

# Bioenergy & Alternative Fuels

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November 25, 2008

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The screenshot shows a Google search interface with the query 'biomass puns'. The search results are displayed under the 'Web' tab, showing the first 10 results. The first result is titled 'Notes from the biomass » Blog Archive » Great puns' and is dated July 16th, 2006. The second result is titled 'Notes from the biomass » Blog Archive » re' and is dated July 15th, 2006. The third result is titled 'Assuming a 50% cell occupancy of the lorica overestimates ...' and is dated 1989. The fourth result is titled 'Benthic and pelagic fish biomass of the upper continental slope ...' and is dated 1989.

Google   [Advanced Search](#)  
[Preferences](#)

Web [Books](#) Results 1 - 10 of about 35,800 for [biomass puns](#) (0.17 seconds)

[Notes from the biomass » Blog Archive » Great puns](#)  
Notes from the **biomass**. Horizontal meme transfer ... Great puns. Posted on July 16th, 2006 by Roland Krause in Miscellaneous ...  
[nftb.net/?p=16](#) - 12k - [Cached](#) - [Similar pages](#)

[Notes from the biomass » Blog Archive » re](#)  
I used the weekend to set up Notes from the **biomass** at this site and move ... Notes from the **biomass** » [Blog Archive](#) » The night is short and so are we on ...  
[nftb.net/?p=15](#) - 13k - [Cached](#) - [Similar pages](#)  
[More results from nftb.net »](#)

[Assuming a 50% cell occupancy of the lorica overestimates ...](#)  
To estimate **biomass** and production, the cell volume of tintinnine ciliates has been assumed to be .... [PuNs natn. Inst. Oceanog., Paranjape, M. \(1987\)](#). ...  
[www.springerlink.com/index/U2184250V224Q5J7.pdf](#) - [Similar pages](#)  
by GL Gilron - 1989 - [Cited by 14](#) - [Related articles](#) - [All 3 versions](#)

[Benthic and pelagic fish biomass of the upper continental slope ...](#)  
to verify species composition) to estimate **biomass** (e.g. .... [PuNs Can. Fish. aquat. Sciences](#) 58:229-246. Harden Jones, F. R., Arnold, G. P. (1982) ...  
[www.springerlink.com/index/U760462163T7N12T.pdf](#) - [Similar pages](#)  
by JL May - 1989 - [Cited by 31](#) - [Related articles](#) - [All 3 versions](#)

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# 时势造英雄

May you live in interesting times...

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## Light Crude Oil (NYMEX)

10/31/2008 C=67.81 -32.83 O=99.05 H=100.00 L=62.45 Mov Avg 3 lines

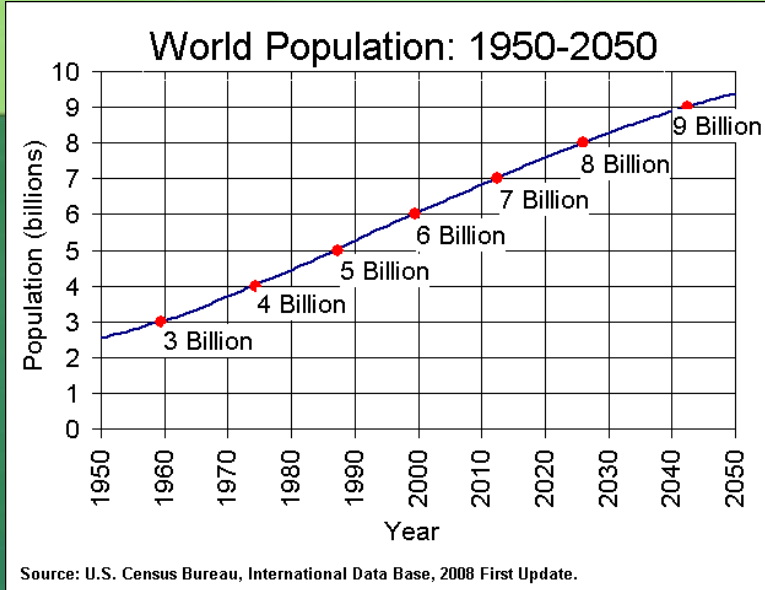
Volume 9636113.00 Open Interest 889745.00

Created with SuperCharts by Omega Research © 1997

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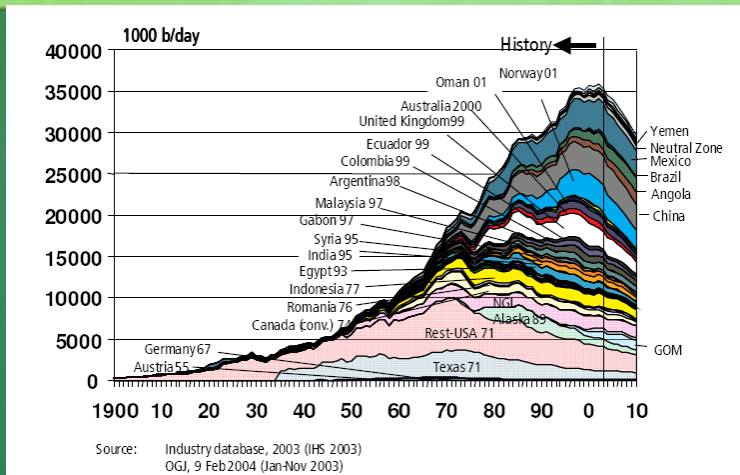


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## Peak Oil?

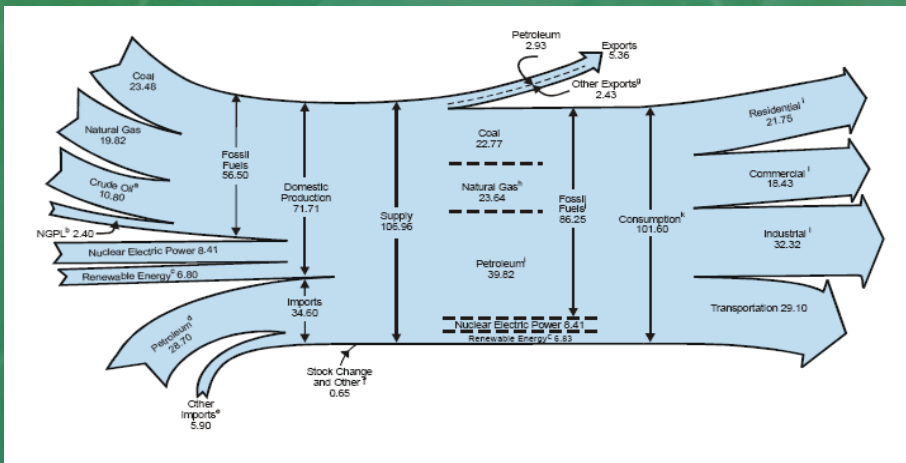


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# US Energy Flow in Quads

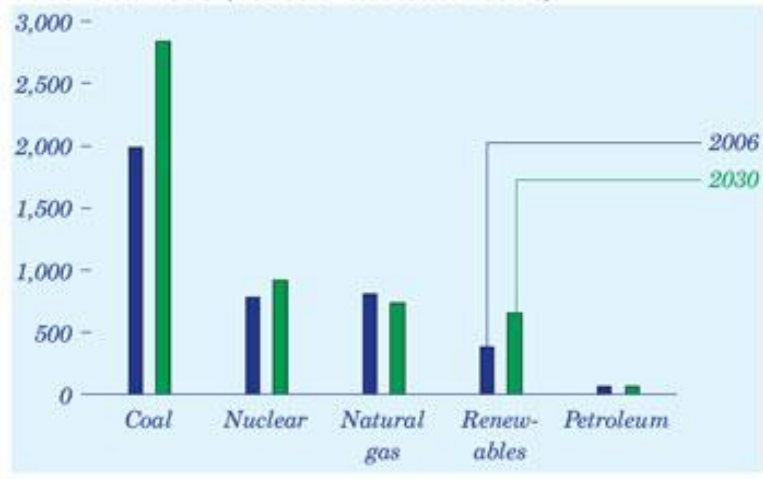


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**Figure 61. Electricity generation by fuel, 2006 and 2030 (billion kilowatthours)**

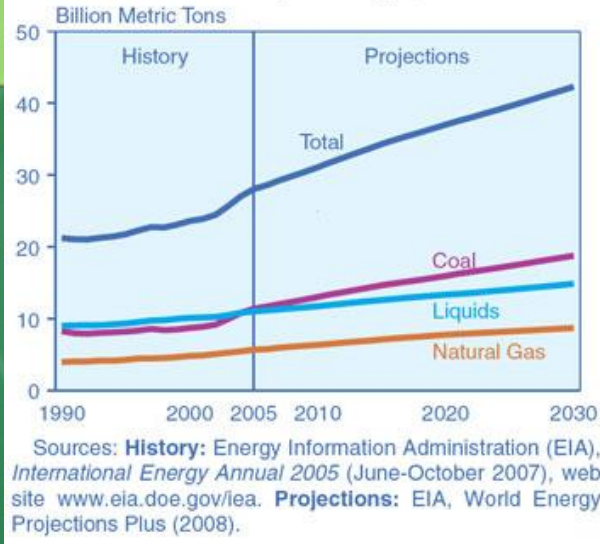


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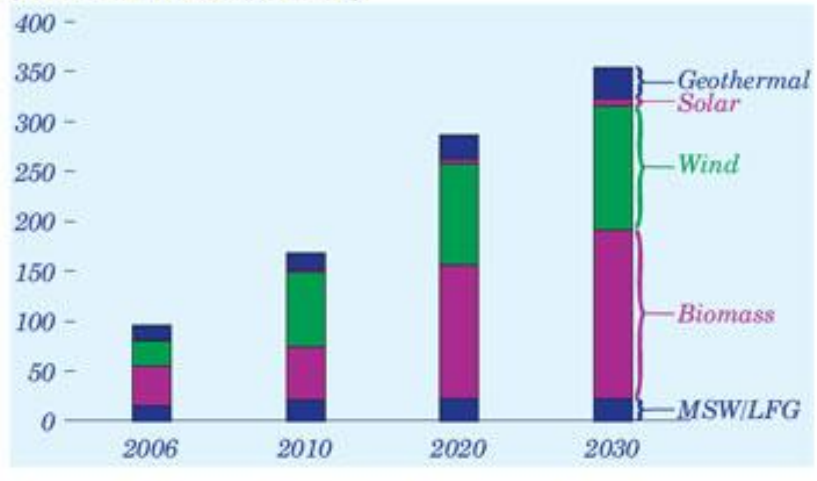
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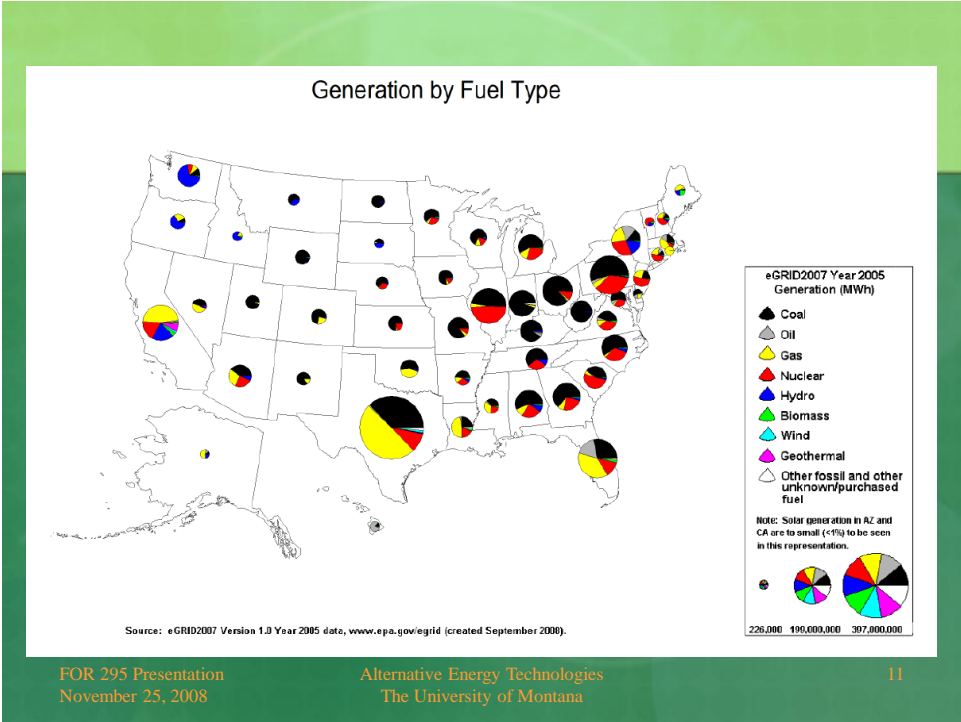
8

**Figure 76. World Energy-Related Carbon Dioxide Emissions by Fuel Type, 1990-2030**



**Figure 66. Nonhydroelectric renewable electricity generation by energy source, 2006-2030 (billion kilowatthours)**





# Terminology

- Renewable
- Sustainable
- Alternative

## Biomass Definition

- Any renewable organic matter such as agricultural crops, crop-waste residues, wood, animal and municipal wastes, aquatic plants and fungal growth used for the production of energy.



## Biomass Utilization

- Biopower
- Biofuels
  - Ethanol
  - Methanol
  - Biodiesel
  - Methane
  - Producer gas
- Bioproducts – lubes, composites

## The Promise of Biomass

- Renewable
- Abundant
- Carbon Neutral
- Diffuse
- Global
- Helps Agriculture, Forest
- Multiuse
  - Food
  - Shelter
  - Energy
  - Materials



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## The Problem with Biomass

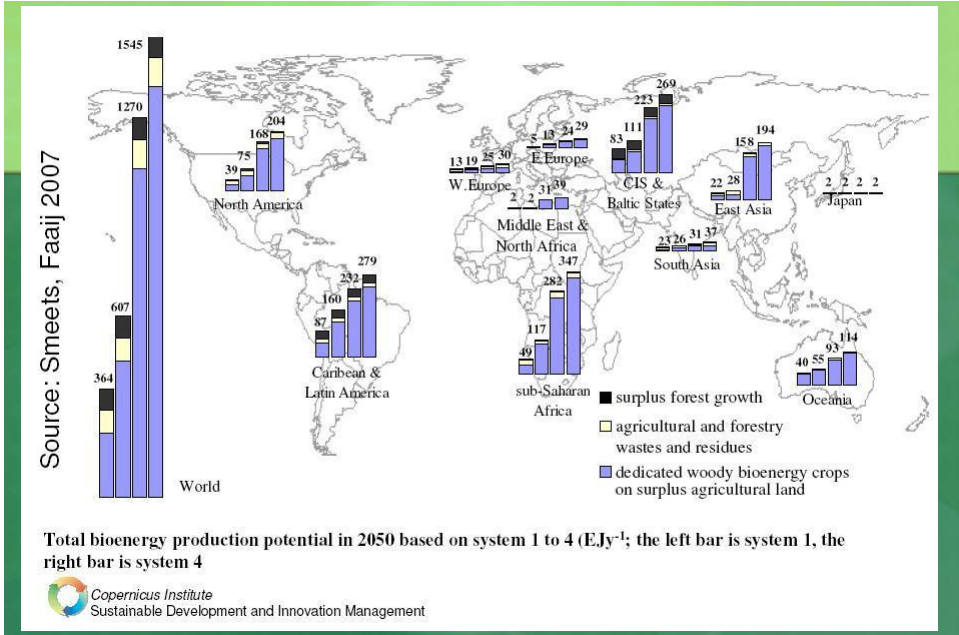
- Costly to gather
- Low energy density
- Low physical density
- Moisture content
- Costly to transport
- Additional processing
- Arable land competition
- Water resources
- Fuel vs. feed
- Deforestation

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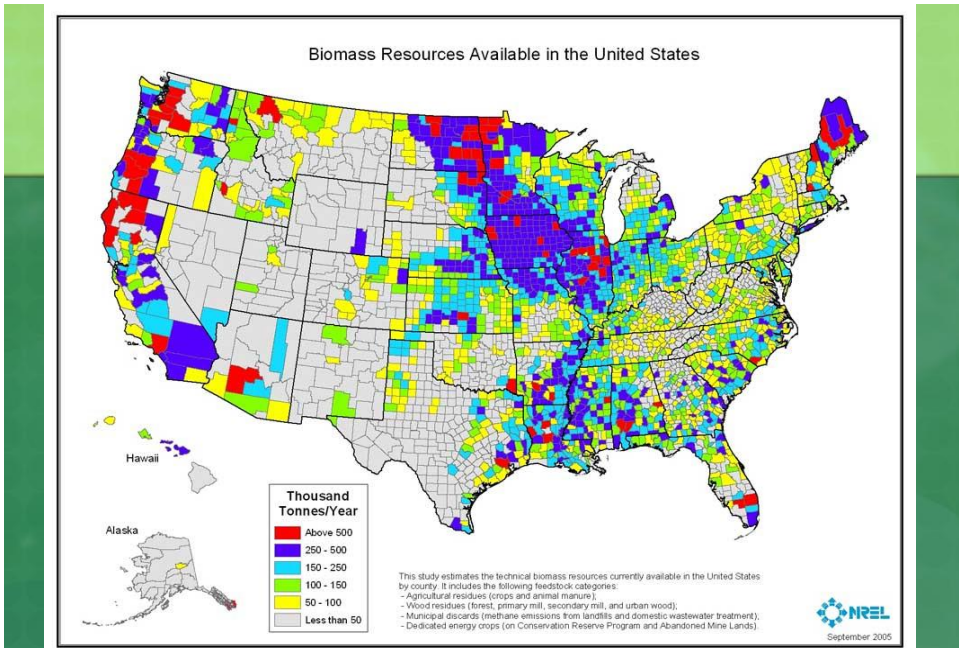




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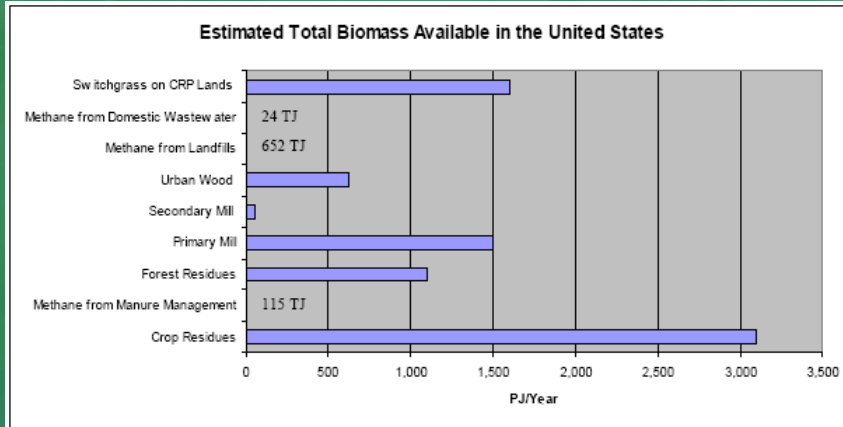


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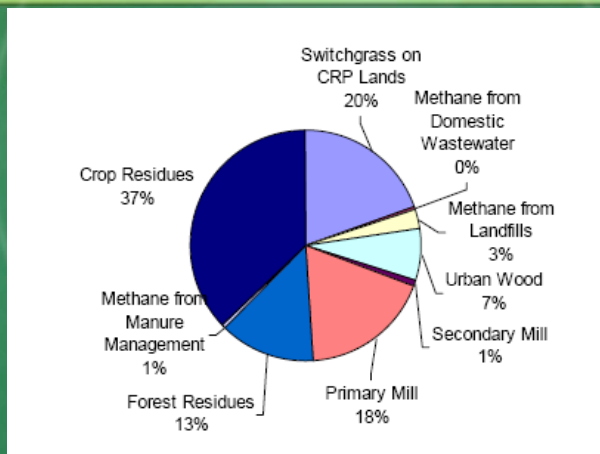
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# US Annual Biomass Potential



# Feedstock Breakout

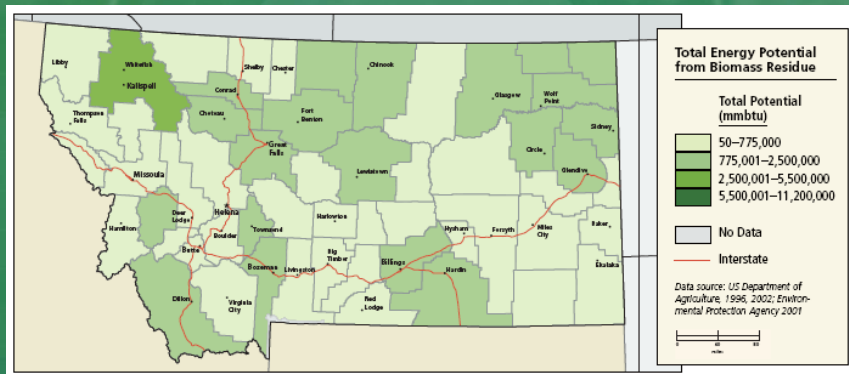


# US Installed Biomass Generation

Type of Biomass	Number of Installations	Capacity, MW
Wood	259	5,332
Pulping Liquor	6	443
Bagasse and Other Agricultural Residue	39	669
Digester Gas	61	112
Landfill Gas	174	583
Tires	3	69
Total (Above + Other Sources)	678	10,006

Source: Adapted From Table 5-2 T.C. Schweizer, et al., EPRI Report No. TR-111893 (1998).

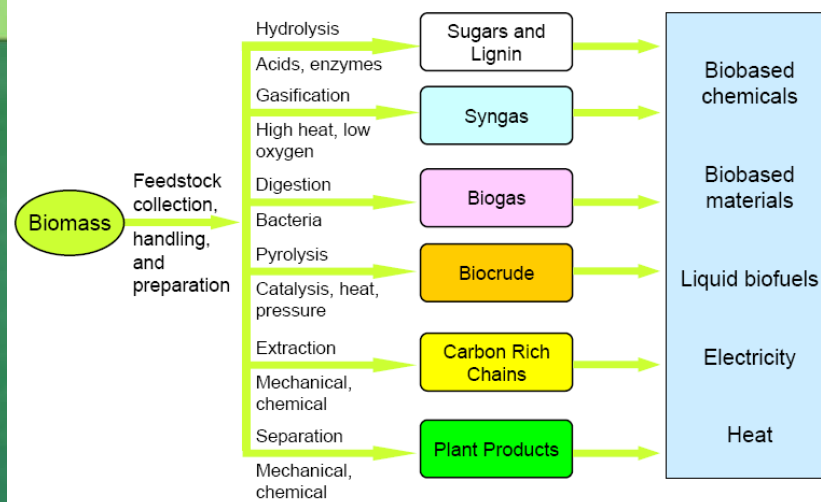
# Montana Biomass Resource



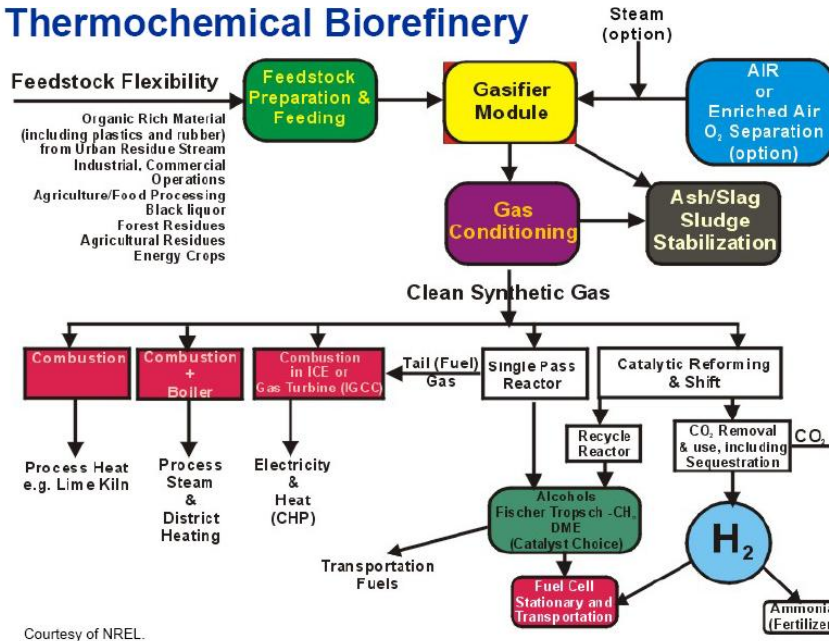
# Criteria for Biomass Development

- Residues/wastes utilized
- Does not compete with food/feed
- Energy crops on unused or marginal lands
- Minimizes or eliminates resources
  - Irrigation, tilling, pesticides, herbicides
- Regionally produced and consumed

## Biorefinery “Platforms”



## Thermochemical Biorefinery



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## Bio-Ethanol Debate

“Ethanol fuel from corn faulted as 'unsustainable subsidized food burning' in analysis by Cornell scientist”

Cornell News Headline, 8/16/2001

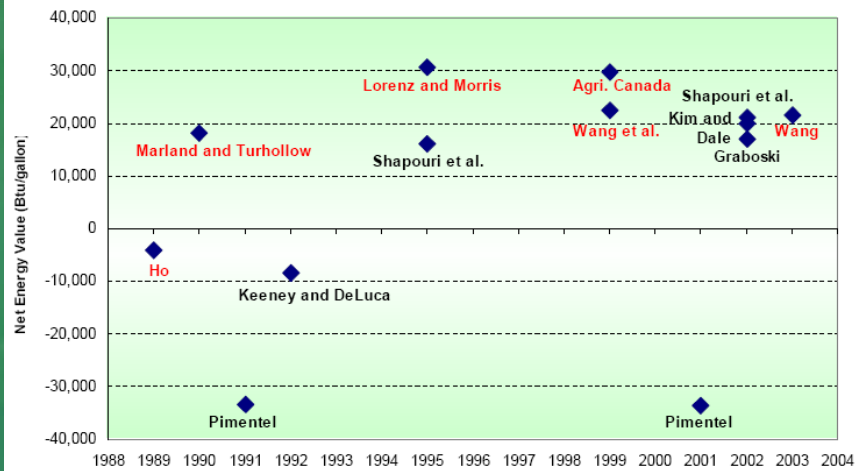
- Author: David Pimentel
- Current studies estimate 25% to 35% more energy derived than invested.

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# Ethanol Energy Balance



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# Ethanol Summary

Authors and Date	NEV [Btu]
Pimentel (1991)	-33,517
Pimentel (2001)	-33,562
Keeney and DeLuca (1992)	-8,438
Marland and Turhollow (1990)	18,154
Lorenz and Morris (1995)	30,589
Ho (1989)	-4,000
Agri. and Agri-Food, CAN (1999)	29,826
Wang et al. (1999)	22,500
Shapouri et al. (1995)	20,436
Kim and Dale (2002)	23,886 – 35,463

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## Pimentel Critique

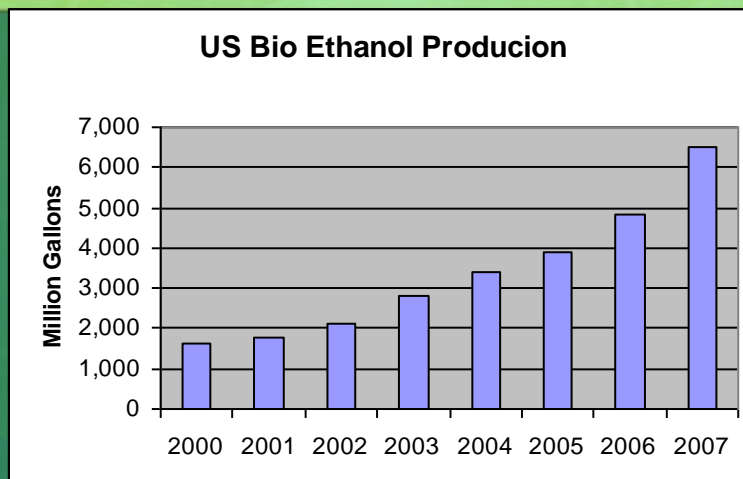
- His corn yields date from pre-1992
- His value for energy required to produce ethanol and the ethanol yield date from pre-1980
- His figures for energy to produce fertilizer are 1990 world-wide values, not recent U.S. values
- He assumes all corn is irrigated (only 16% is)
  - virtually no irrigated corn is converted to ethanol
- He does not properly assign an energy credit for the high protein DDGS co-product

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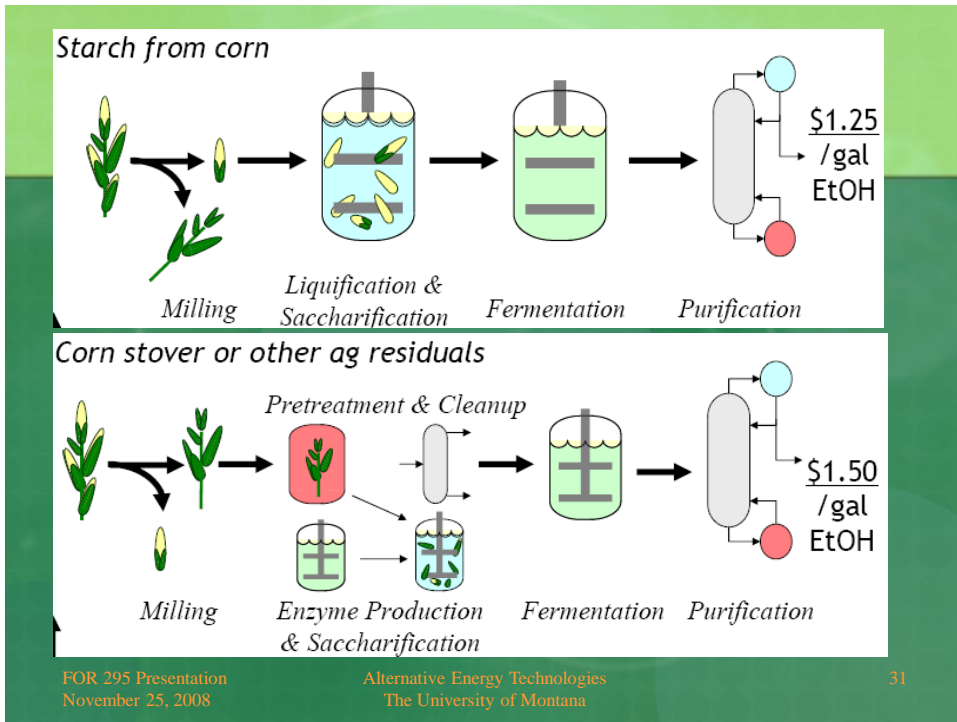
## US Ethanol Capacity



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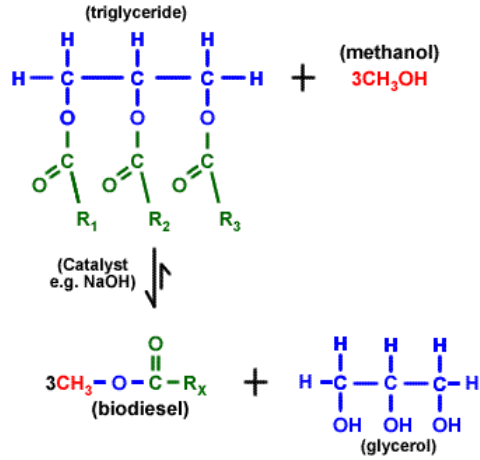


## Biodiesel Facts

- Lower energy content than Diesel
  - Biodiesel: 118,296 BTUs per gallon
  - No. 2 Diesel: 129,500 BTUs per gallon
    - Source National Biodiesel Board
- Energy Lifecycle
  - 3.2 units of energy are produced for each energy unit used
    - Source NREL



# The Chemistry

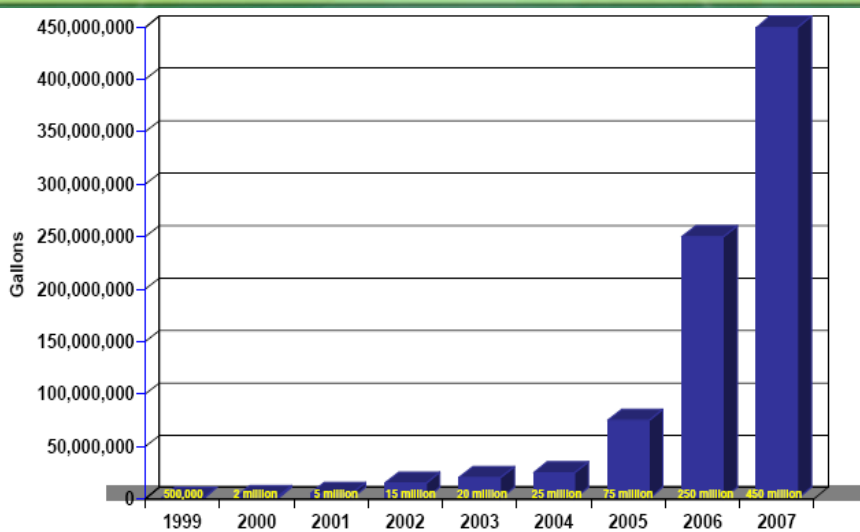


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## US Bio Diesel Production



## Climate Choice

*Advancing technologies that protect the climate*

**Technologies** | [About Climate Choice](#) | [How to Participate](#) |  
[Program Benefits](#) | [Nominate a Technology](#) | [Home](#)

### Technologies

In March 2008, EPA announced its first three climate choice technologies:

Micro-Combined Heat and Power (CHP) for residential homes. By generating heat and electricity for the home, this technology reduces greenhouse gas emissions and electricity demand. [Learn more about Micro CHP.](#)

High-efficiency outdoor area lighting. Advances in outdoor area lighting offer substantial energy savings and reduced maintenance. [Learn more about high-efficiency outdoor area lighting.](#)

Advanced new home construction: a technology package to minimize carbon emissions from newly constructed houses. [Learn more about advanced new home construction.](#)

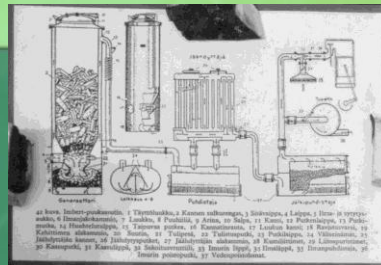
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# Downdraft Gasification

- 1<sup>st</sup> explored in late 1600's
- Used in WWII by Swedes & Germans
- Updated technology
  - Computerized
  - Advanced process control
- Combined heat & power
- Modular & portable
- Scalable: 5 – 50 kW



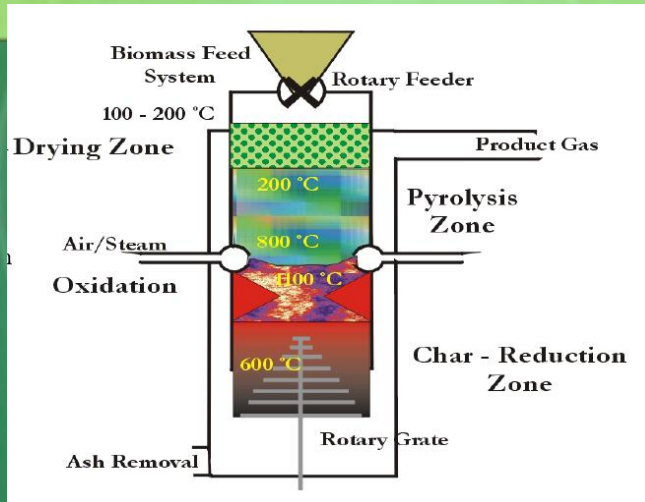
Bus, Germany

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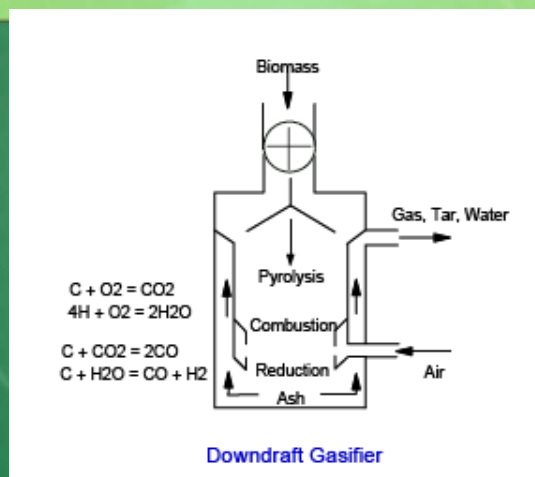
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# Gasifier Schematic



# Gasifier Chemistry





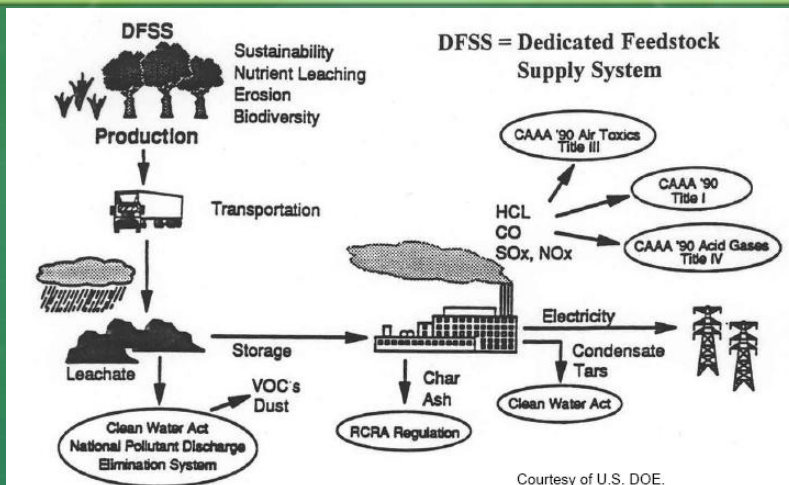
Gainesville, Florida, 1981. The tiny generator that powers this wood-burning motorcycle was constructed at the University of Florida out of a fire-extinguisher casing. The vehicle gets 70 km per kg of wood (20 miles per lb). (Glow Photo by Barbara Hansen)



Germany, about 1943. Mass production of gas-powered vehicles, Inlet factory, where some 150,000 gas-powered were manufactured during World War II. (U. S. Donath)



# Biomass & the Environment



Courtesy of U.S. DOE.

## Other Alternative Fuels

- Natural gas
- Propane, lpg
- Hybrid
- Hydrogen
- Electric
- Compressed air

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## Hydrogen



- Hydrogen safety
- ICE vs Fuel Cell
- Storage
- Water is exhaust

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## Electric

- Speed, range, charging
- Batteries



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## Compressed Air

- 68 mph
- 125 mile range
- 5 minute refill
- On-board compressor
- 5000 psi
- \$13,000
- India 2009



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## Conventional Mass Transit

- Massive Costs
  - 10 to 100's million \$
- Limited coverage
- Schedule
- Frequent stops
- Often crowded
- Inconvenient
- High maintenance & operating costs



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## Personal Rapid Transport



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## Summary

- Biomass has vast potential and will play an increasing role in the new energy paradigm
- Focus should be on utilizing residues and marginal lands
- Bio ethanol has a positive energy balance
- Biofuels improve environment, economy, and national security

## 时势造英雄

- May you live in interesting times...
- May you come to the attention of the authorities
- May you find what you are looking for