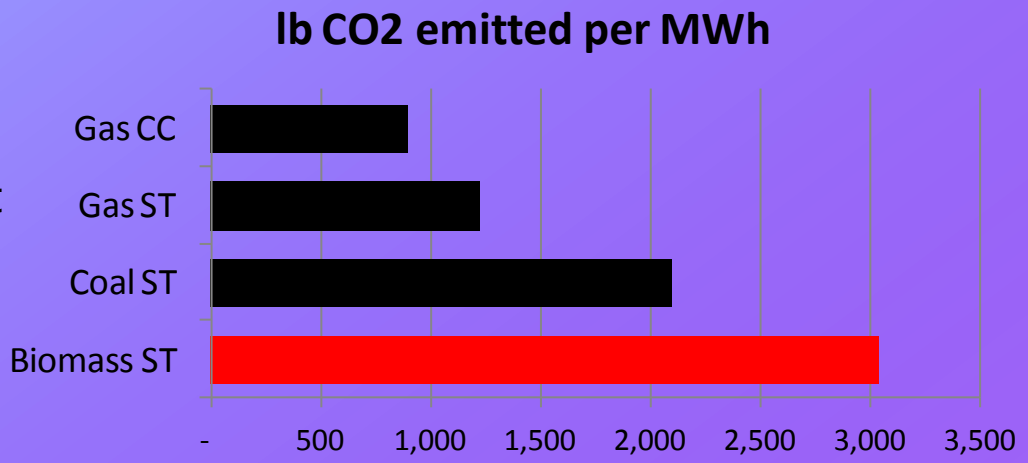
Biomass power facilities emit more CO_2 per MWh than coal or gas facilities

	Fuel CO2 per heat content (lb/mmbtu)	Facility efficiency	Fuel mmbtu required to generate 1 MWh	Lb CO2/MWh
Gas combined cycle	117.1	0.45	7.54	**883**
Gas steam turbine	117.1	0.33	10.40	**1,218**
Coal steam turbine	205.6	0.34	10.15	**2,086**
Biomass steam turbine	213	0.24	14.22	**3,029**

A biomass plant emits

~150% the CO2 of a coal plant
~250% the CO2 of a gas plant
~ 340% the CO2 of a combined cycle plant

Fuel CO2 per heat content data are from EIA. Efficiency for fossil fuel facilities calculated using EIA heat rate data (http://www.eia.gov/cneaf/electricity/epa/epat5p4.html); biomass efficiency value is common value for utility-scale facilities.



U.S. Biomass industry CO_2 emissions, 2009

Fuel type	fuel (tons)	heat input (mmbtu)	CO2 emissions (tons)
Agricultural fuels	4,252,601	32,312,178	5,613,433
Wood solids	48,165,174	489,243,148	48,566,550
Pulping liquors	57,011,003	645,150,689	32,923,854
"other" biomass solids	1,981,226	20,853,306	1,997,736
Total	**111,410,004**	**1,187,559,321**	**89,101,573**

Equivalent to combined reported power sector emissions from RI, SD, DE, AK, ME, NH, CT, HI, OR, WA, and NJ

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Not controversial that biomass emits more CO_2 per unit energy than fossil fuels…

So why has biomass energy been treated as "*carbon neutral*"?

- The "waste" argument: Materials burned are "waste" – would decompose and emit CO_2 anyway – e.g. forestry residues.
  - No *net* increase in CO_2 emissions, but release from combustion is instantaneous while decomposition takes years to decades.
- The "resequestration" argument: Future forest growth re-sequesters carbon that's released by burning.
  - No net release of carbon. However, resequestration takes decades to centuries.

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Manomet Study commissioned by State of Massachusetts

Forest modeling study using USFS data

- Examined use of both "waste" wood and whole tree harvesting for fuel
- Took into account that forests are *currently* taking CO_2 out of the atmosphere - the "business as usual" scenario

Burning biomass creates a **"carbon debt"** relative to fossil fuels

- Length of time to repay debt depends on type of fuels, efficiency of burner

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Manomet Study

Commissioned by the State of Massachusetts to examine carbon and forest cutting impacts of biomass power

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

When using whole trees as fuel, net CO_2 emissions are greater than coal emissions for more than 45 years.

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“Southeastern Study”

Colnes et al, 2011.: Biomass Energy Resource Center, Forest Guild, Spatial Informatics Group

Biopower in the Southeast creates carbon debt

Southeastern Study (Colnes et al, 2012)

Executive summary:

"The expanded biomass scenario creates a carbon debt that takes 35-50 years to recover. This outcome depends on the fossil fuel pathway used for comparison and assumes forests re-occupy the site through planting or natural regeneration, with no forest land conversion."

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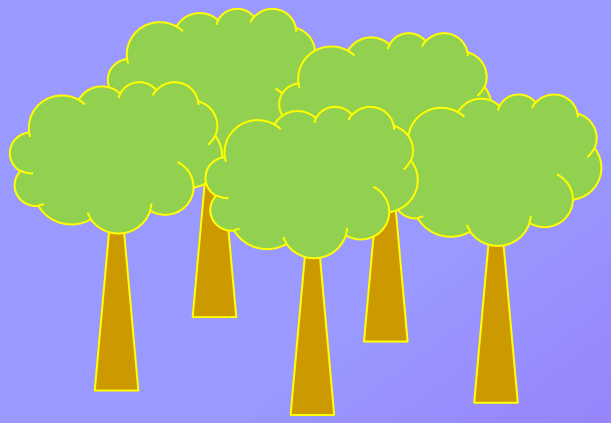
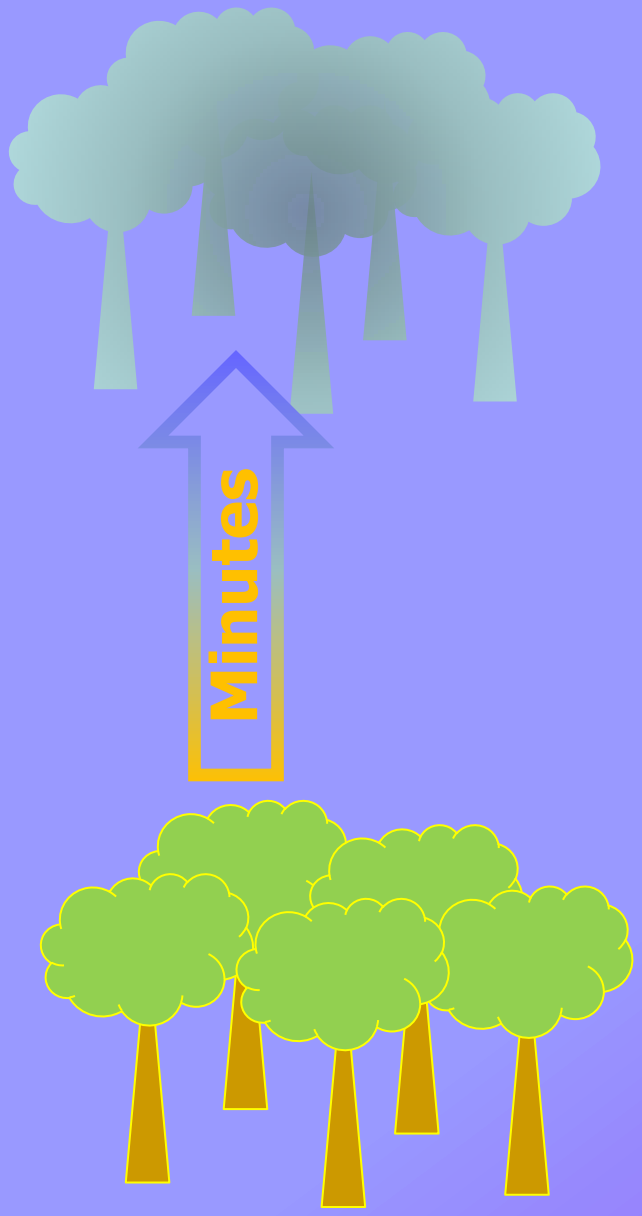
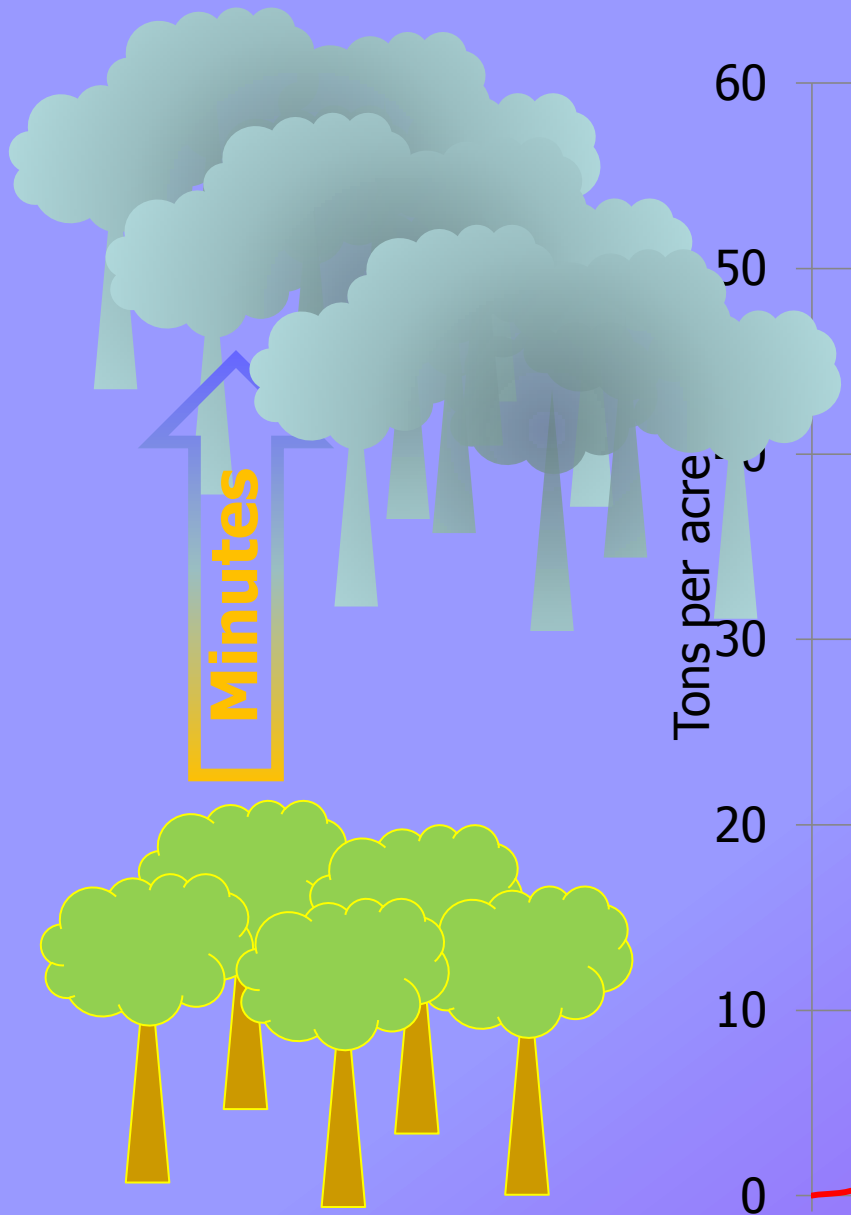
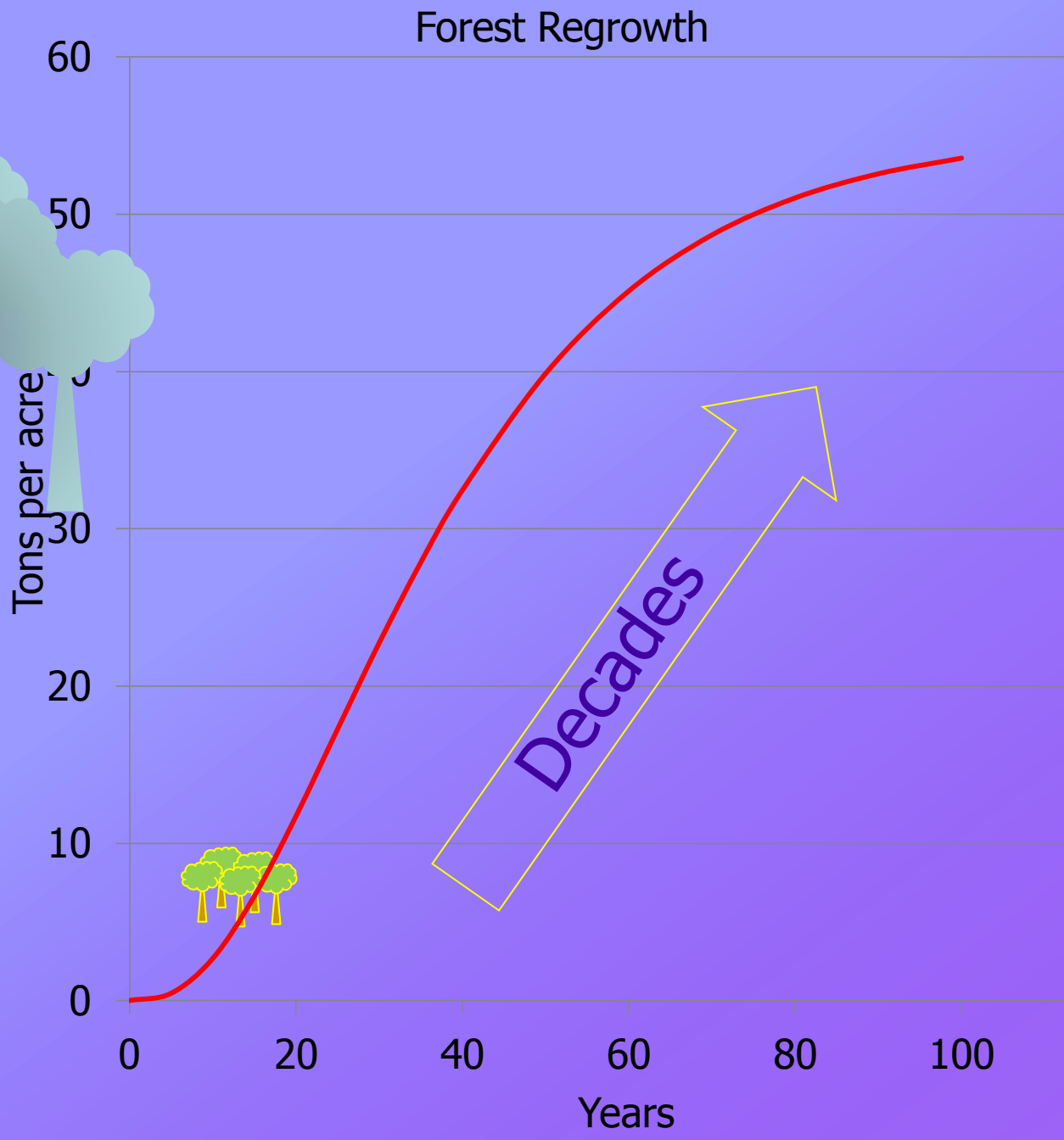
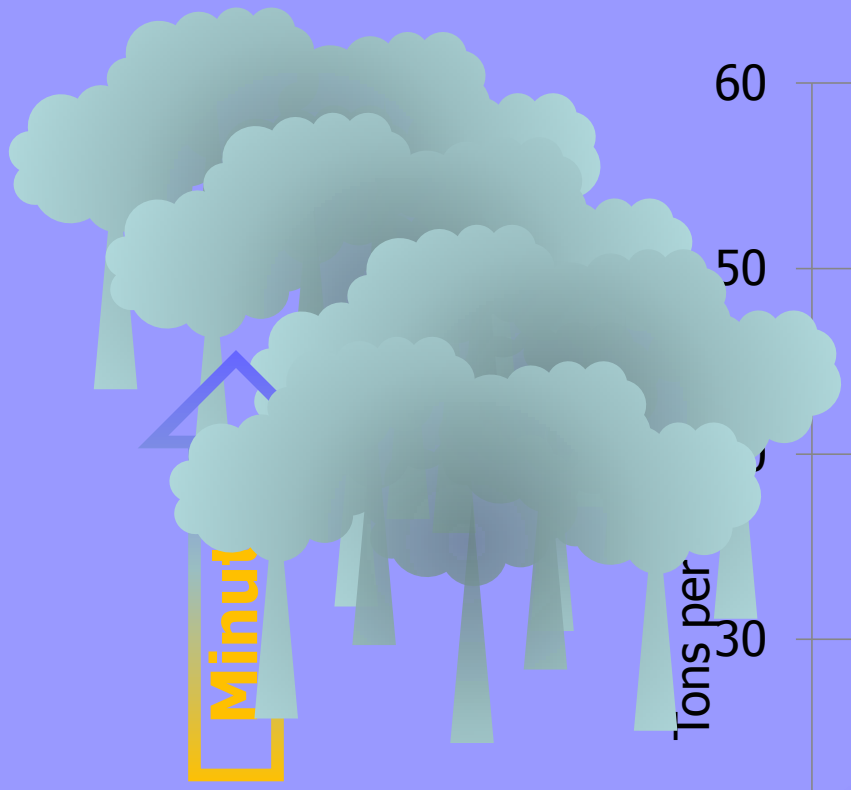


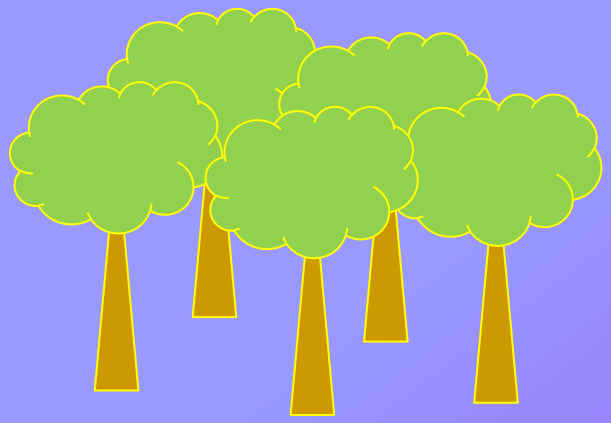


Biomass Combustion


Minutes
Biomass Combustion


Forest Regrowth
Tons per acre
60
50
30
20
10
0
0
20
40
60
80
100
Years
Decades





Biomass Combustion

Forest Regrowth

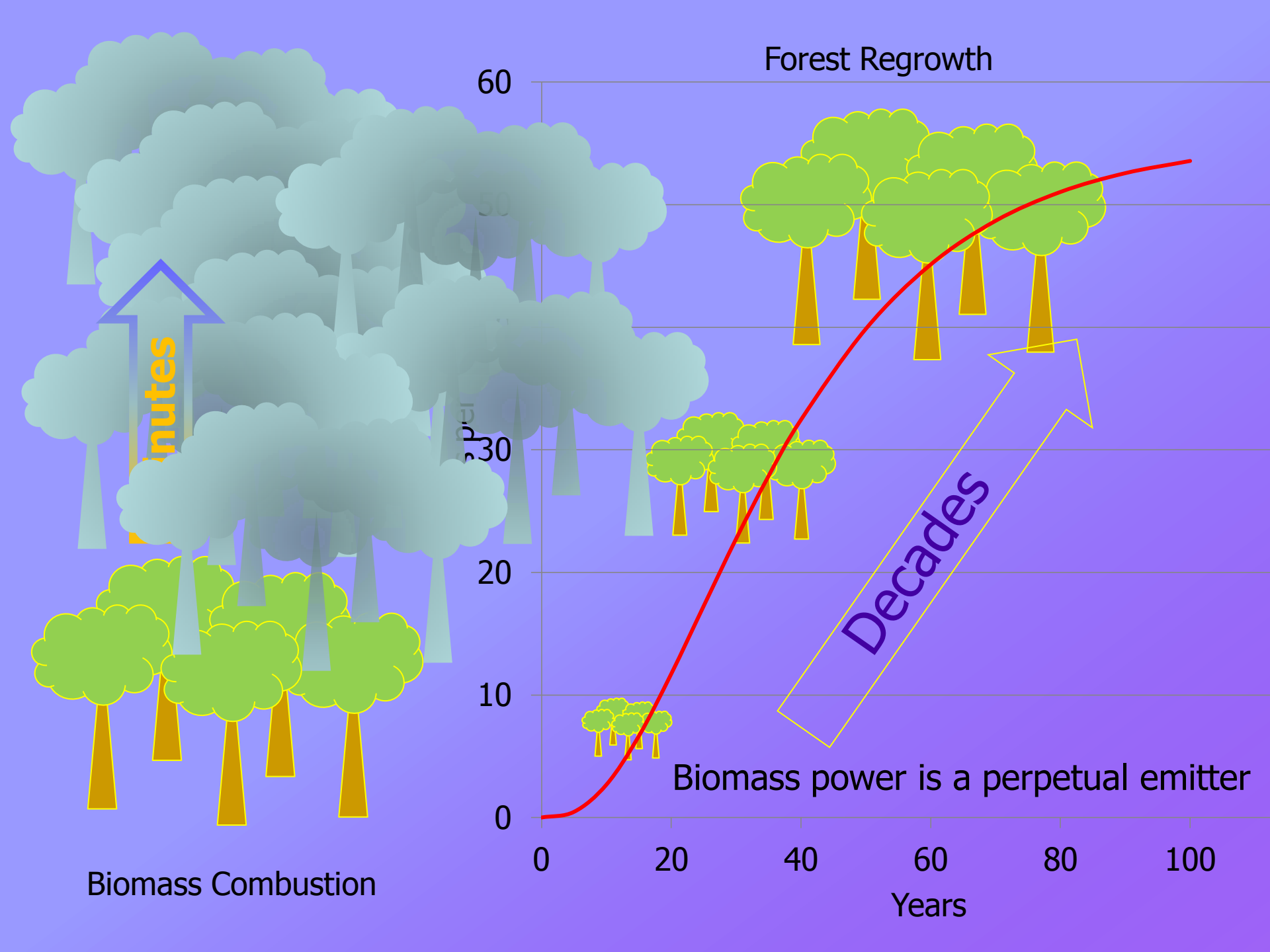
Tons per

60
50
30
20
10
0

0
20
40
60
80
100

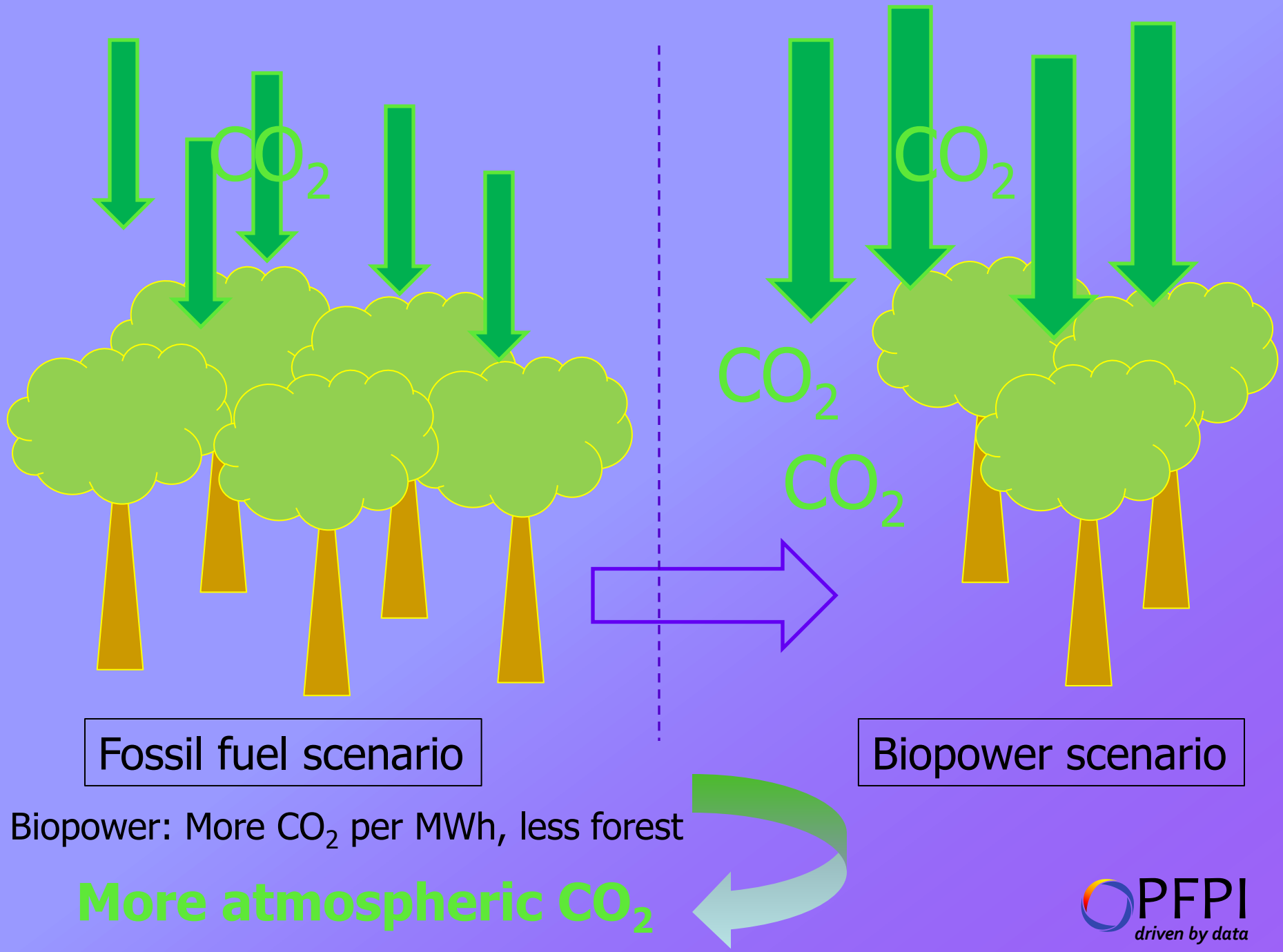
Years

Decades


Forest Regrowth
60
30
20
10
0
0
20
40
60
80
100
Years
Decades
Biomass power is a perpetual emitter
Biomass Combustion

Do carbon accounting wrong, and you end up with this...

Photo: Dogwood Alliance


CO_2
CO_2
CO_2
CO_2
Fossil fuel scenario
Biopower scenario
Biopower: More CO_2 per MWh, less forest
More atmospheric CO_2
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New MA regulations constrain biomass power eligibility for the RPS

Efficiency

- 50% efficiency to qualify for ½ REC/MWh (60% for full REC)
  - Promotes combined heat and power

GHG emissions accounting

- Framework accounts for carbon debt of whole tree harvesting
- Requires 50% reduction in GHGs over 20 yrs compared to combined cycle natural gas facility

Harvesting Sustainability

- Allowable biomass removals (as a percent of the forest products harvested) depend on soil conditions
- Protection old growth, steep slopes; retention of naturally down woody material
- Harvest plans/fuel sourcing plans required

No construction-demolition-derived fuels

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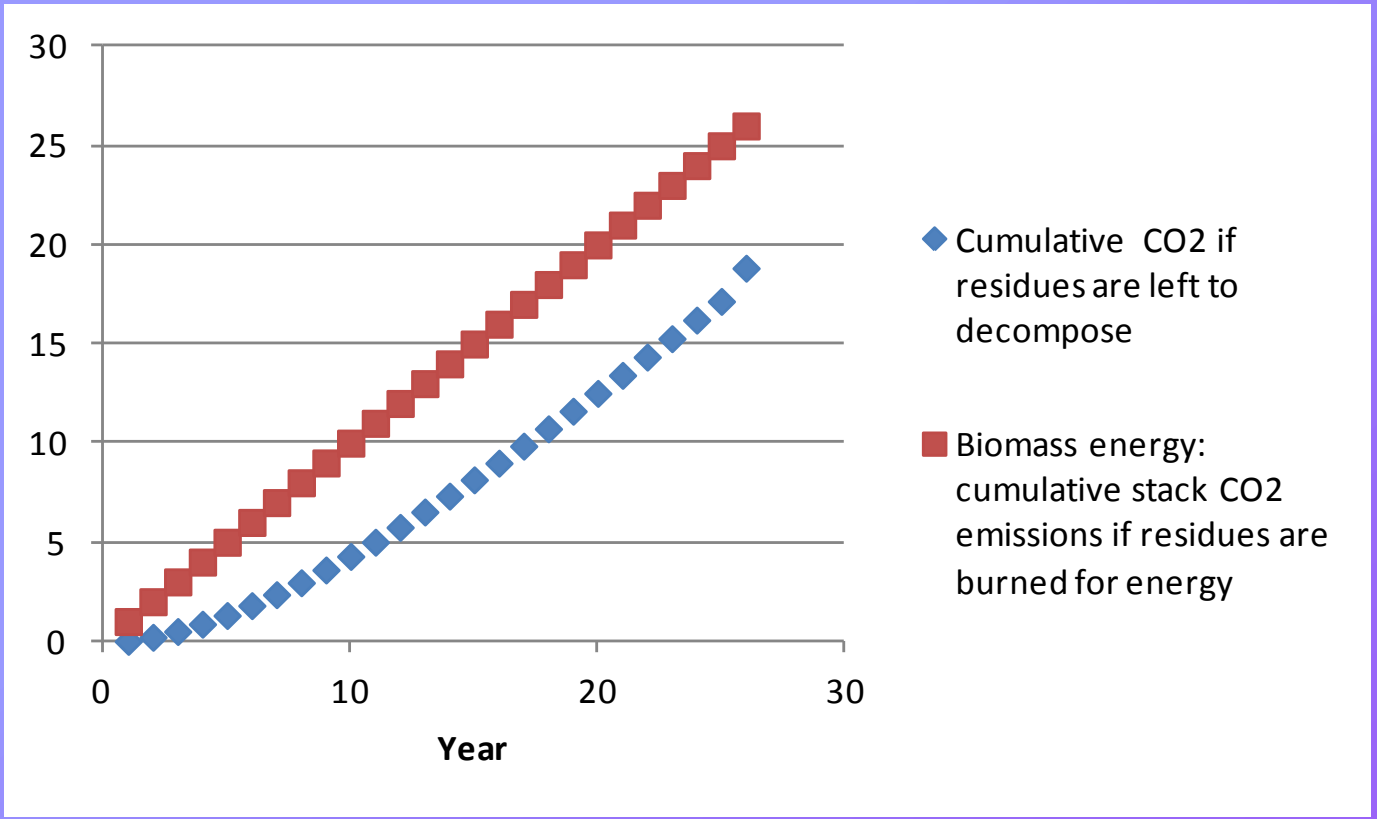
TVA's statements on biopower - decomposition

"Because decomposition in landfills produces carbon dioxide and methane, biomass cofiring could reduce these sources greenhouse gases as well."

EPA: landfilling with gas capture a better alternative than garbage or waste wood incineration



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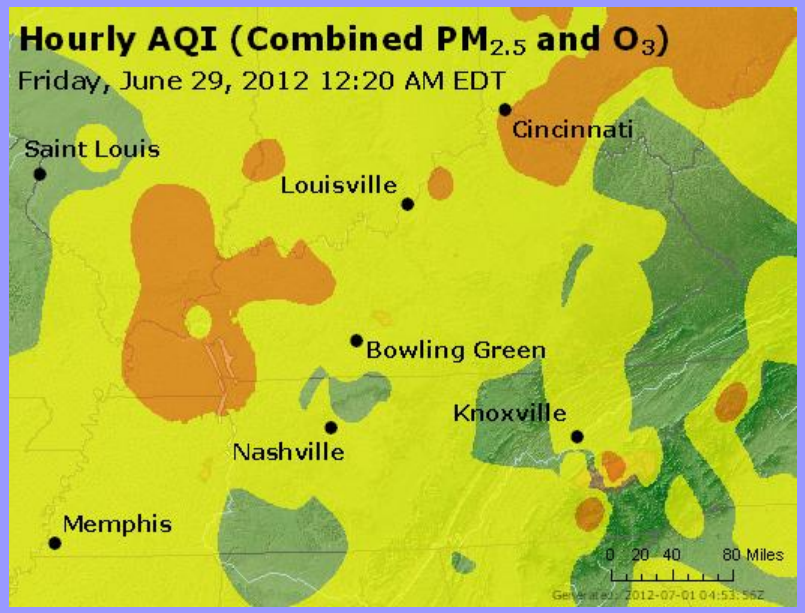
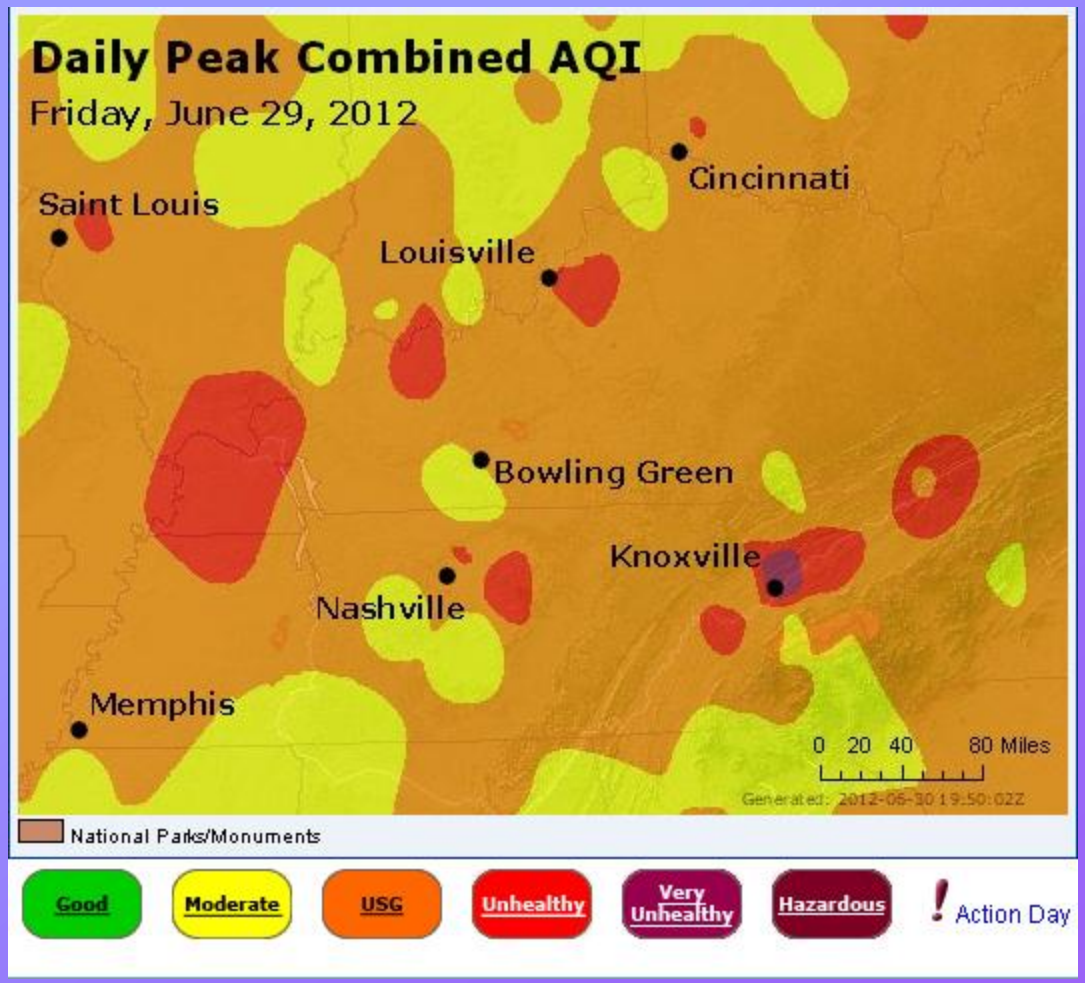
AIR POLLUTION EMISSIONS

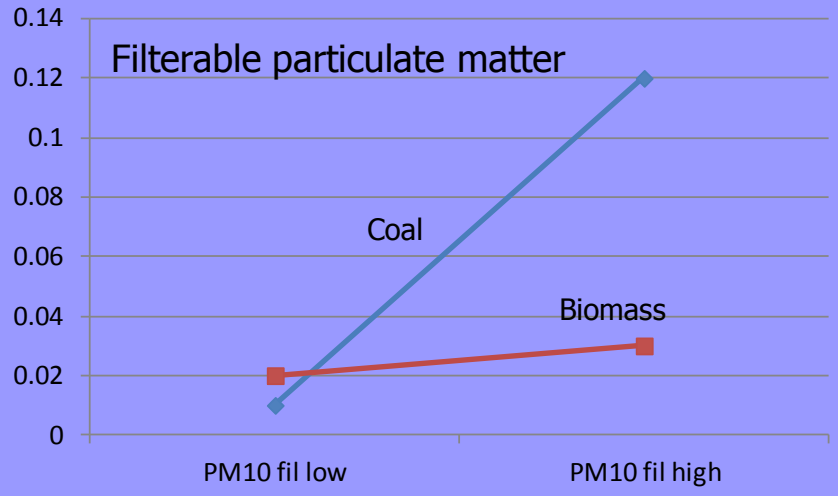
Air quality in the Southeast is poor

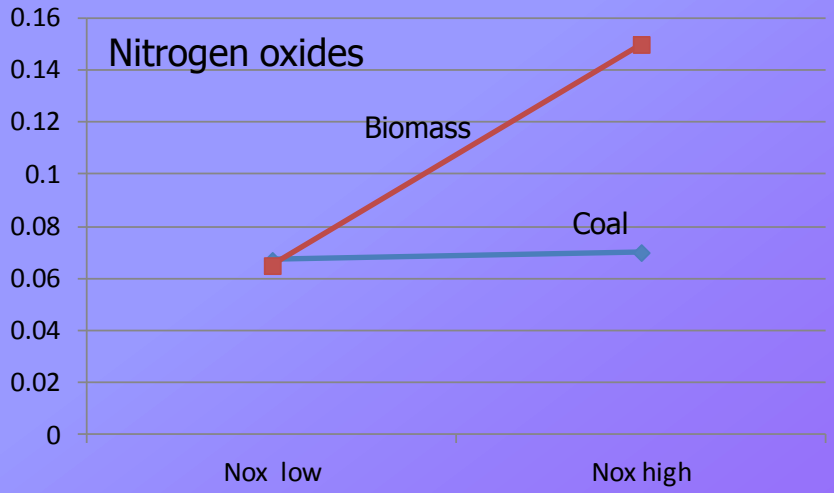


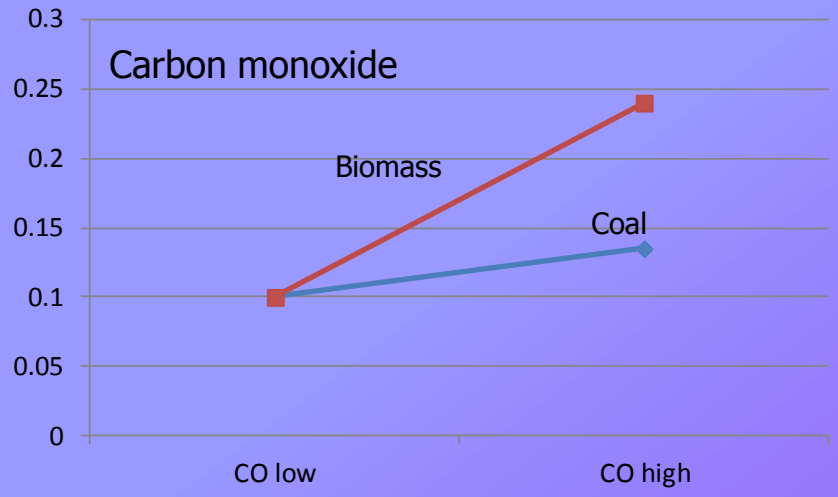


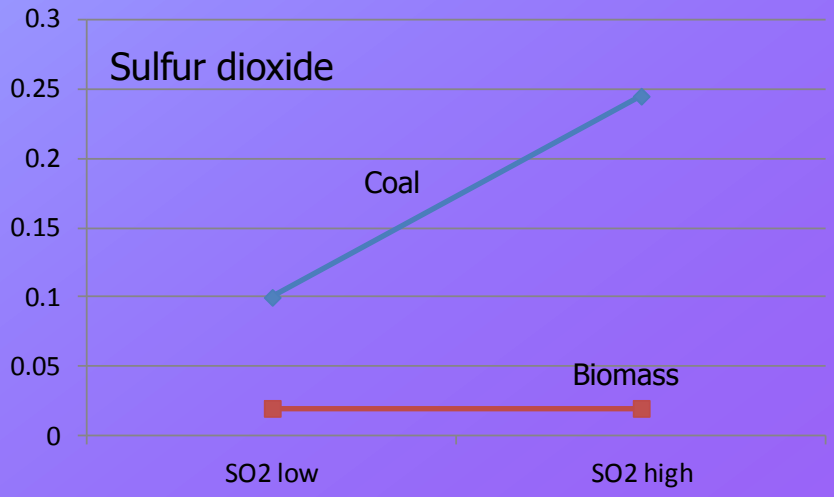
AIRNOW.gov: Daily Air Quality Index (AQI) Combined metric of ground-level ozone and PM2.5 concentrations

"Cleanest" biopower plants emit as much pollution as coal (and sometimes more).









Range of emission rates of 5 top performers in EPA's RACT/BACT/LAER Clearinghouse (lb/mmbtu)

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Permitted emissions (tons per year) at Dominion's converted coal plants in Virginia (153 MW of biopower)

Pollutant	Tons
PM_{10}	268
SOx	131
NO_2	1,245
CO	2,754
VOCs	132

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Permitted emissions for Russell Biomass, 50 MW plant in MA (forest wood only)

Particulate matter: 84.3 tons/yr
Nitrogen oxides: 194.5 tons/yr
Carbon monoxide: 243.1 tons/yr
Sulfur oxides: 81 tons/yr
Volatile org. compds: 32.4 tons/yr

Ammonia: 32.4 tons/yr
Mercury: 8 lb/yr
Lead: 400 lb/yr
Hydrochloric acid: 11.4 tons/yr
Hazardous air pollutants: 49.1 tons/yr

CO2: 635,000 tons/yr

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Co-firing just 5% biomass increases emissions of hazardous air pollutants at coal plants (by tons per year)

	PTE - Coal only	PTE - Coal/biofuel
Pollutant	tpy	tpy
POM (reported as PAH)	0.02	0.20
Acetaldehyde	0.66	1.71
Benzene	1.51	6.89
Formaldehyde	0.28	5.98
Toluene	0.28	1.46

Killen Coal Plant, OH: **50% increase in carbon monoxide** ; significant increases in organic hazardous air pollutants

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"Urban" wood as biomass fuel – loaded with toxics

- Construction and demolition waste
- Contains pressure-treated wood, plastics
  - Emissions of hazardous air pollutants: heavy metals, dioxins, hazardous organics like formaldehyde and benzene
- EPA's "waste" rule requires demonstration that contamination no greater than traditional fuels
- But sorting out and burning "clean" wood is lowest use; this material can be recycled

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WATER USE

Biopower water use for cooling – same as coal

Permitted withdrawals at Russell Biomass in MA, a 50 MW biomass plant

- ~650,000 tons of wood per year
- Avg cooling water withdrawal **670,000 gpd**; Peak: **885,000 gpd** (~20 acre-feet/day)
  - Closed loop: 15% returned to river as "boiler blowdown"

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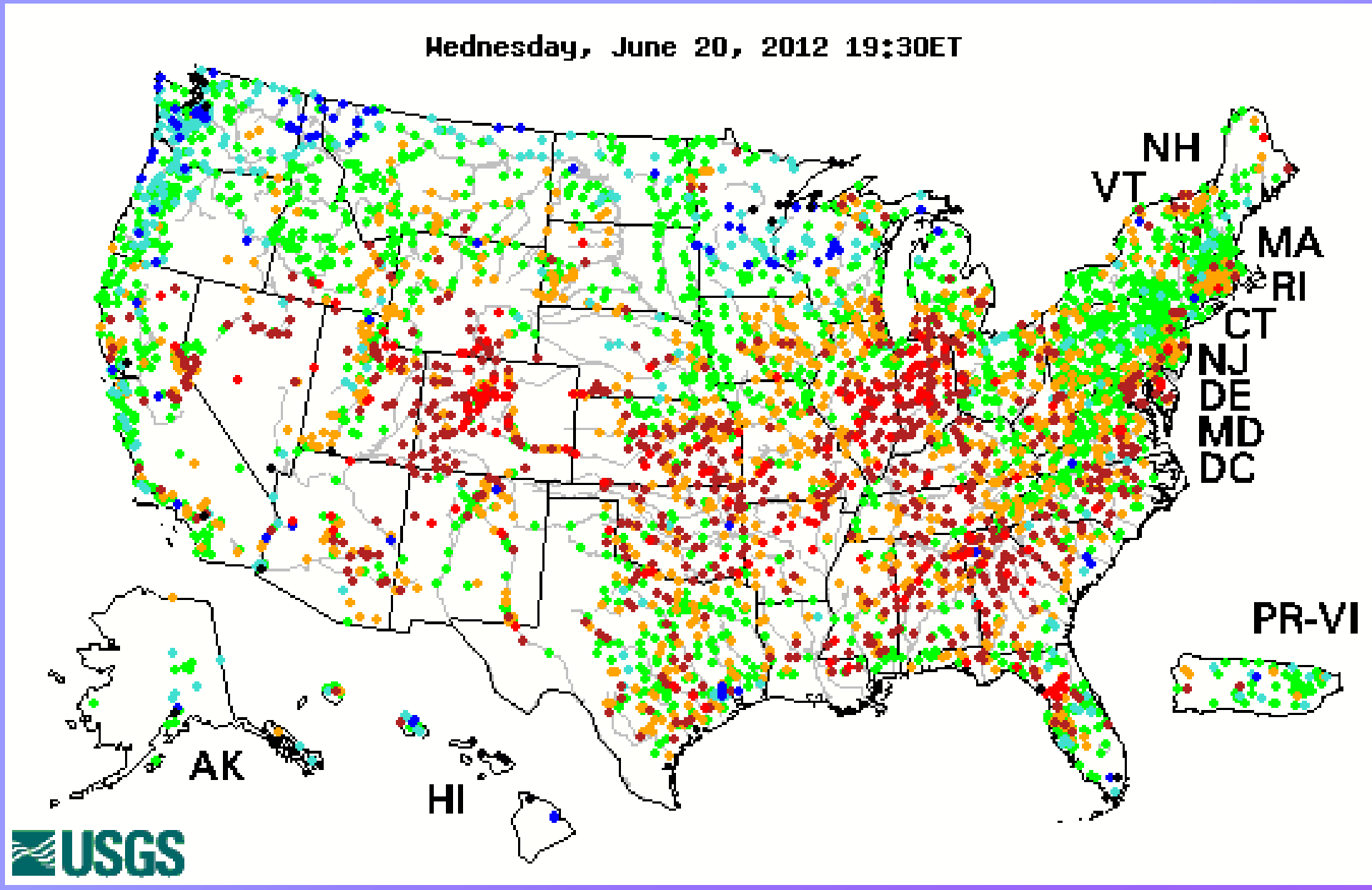
Biopower has same vulnerability to drought as coal



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