# The Role of Forests in Energy and Climate Change

A Path Toward Sustainability?

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**Forester and Forest Ecologist**

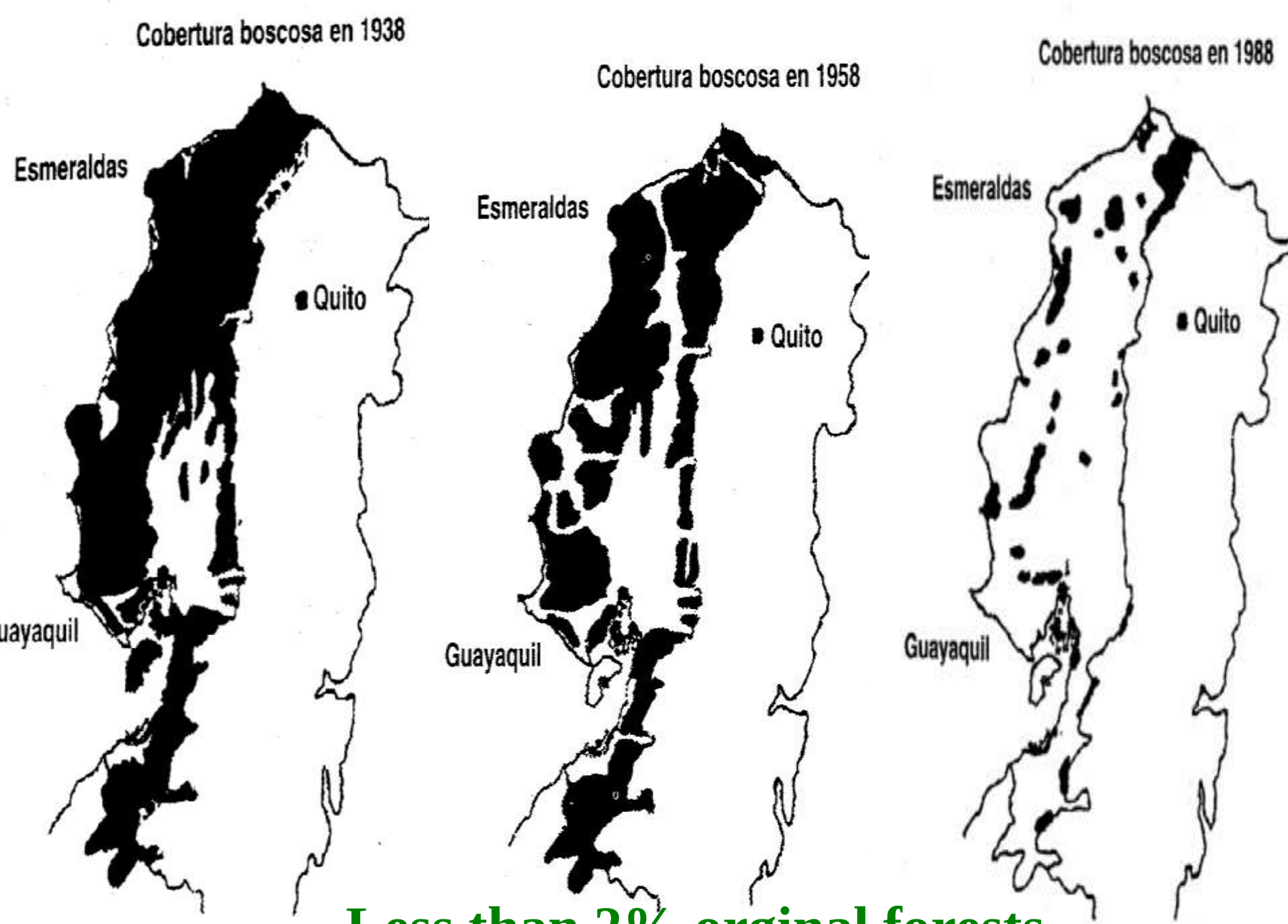
# Where does Forest Management Fit?

- Climate Change
  - Is HRV relevant?
  - What is the DFC?
  - Carbon Offsets = Mitigation
  - Resilience, Resistance, Adaptation
- Energy Independence
  - How much can we really affect?
- Common Vision? Interest Groups? How do we get there?
- Are we asking the right questions?

# Sustainability

# Climate Change

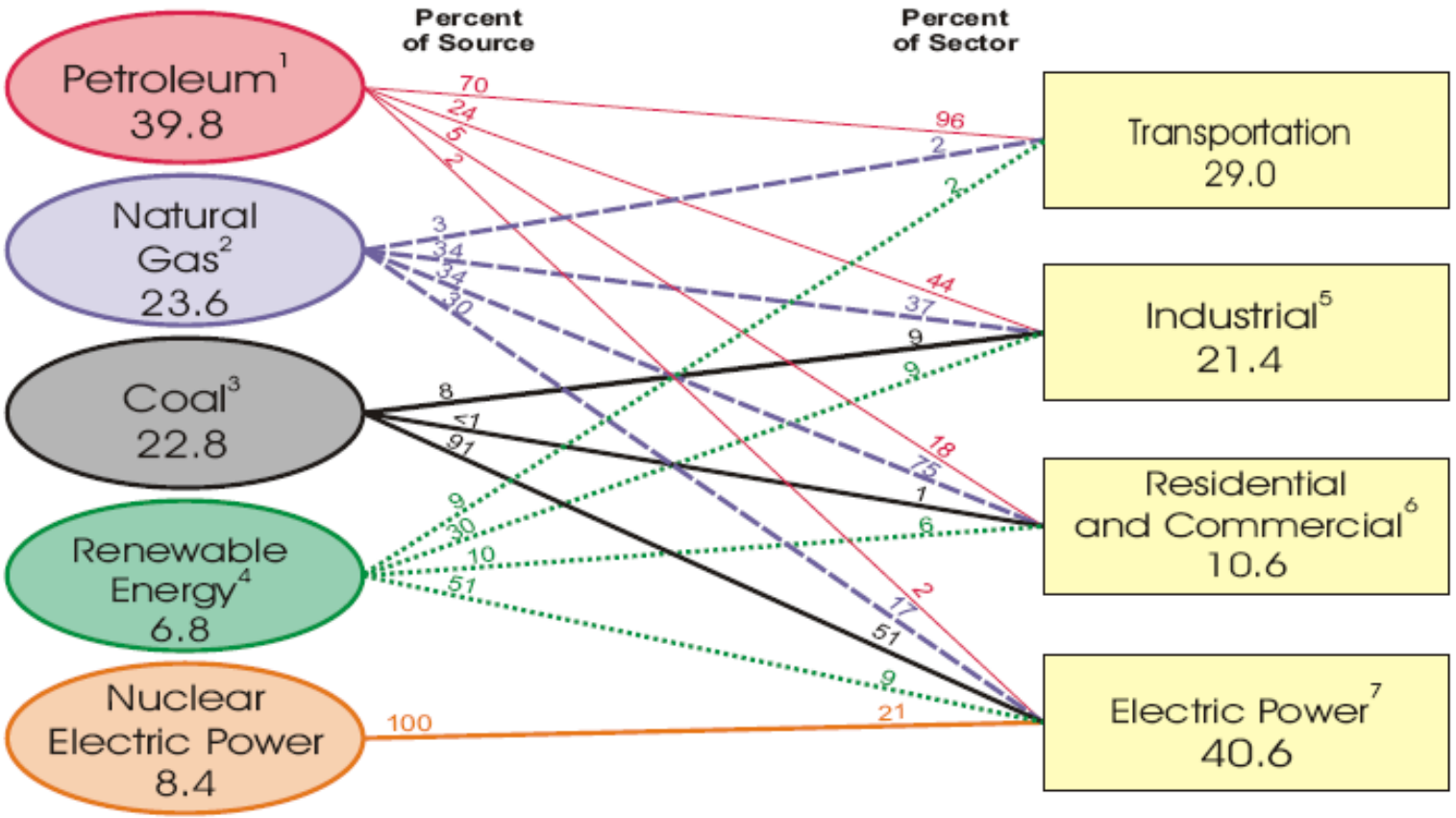
- Forests as C filtration system
- Renewable Solar collectors w/ Cellulose batteries that provide Co-Benefits:
  - Water filtration and storage system;
  - Native plant and animal habitat=Biodiversity;
  - Wonderful Recreation opportunities
- International perspective
  - Stop deforestation – 20% of C release
  - Afforestation/Reforestation – C capture
- National perspective
  - Forest conversion
  - Not reforesting after wildfires
- Policy – Cap and Trade  or C Tax




**Less than 2% orginal forests**

# U.S. Primary Energy Consumption by Source and Sector, 2007

(Quadrillion Btu)




[1] Does not include 0.6 quadrillion Btu of fuel ethanol, which is included in "Renewable Energy."
[2] Excludes supplemental gaseous fuels.
[3] Includes less than 0.1 quadrillion Btu of coal coke net imports.
[4] Conventional hydroelectric power, geothermal, solar/PV, wind, and biomass.
[5] Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.
[6] Includes commercial combined-heat-and-power (CHP) and commercial electricity-only plants.
[7] Electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public.

Note: Sum of components may not equal 100 percent due to independent rounding.

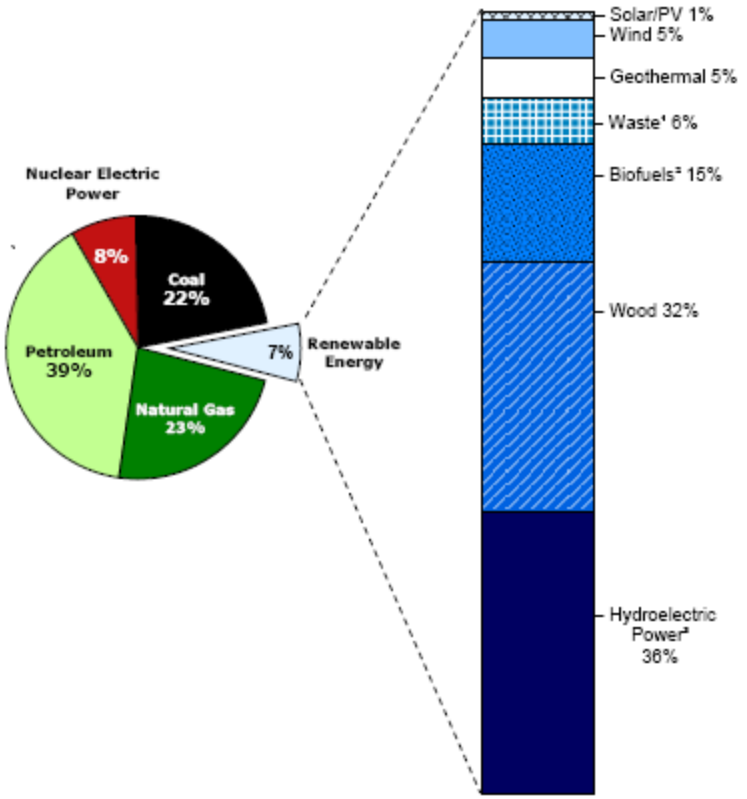
Sources: Energy Information Administration, *Annual Energy Review 2007*, Tables 1.3, 2.1b-2.1f and 10.3.

# Efficiencies

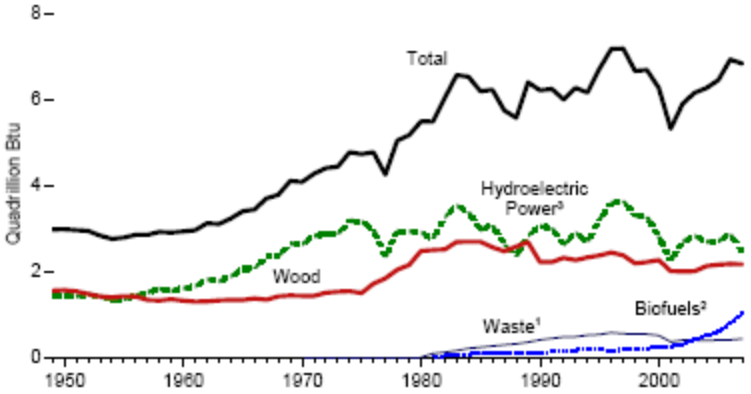
- Power production
  - Dedicated – 25% efficient
  - w/o counting line loss
- Transportation
  - Cellulosic ethanol – 40%
  - Train vs. plane vs. car
- Thermal or CHP – 70-90%
- Conservation – "Negawatts"
  - Long-term vs. short bldg life
  - Embodied Energy

## Figure 10.1 Renewable Energy Consumption by Major Sources

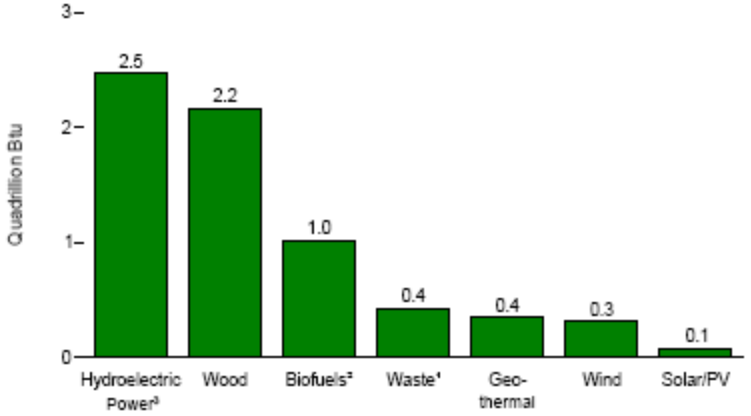
### Renewable Energy as Share of Total Primary Energy Consumption, 2007




### Renewable Energy Total Consumption and Major Sources, 1949-2007




### Renewable Energy Consumption by Source, 2007




[1] Municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural byproducts, and other biomass. Through 2000, also includes non-renewable waste (municipal solid waste from non-biogenic sources, and tire-derived fuels).
[2] Fuel ethanol and biodiesel consumption, plus losses and co-products from the production of fuel ethanol and biodiesel.
[3] Conventional hydroelectric power.
Note: Because vertical scales differ, graphs should not be compared.
Sources: Tables 1.3 and 10.1.

# Mountain Top Removal

Coal Mining multiple layers of seams with rock between blasted and pushed into draws.

No Free Lunches!

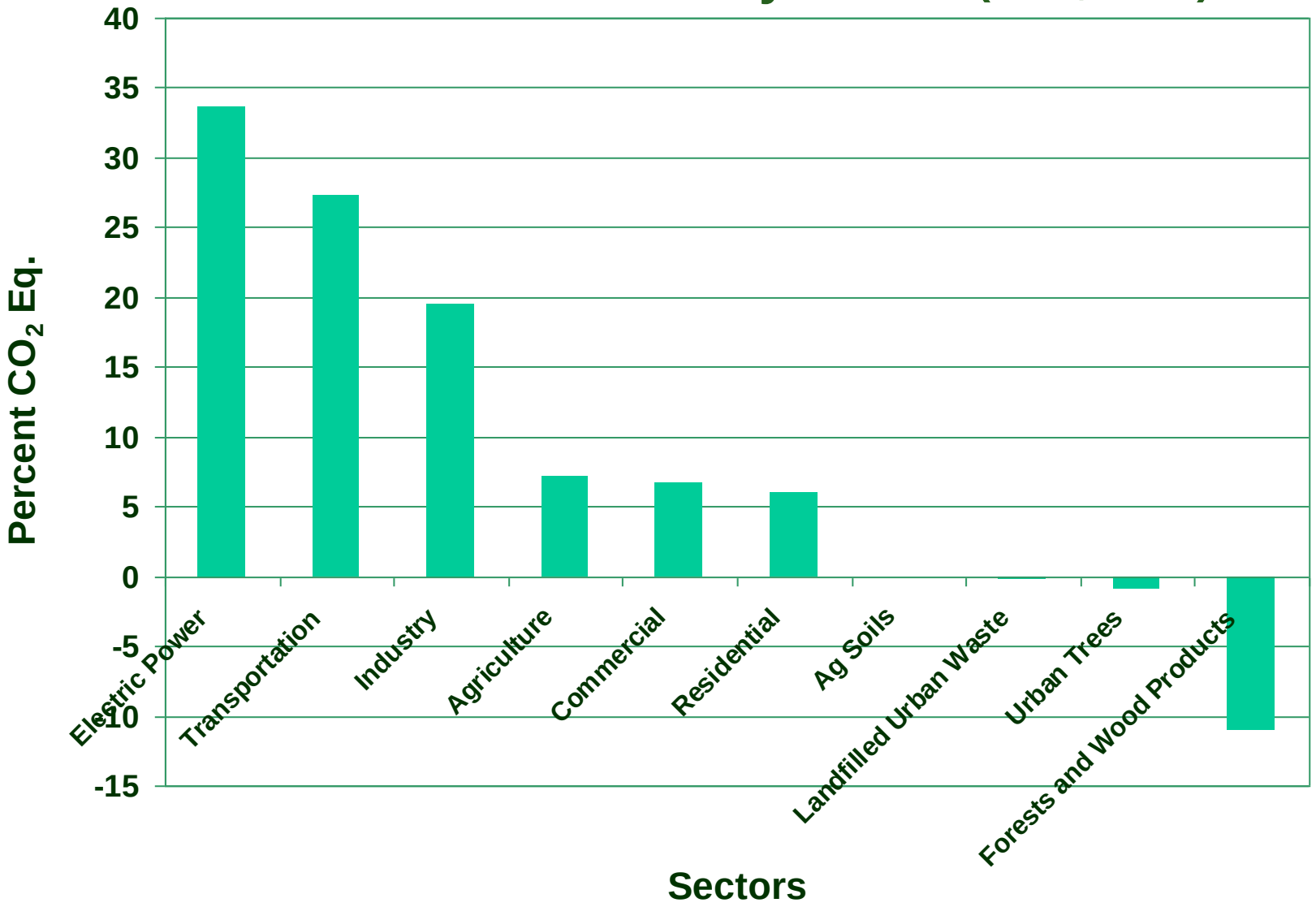
Don’t Ask Don’t Tell

# Mountain Top Removal

# Energy Choices

- Tar Sands footprint
  - Water quality
  - C 3x conventional oil
- Coal-Bed methane
  - Water quality/quantity
- Wind Farms – birds/bats, not firm
- Solar Farms – huge expanses needed, batteries, not firm
- Geothermal – effects?
- Tidal/Wave – marine life?
- Nuclear – storage safety issue
- Biomass – use trade-offs

# Percent Total U.S. Greenhouse Gas Annual Emissions by Sector (EPA, 2003)




Note: Negative numbers denote sequestration.
Forests and wood products sequester 11% U.S. GHG emissions annually.

# Role of Forests in Energy Security and Climate Change

- **Embodied Energy**
- **Fossil fuel offsets**
  - **1 BDT= 2.7 barrels of oil**
  - **50 t/ac = 135 barrels/ac**
- **Sequestered C in live forests**
- **Sequestered C in utilized wood**

# Wood Energy

- Reduce fossil fuel - Embodied Energy
- Locally abundant – disposal problem
- Renewable – solar collectors w/ non metal batteries
- Save money – Not a higher cost renewable energy
- Revenues stay in the country
  - Balance of trade benefits
  - Local community benefits

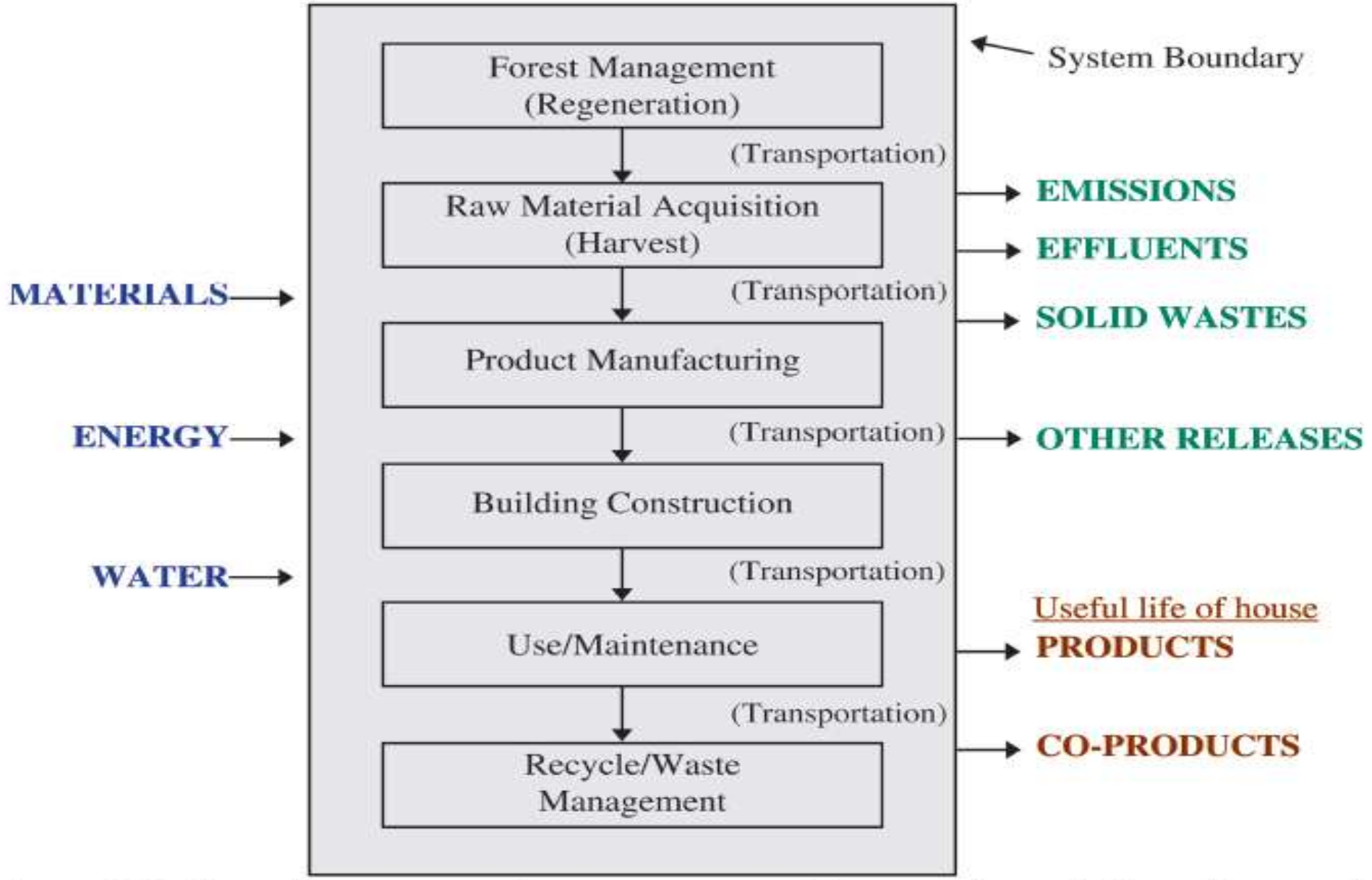
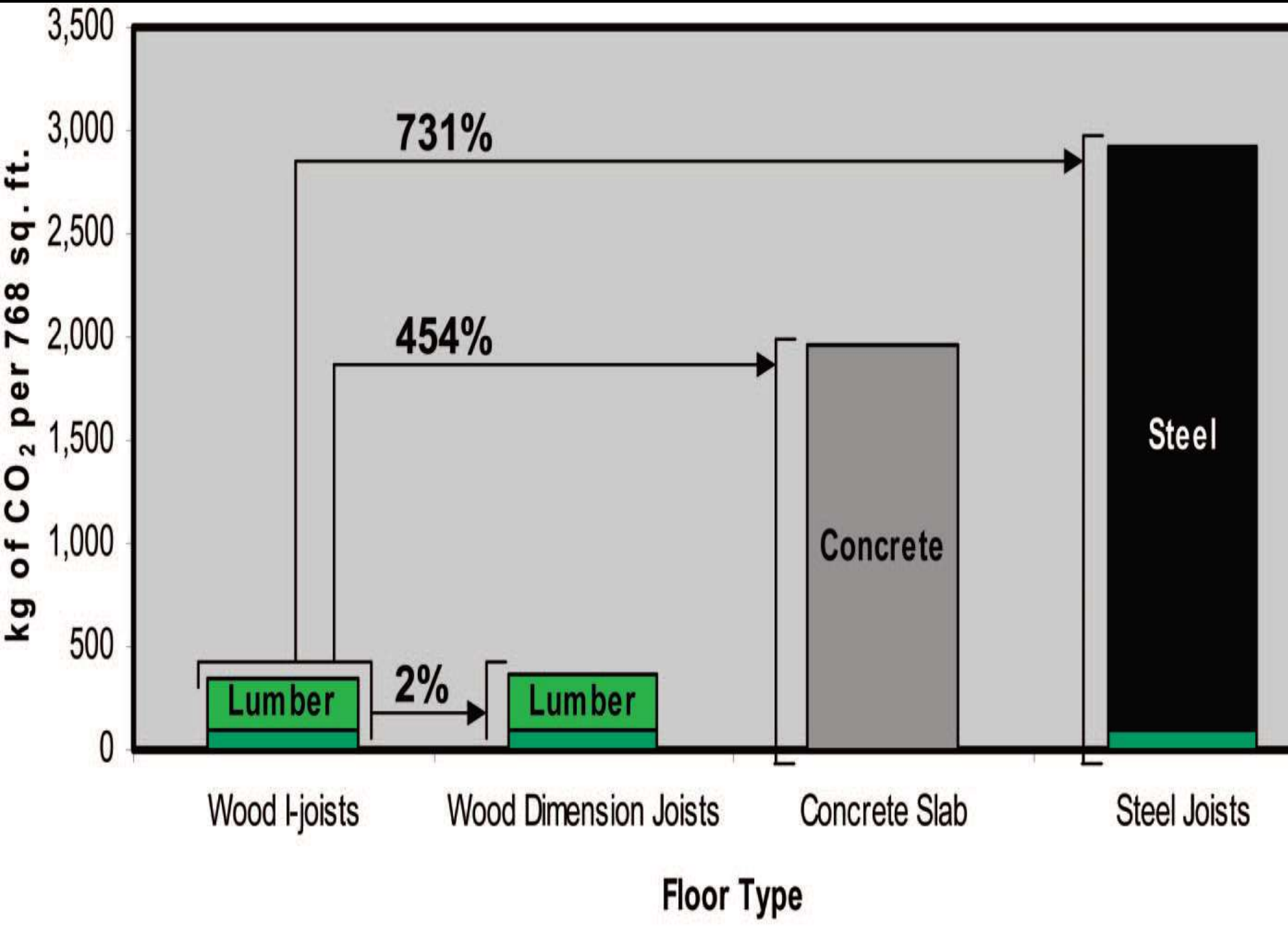
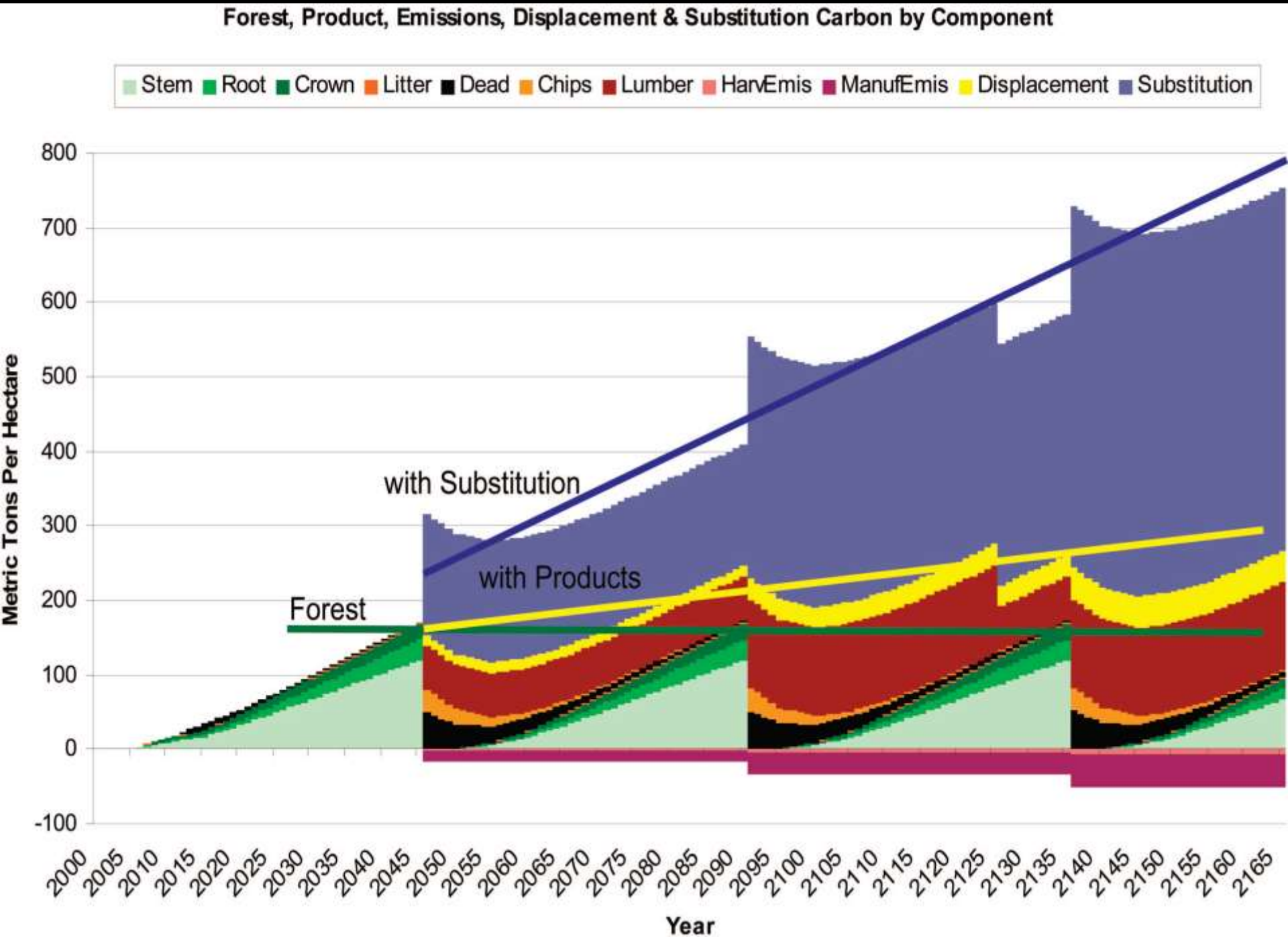



Figure 3-1. Life-cycle assessment from regeneration of trees to disposal of wood materials (Source: CORRIM Presentations, www.corrim.org/ppt/2005/fps_june2005/lippke/index.

# Wood vs. Concrete and Steel in Home Construction

- **Energy Use**
  - wood-frame house uses 17% less energy than steel-frame and 16% less than a concrete block house.
- **Global Warming**
  - Wood-frame house has 26% and 31% less impact on global warming than steel and concrete houses, respectively.
  - Growing wood in renewable forests "sequesters" carbon from the atmosphere.
  - More than half the energy used by wood mills comes from renewable biomass resources.
- **Water Emissions**
  - Wood-frame house has a 312% less adverse impact on water quality as a steel-frame house.
- http://www.corrim.org/reports/ for details


3,500
3,000
2,500
2,000
1,500
1,000
500
0
kg of $CO_2$ per 768 sq. ft.
731%
454%
2%
Lumber
Lumber
Concrete
Steel
Wood I-joists
Wood Dimension Joists
Concrete Slab
Steel Joists
Floor Type


Forest, Product, Emissions, Displacement & Substitution Carbon by Component
Stem
Root
Crown
Litter
Dead
Chips
Lumber
HarvEmis
ManufEmis
Displacement
Substitution
800
700
600
500
400
300
200
100
0
-100
Metric Tons Per Hectare
with Substitution
with Products
Forest
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
2060
2065
2070
2075
2080
2085
2090
2095
2100
2105
2110
2115
2120
2125
2130
2135
2140
2145
2150
2155
2160
2165
Year

Bodegas Vineyard

Spain

# London, England

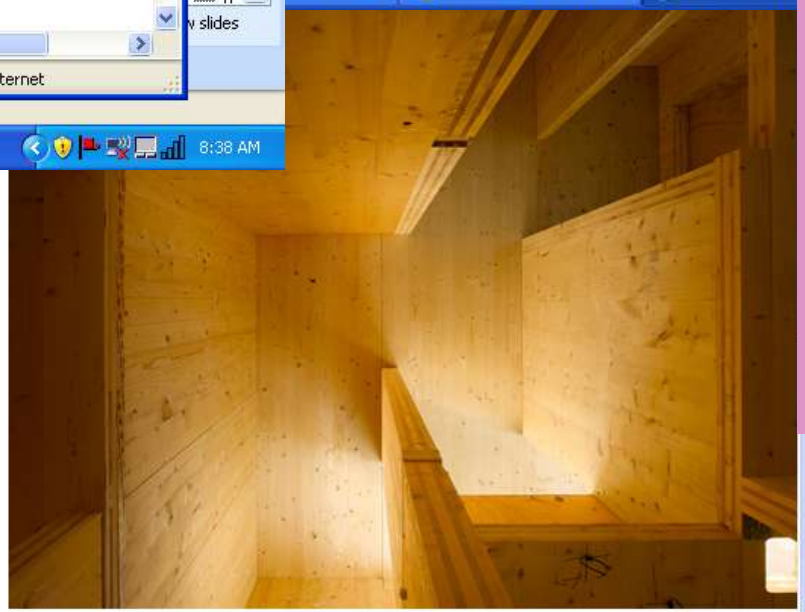


## Murray Grove

### The world's tallest modern timber residential building

We have recently completed a new nine-storey residential building in Hackney, providing both private and affordable housing. Constructed entirely in timber, Murray Grove is the tallest modern timber residential building in the world.

A modern and engaging counterpart to the 1950s and 60s ground hugging slab blocks next door; the building's striking facade has been inspired by the work of artists Gerhard Richter and Marcus Harvey. Recording the changing light and shadows formed on the vacant site by the surrounding buildings and trees, we captured the pattern through a sun-path animation before pixilating and blurring the result and wrapping the image around the building.



… the tallest timber building in the world at nine stories, and will save 125 tonnes of carbon emissions compared to a concrete structure.

# Higher Value

# Engineered Roundwood

Blue Pine

Douglas-fir

Larch Flooring

# Small Wood to Big Wood Glulam Beam

Stave church in Norway

More than 500 years old

Protected with wood tar

# More than 200 years old

Protected with a paint,  (forms a film)

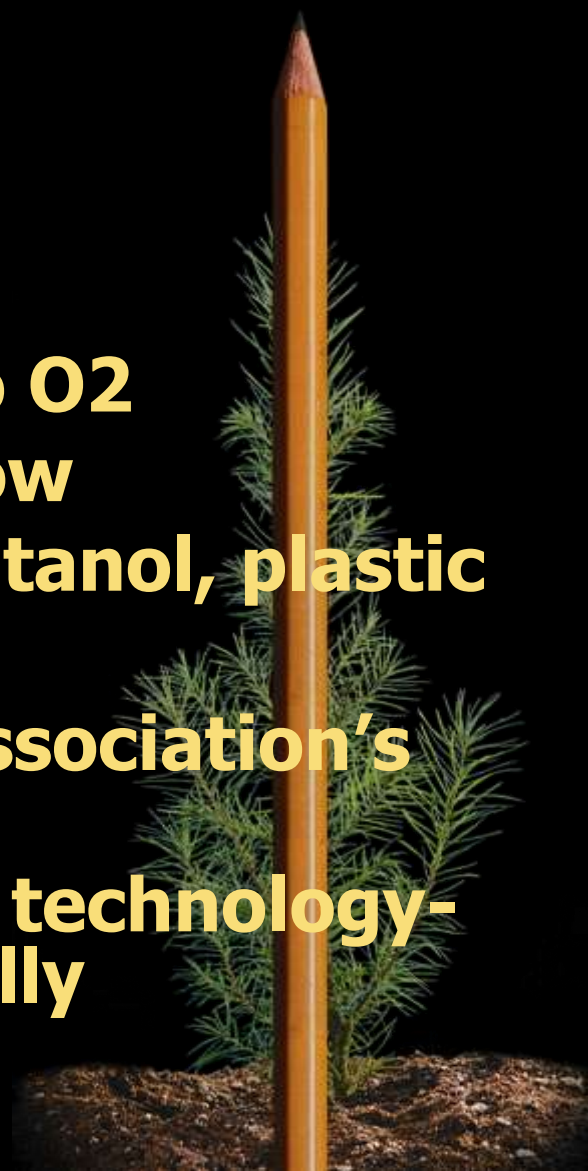
# Woody Biomass Potential

**368 million tons annually**

Biomass as a feedstock for a bioenergy and bioproducts industry

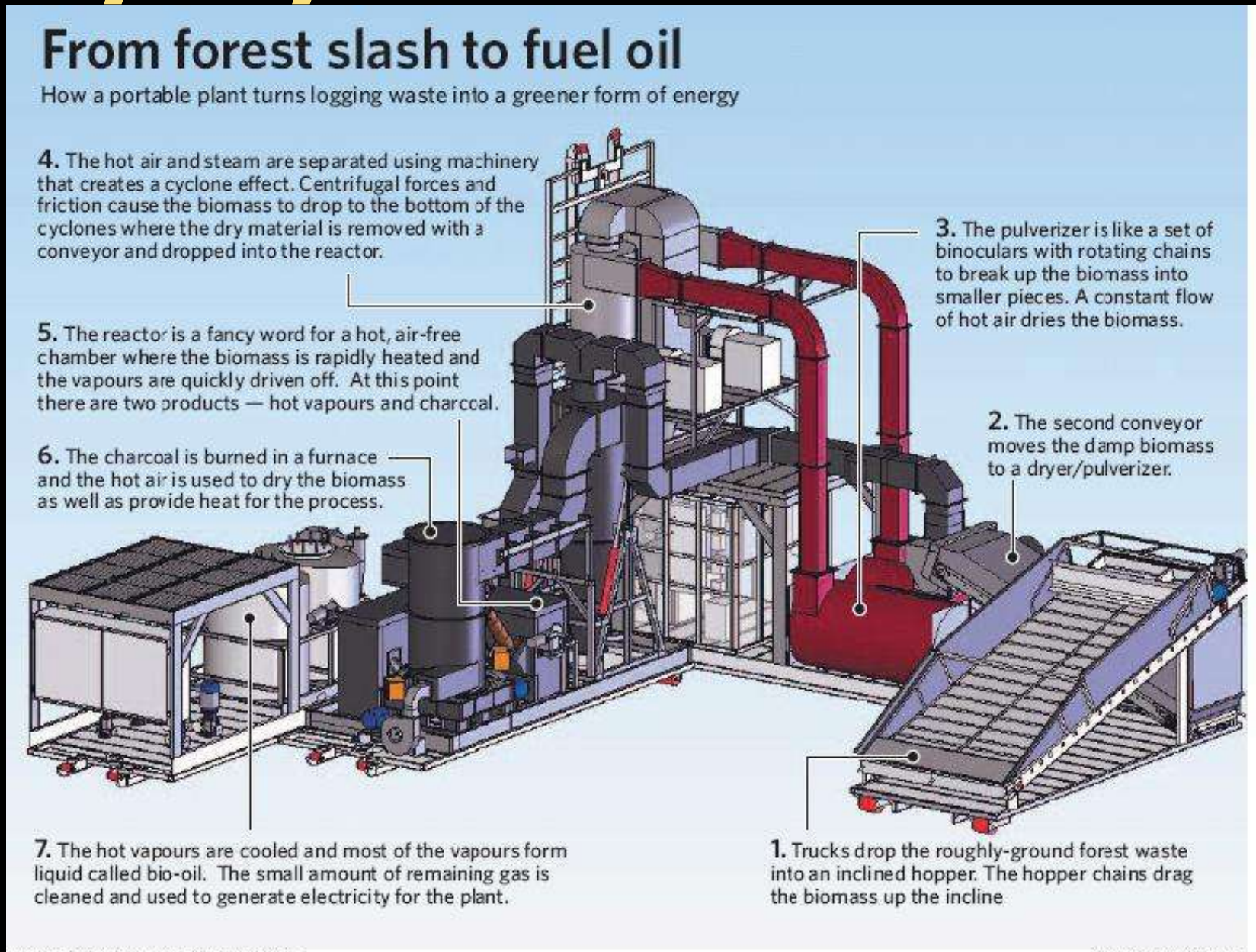
# Future Technologies

- Cellulosic Ethanol and Diesel
  - Fermentation ethanol only
  - Thermo – Chemical
    - Gasification – low O2
    - Fast Pyrolysis – Bio Oil - No O2
    - Torrefied Wood – No O2 slow
- Biorefinery – ethanol, diesel, butanol, plastic
- Pulp mills – half way there!
  - American Forest and Paper Association's "Agenda 2020" initiative
- Combine forest/ag & clean coal technology- capture C and store it geologically



# EERC-Gasifier

# Pyrolysis – Bio-oil & char



# 50 TPD/DRYER

Produce: Bio-Oil, BioChar, Mineral ash and combustible Gases

# Role of Forests continued

- Manage the forests to restore resiliency to deal with:
  - More fire, insects & disease
  - More invasives
  - Select seral drought tolerant
- Ecosystem Services
  - Water for fish, farms, fun
  - Wildlife habitat
  - C sequestration in live forests

# Treated vs. Untreated

Rodeo-Chediskeei Fire

Camp 32
Fire
2005


"The sharp line in the aerial photograph is obvious, abrupt and dramatic: black forest on one side, green canopy on the other. " Missoulian Sept. 2005. Camp 32 Fire Eureka, MT

# Post Disturbance Salvage?

- Carbon/Energy Mgmt Implications
- Bark Beetle/Fire emissions
- Double burn implications
- Post harvest plantation burns
- Snag – down woody needs
- Decay emissions – $CH_4$, $CO_2$ mix

# Watershed Values

Hayman Fire

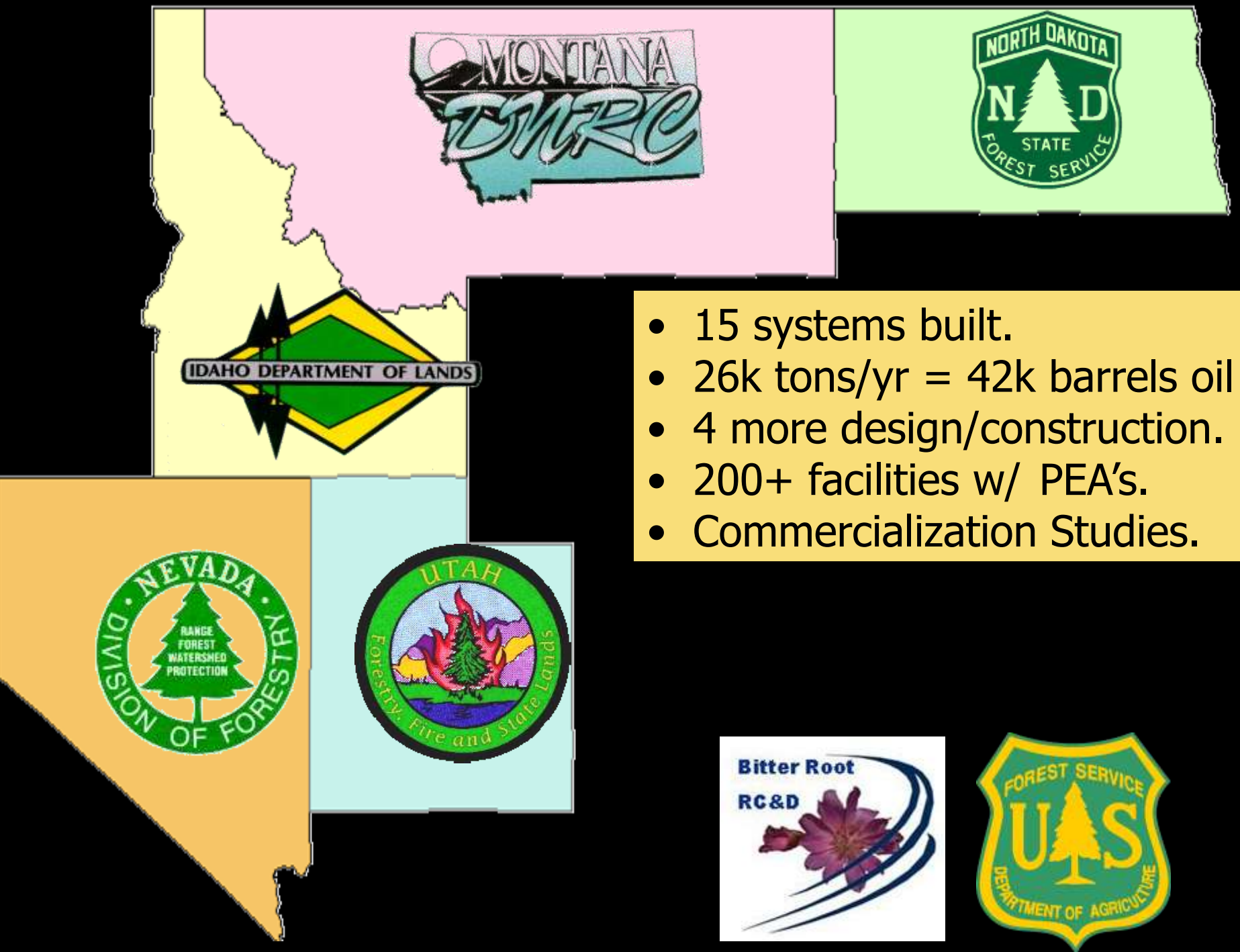
137,760 acres, 2002, Colorado

| | |
|---|---|
| Lost value of water storage capacity | $37 million |
| Fisheries losses | $297,000 |
| Burned area emergency rehabilitation | $23.71 million |
| NRCS Grants for state, Co., & pvt rehab | $10.80 million |
| Denver water emergency rehabilitation | $2.23 million |
| Requested FS long-term rehab funding | $36.77 million |
| **Total estimated cost of the Hayman Fire** | **$110.8 mill** |

**Almost $800/ac**

# Existing Technologies

**Combined Heat and Power**
**Fuels For Schools And Beyond**




- 15 systems built.
- 26k tons/yr = 42k barrels oil
- 4 more design/construction.
- 200+ facilities w/ PEA's.
- Commercialization Studies.

# What are the Opportunities?

- Boiler databases by state
- MT – 7300 boilers
- UT – 12,000+
- MI – 65,000 boilers
  - 38k <750k btu/hr – 58%
  - 15k .75-2.5 mill btu/hr – 23%
  - 3k 2.5-5 mill btu/hr
- OR – 10,700 boilers
- Majority in sweet spot for pellets
- Retrofit vs. new construction
- Develop bulk delivery for residential and commercial

# Oregon Boiler Size and Age

| **Size MM BTU** | **< .750** | **.75 - 2.5** | **2.5 - 5** | **5 - 20** | **20+** |
|---|---|---|---|---|---|
| Manuf. date: | | | | | |
| < 1950 | 586 | 42 | 16 | 10 | 28 |
| 1950-1970 | 1523 | 234 | 130 | 69 | 67 |
| 1970-1980 | 875 | 223 | 60 | 46 | 39 |
| 1980-1990 | 1359 | 539 | 90 | 41 | 46 |
| 1990-2002+ | 2901 | 1239 | 289 | 130 | 108 |
| **Total:** | **7244** | **2277** | **585** | **296** | **288** |

# Existing Systems



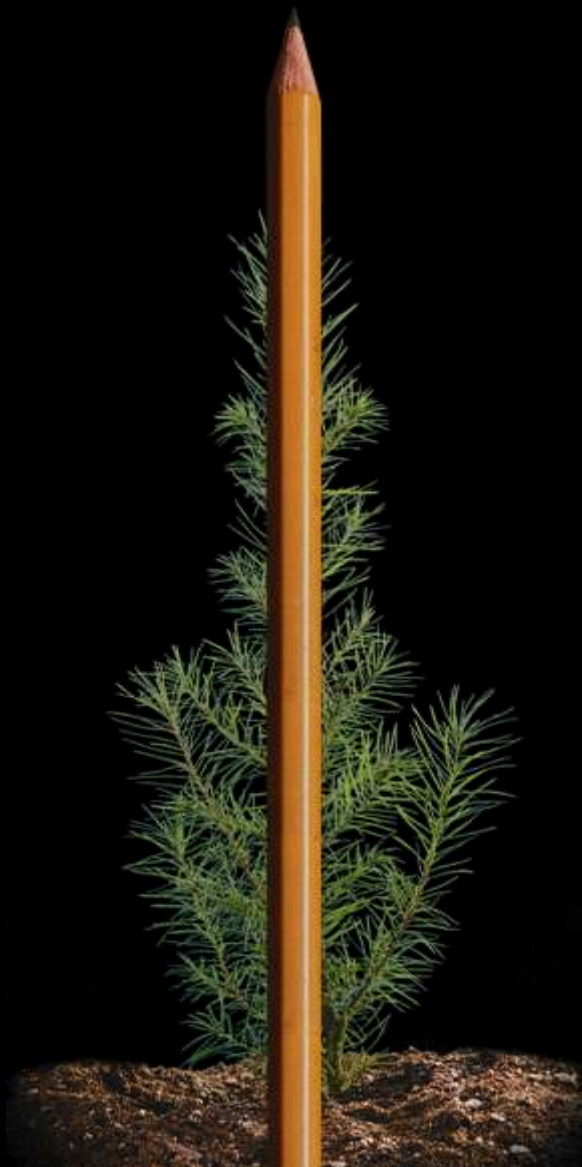

Industry –
Wood Products

Food –
Potatoes, Beer

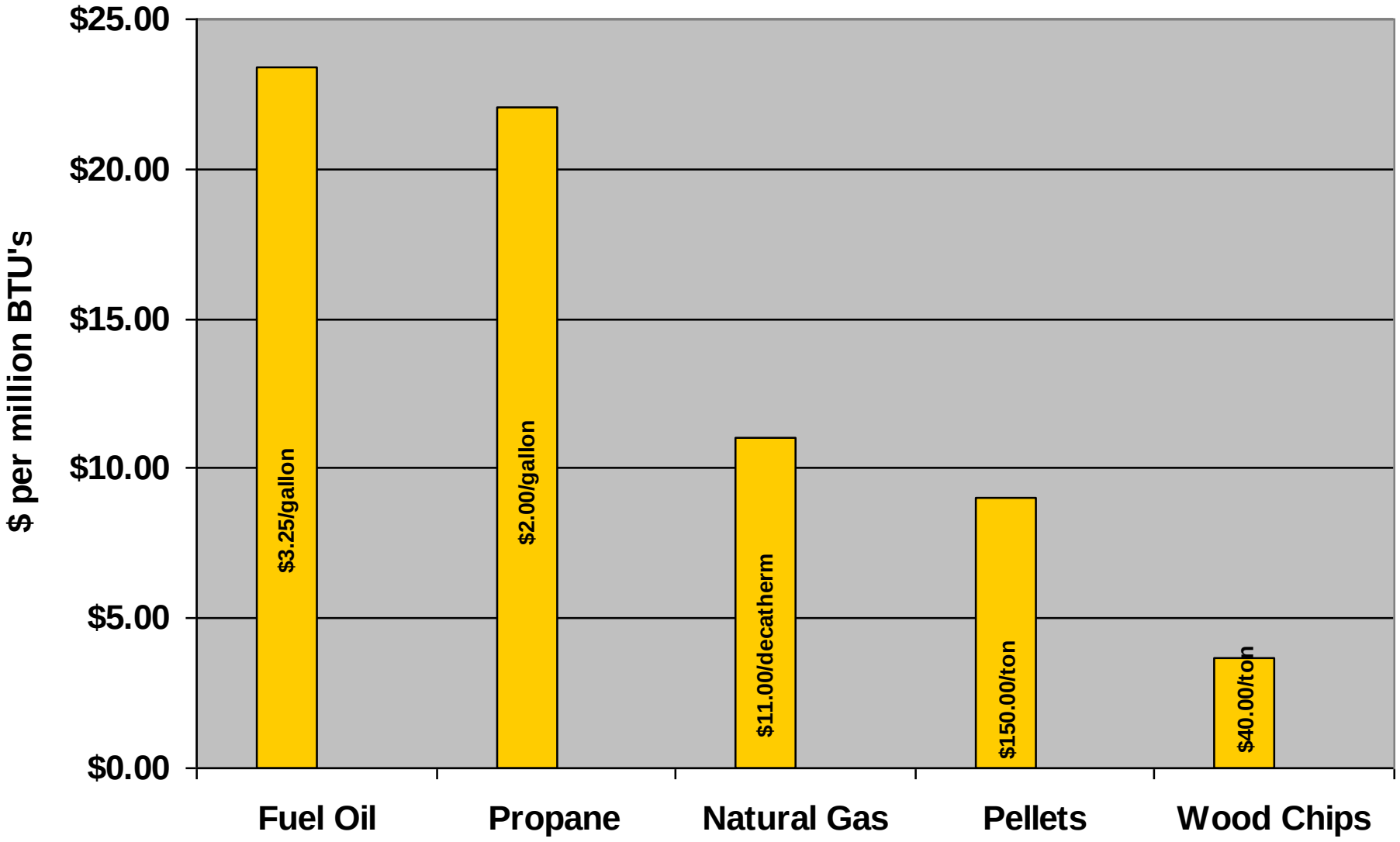
Darby, MT – 4+ yr

# District Energy

- **Universities**
  - U of Idaho
  - Northwestern Missouri State
  - Chadron State College, NE
  - U of So. Carolina
  - UM Western, Dillon MT
  - Middlebury College
  - University of Montana???
- **Communities**
  - St. Paul, MN – 80+% wood fired
    - 31 mill sq ft heat
    - 21 mill sq ft of cooling
    - 25 MW of electricity



# Fuel Cost Comparison



# Automated Facility

Darby, MT

# Darby, MT



Offset Fuel Oil

Saved $140k

# Pellet Systems

- Fuel is twice as costly
- Storage smaller, cheaper
- Boiler smaller, cheaper

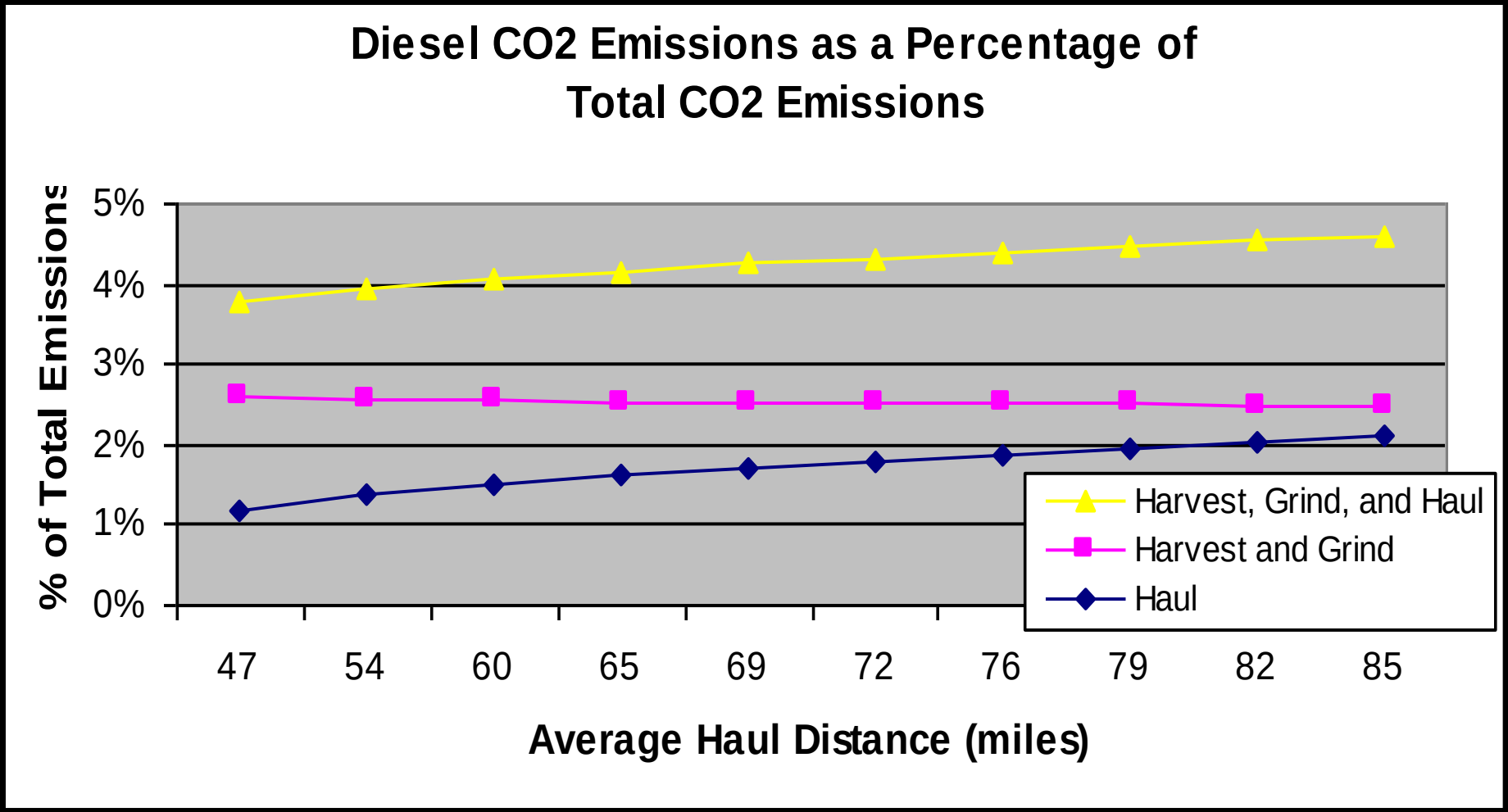

Tarm

170 k btu system

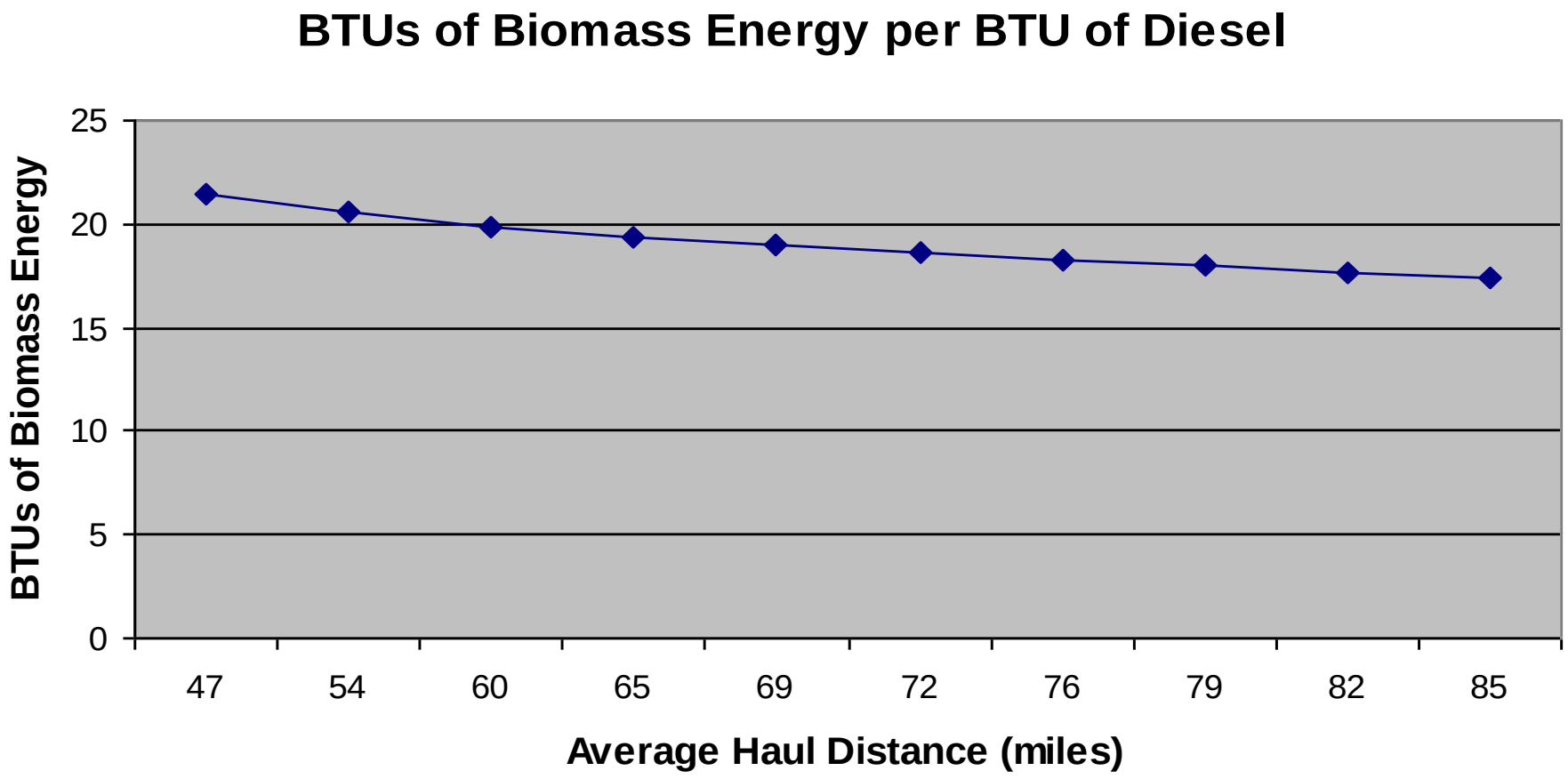
# Pellet Systems

- Solagen
- 750k btu/hr
- Utility grade pellets

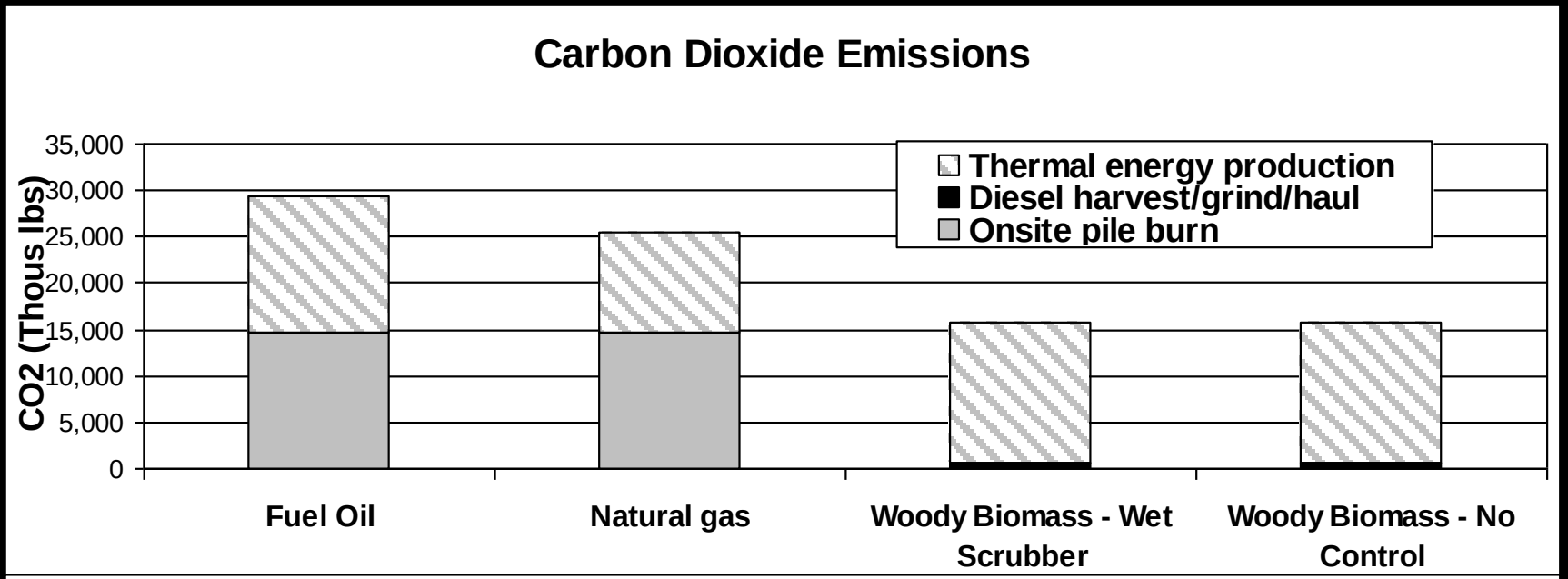
# Affect of Haul Distance on Carbon Dioxide (CO2) Emissions

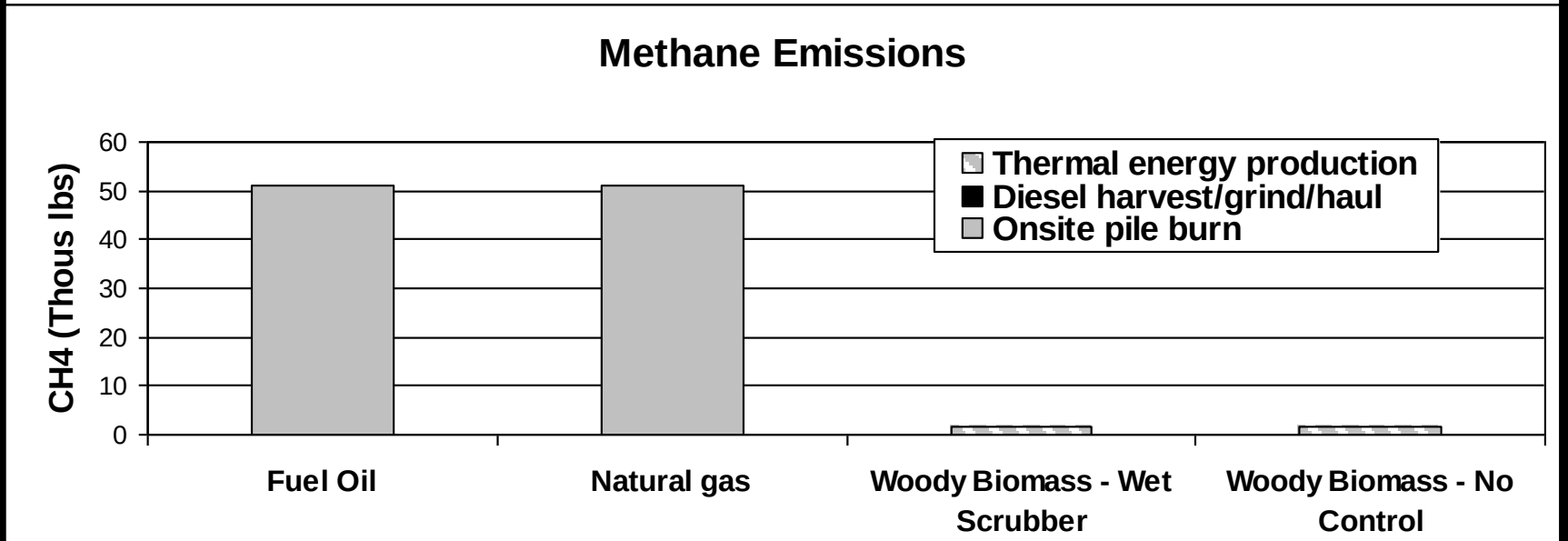


# Biomass Energy Return



# GHG Emissions per 1,000 Acres Treated



# Mechanical Treatment Study

- Partners – GNF, KNF, Research (SRS, RMRS,San Dimas), S&PF, Industry, UM, INL
- Research Goals
  - Cost-production/ac treatment comparison
  - Soils – nutrients, disturbance, compaction compared to wildfire
  - Energy source – Millions of BTU's
- Hebgen L. project underway
- Lower Pinkham – Eureka RD this winter

# Dump at Central Location

Slash Collection Report

Accumulation Yard

Moisture management



www.fuelsforschools.org click on new information

# “Canned Wood” - Forwarders

Fire Hazard & Bark Beetle Hazard Thinning Project

Slash, Pile and Burn or Pay to Thin Remove and Utilize

Before

After

# Where from Here?

- Does intervention management of forests fit your dogma?
- How do we manage wilderness?
- How do we connect with interest groups?
- How do we have the hard choice discussions w/o falling into old ‘timber war’ mentality?

# Take Home Message

- **Renewable energy:** transportation, thermal, electrical, conservation (embodied)
- Carbon Neutral/Negative
- It's Economical
- Co-Benefits:
  - Reduce smoke, Water filtration/ storage, Biodiversity, Recreation
- Partnerships – common vision
- Forests are green! Sustainability!