Bio-energy options in Europe

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BIO-ENERGY
ENLARGED PERSPECTIVES

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Issues to be addressed

- Biofuels and bioenergy potential
  - Fuel properties
  - Global and regional potential
- Conversion to end-use energy
  - Small and medium scale heat production
  - Combined heat & power plants
  - Liquid fuels for transportation and power
- Environment
  - Clean combustion, “sustainability”
  - Greenhouse gas balance
- Economy
  - Competition: Energy and materials market
  - Secondary benefits

Basic data on bioenergy

- Potential (EJ/a)
  - Energy equivalent of NPP (60 GtC/a): 2300
  - World fossil fuel consumption 2001: 338
- Calorific value (MJ/kg)
  - Biomass (0% w): 17 - 20
  - Biomass (20% w): 13 - 15
  - Biomass (60% w): 5 - 7
  - Coal: 25 - 30
  - Lignite: 12 - 15

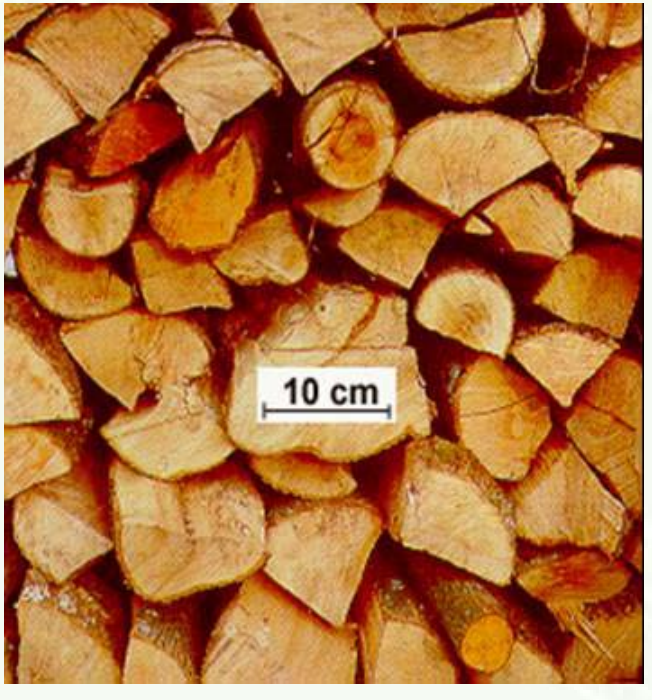
Current use and future potential of bioenergy

- **Current use: 50 EJ/a of 440 EJ/a total world energy consumption (2001)**
- **Future potential (EJ/a)**

	Year		
Scenario	**2025**	**2050**	**2100**
Shell (1996)	85	200–220	
IPCC (1996)	72	280	320
Greenpeace (1993)	114	181	
Johansson et al. (1993)	145	206	
WEC (1993)	59	94–157	132–215
Dessus et al. (1992)	135		
Lashof & Tirpak (1991)	130	215	
Fischer & Schrattenholzer (2001)		350 – 450	

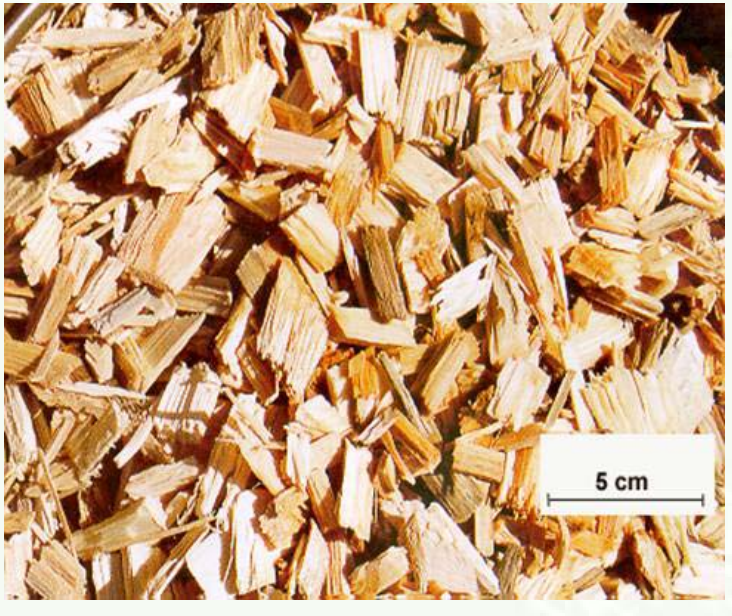
Solid biofuels from lignocellulosics (1)

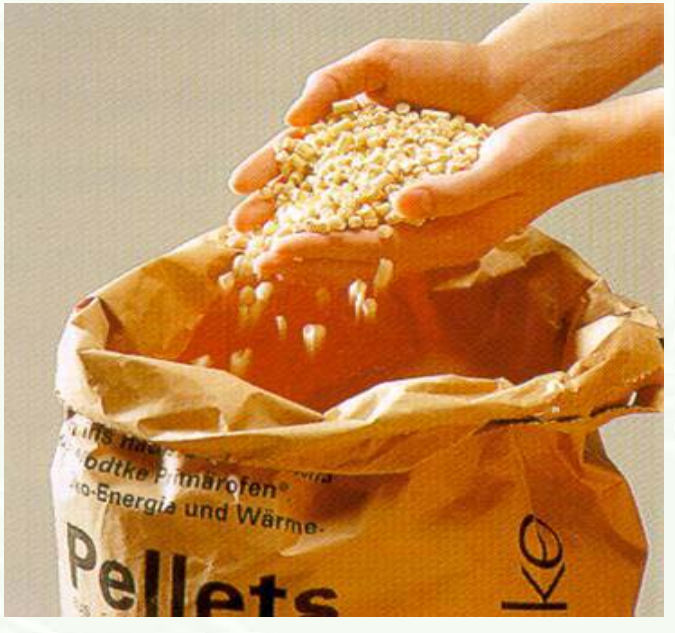
log wood and wood briquettes



Solid biofuels from lignocellulosics (2)

Wood chips and wood pellets





Agricultural crops for liquid biofuels

Courtesy: BLT Austria

Agricultural dedicated crops for biofuels

Courtesy: SLU, Sweden

Fuel wood resource and consumption in European countries (PJ/a)

	Austria	Finland	France	Portugal	Sweden
Resource	230	350	540	70	470
Consum-ption 1995	122	94	338	36	177
Additio-nal use 2010[1]	59/103	55/116	120/168	24/34	81/202

[1] moderate/high scenario

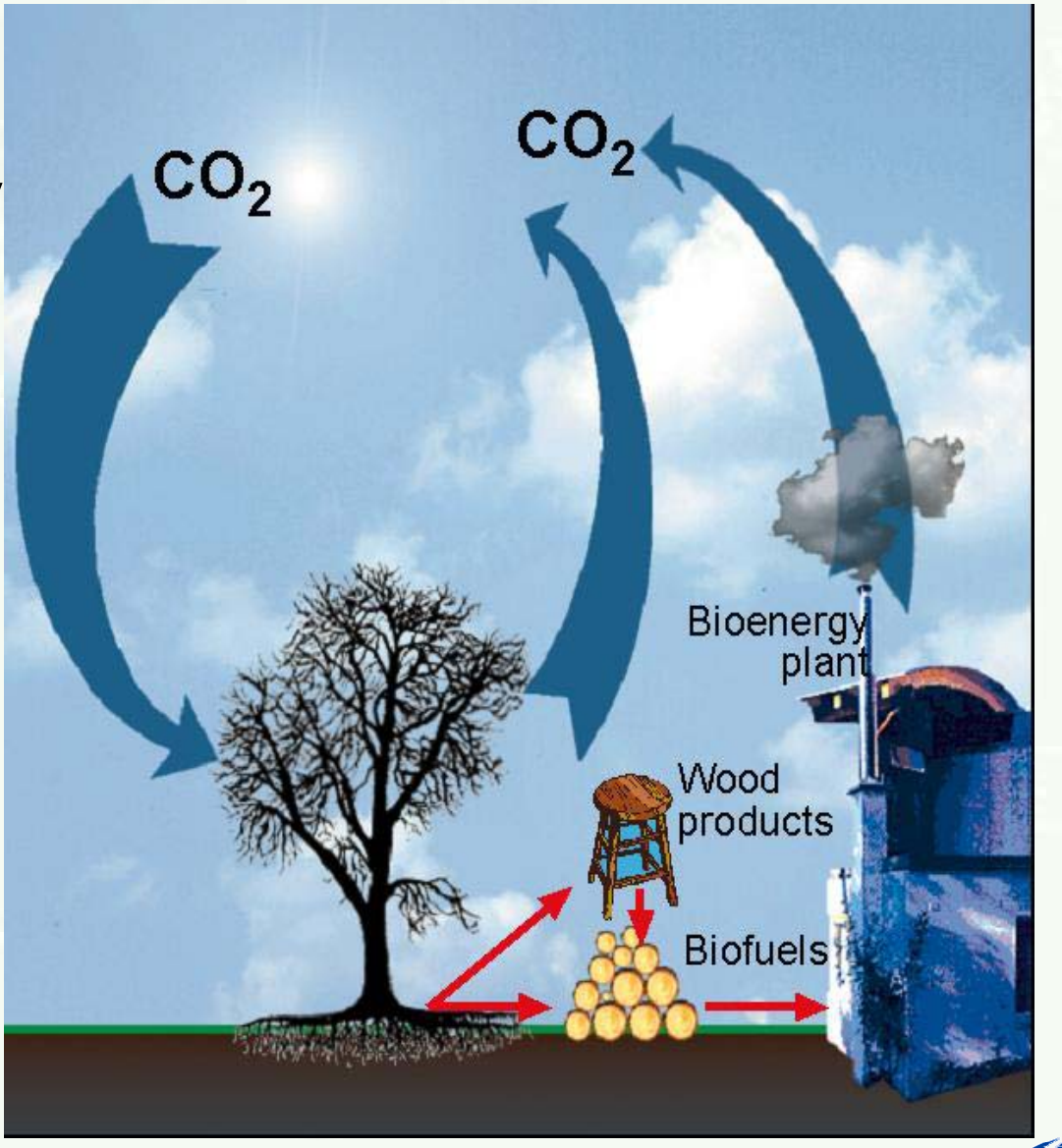
Bioenergy conversion processes to produce end-use energy: electricity, heat, fuels

- Combustion
  - heat
  - electricity
- Gasification (thermal, anaerobic)
  - electricity
  - heat
- Liquefaction (biodiesel, ethanol, bio-oil, syn-fuels)
  - transportation fuels
  - electricity

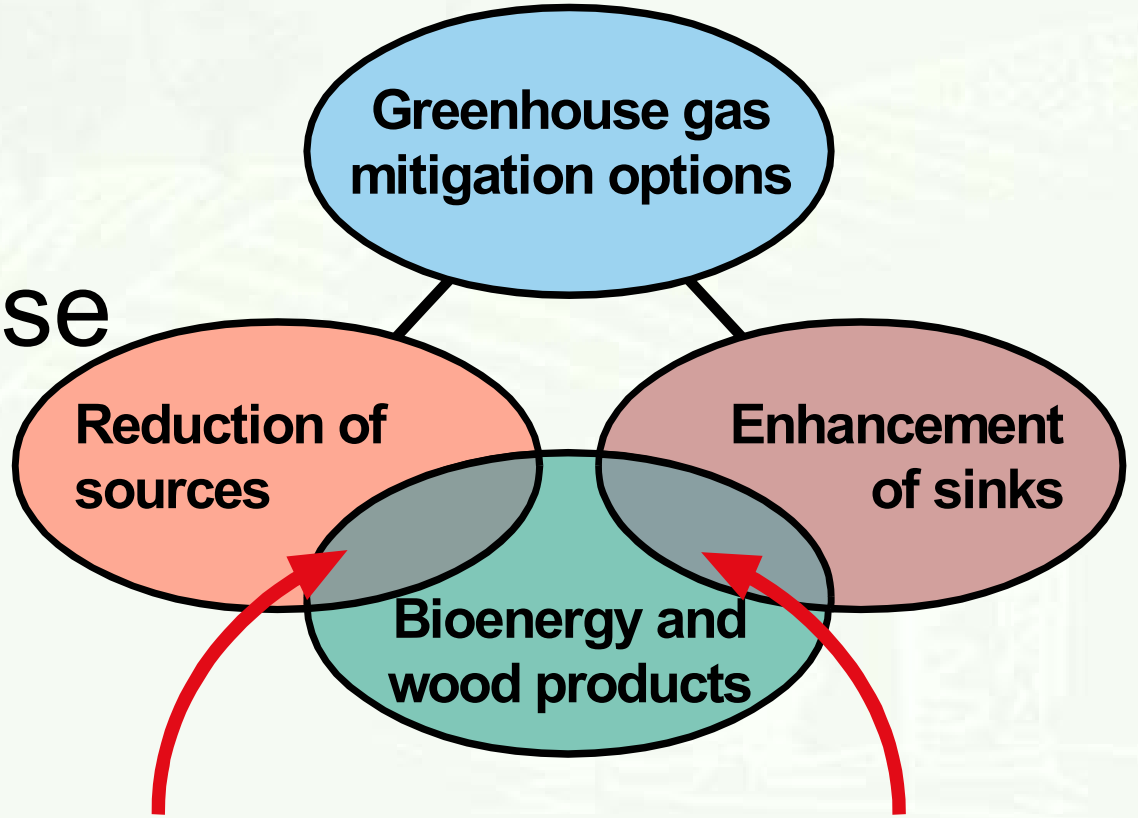
Bioenergy and the environment

- "Standard" emissions: CO, NO_x, C_xH_y, part.
  - Feedstock production, conversion
  - Need for further reduction
- Greenhouse gas emissions: CO_2, CH_4, N_2O, …
  - CO_2: neutral
  - CH_4: benefits
  - N_2O: if fertilized production
- Sustainability
  - Nutrient recycling
  - Avoid stock changes

Bioenergy and the carbon cycle



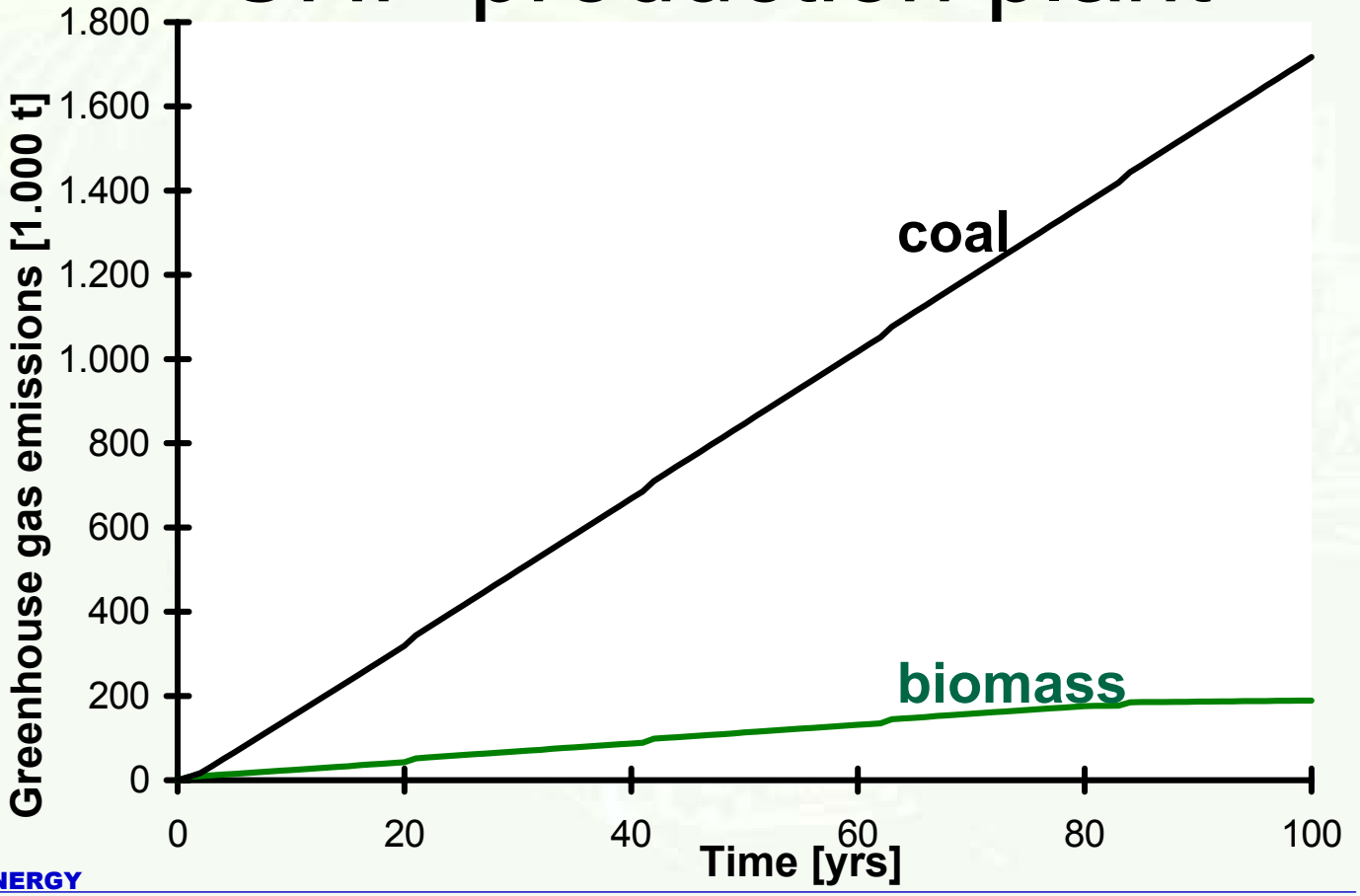
Biomass and greenhouse gas mitigation



- Fossil fuel substitution
- Product substitution
- etc.

- Afforestation and harvest
- Durable wood products
- etc.

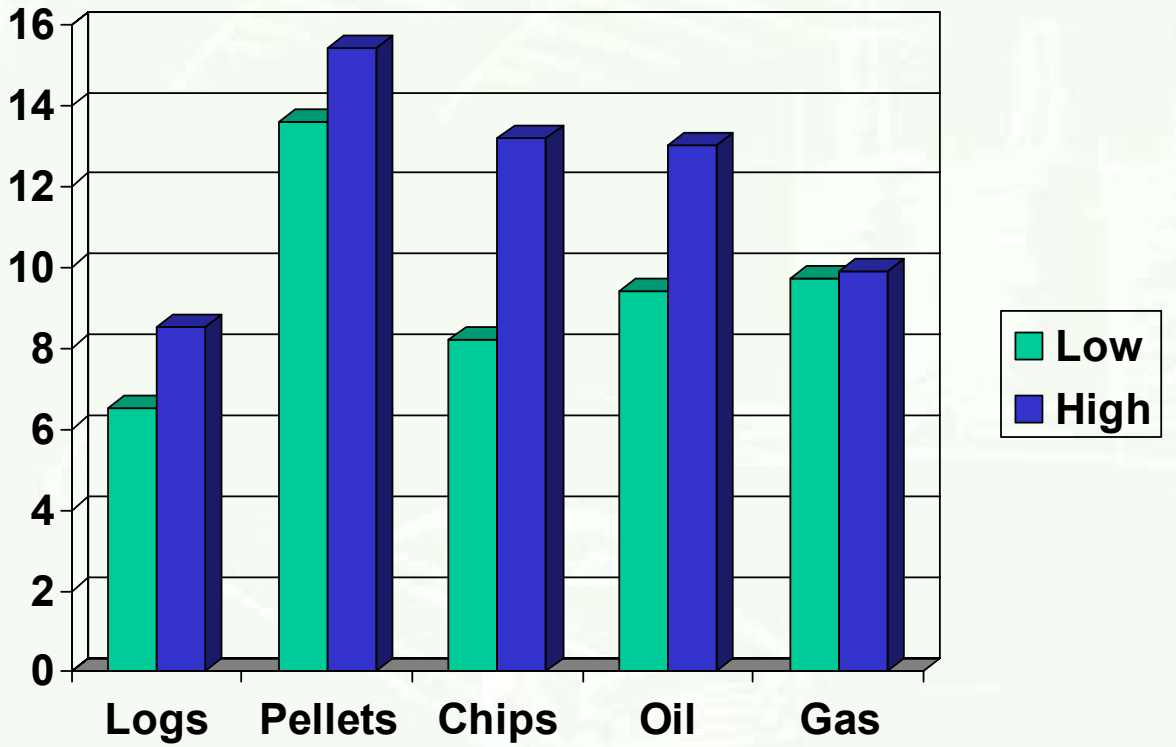
Cumulative greenhouse gas emissions of a 10 MW_{el} CHP production plant



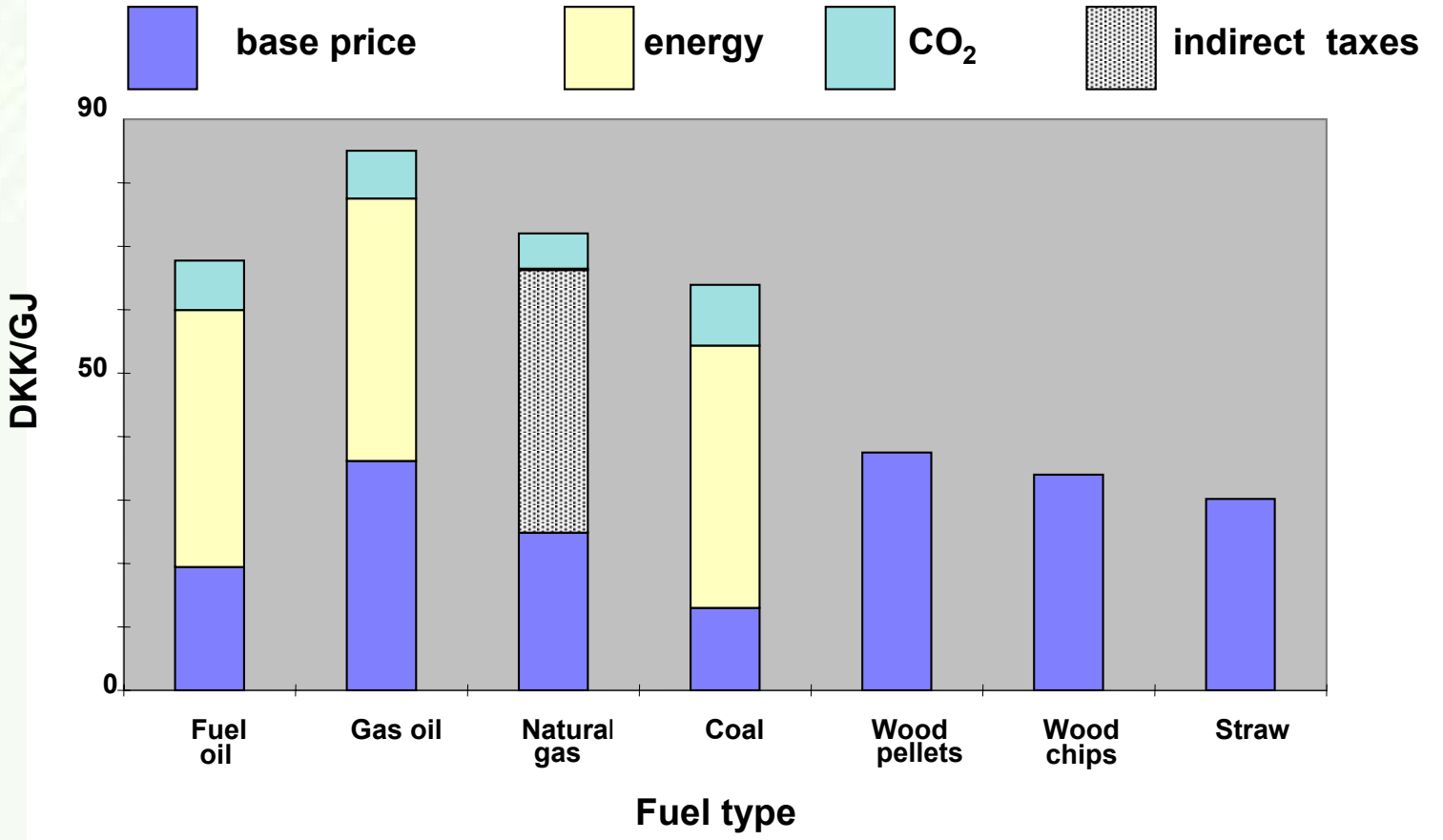
Economy of bioenergy

- "Internal" cost of end-use energy
  - Feedstock market: competition with non-energy market (food/feed, products)
  - Complex conversion systems
  - Generally higher than fossil energy cost
- "External" effects
  - Domestic added value
  - Greenhouse gas credits
- Internalisation not yet achieved
  - "Directives", feed-in tariffs, subsidies: limited
  - Carbon tax based on external cost comparison

Cost of heat from a 15 kW boiler with biomass and fossil fuels (€c/kWh, 2002)



Energy prices in Denmark
Source: dk Technik



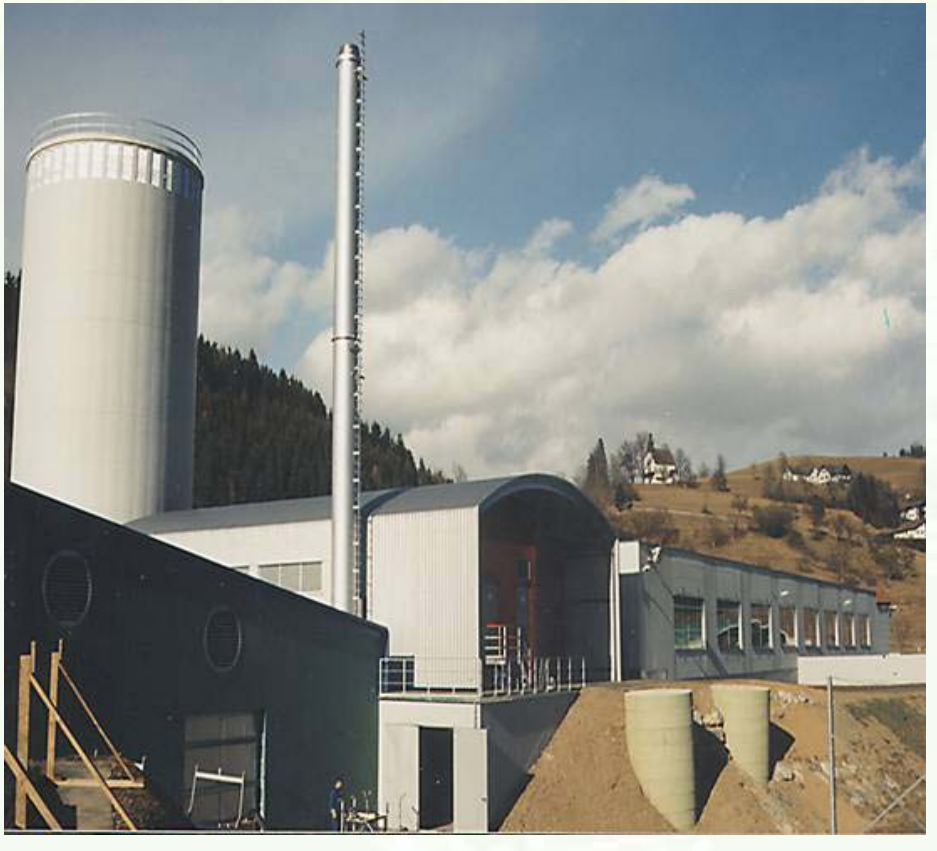
Conclusions

- The current global use of bioenergy of approximately 50 EJ/a may be increased by a factor of two to three, agricultural biomass will play an increasing role
- Bioenergy is an effective and perpetual option for reducing greenhouse gas emissions and resolves critical issues of carbon sink options
- Additional benefits are creation of employment in rural areas, opportunities for SME and new markets for agricultural production
- The exploitation of the potential primarily depends on policy actions based on “external benefits” rather than on technology development

Fireplace and wood pellet boiler

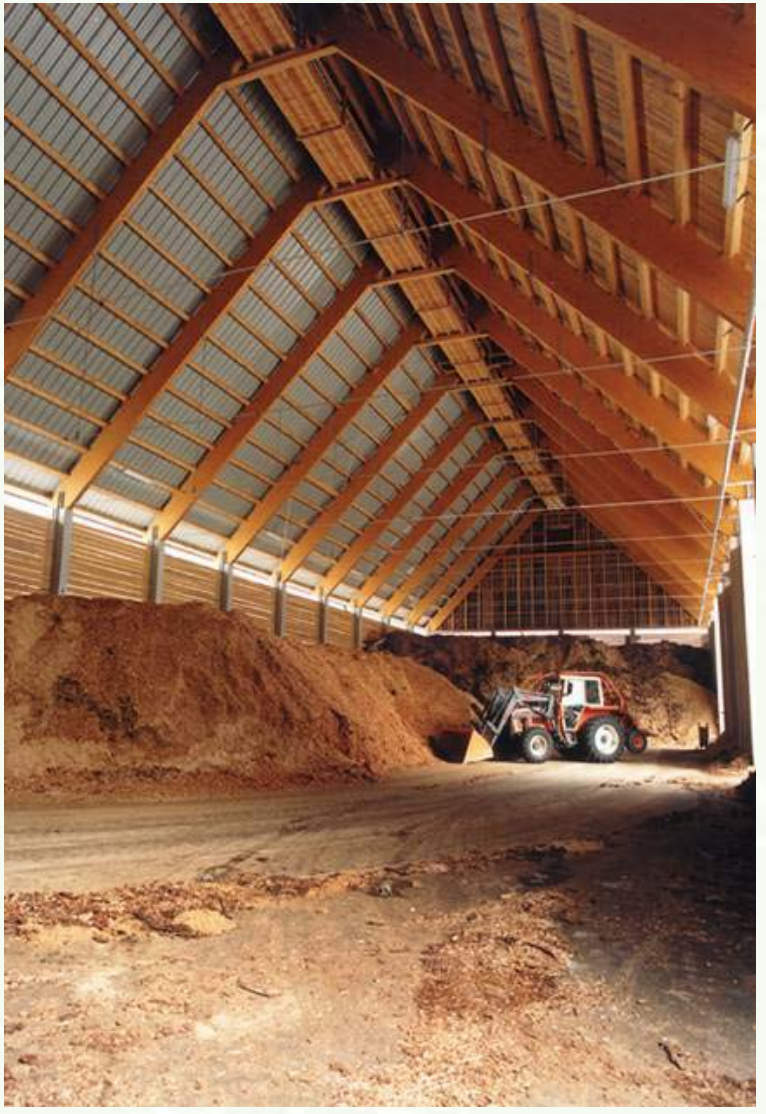
Courtesy: RIKA, Herz, Austria

Biomass heating plant
Passail, Austria



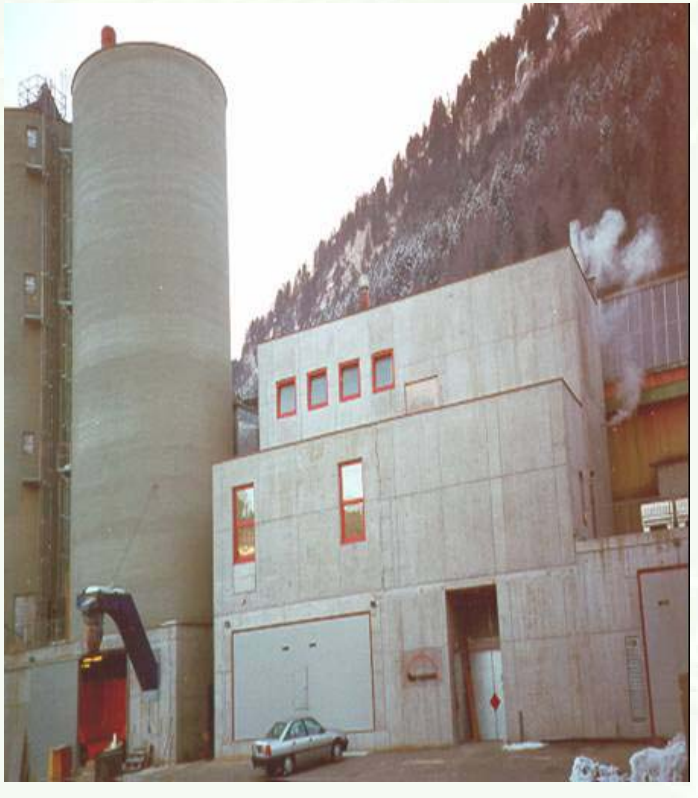
Courtesy: LEV Austria

Wood chip store



Courtesy: LEV Austria

Steam cycle CHP plant
VKW Austria



- **6.3 MW district heat:**
- 29 GWh/yr
- **1.3 MW grid electricity:**
- 4.7 GWh/yr
- **Biomass input:**
- 10.000 t/yr

Courtesy: VKW Austria

Integrated gasification combined cycle power plant

Värnamo, Sweden

Fluidized bed steam gasification with 2 MW_{el} gas engine

Güssing, Austria

Courtesy: RENET Austria

Flash pyrolysis plant

VTT Finland