

# **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

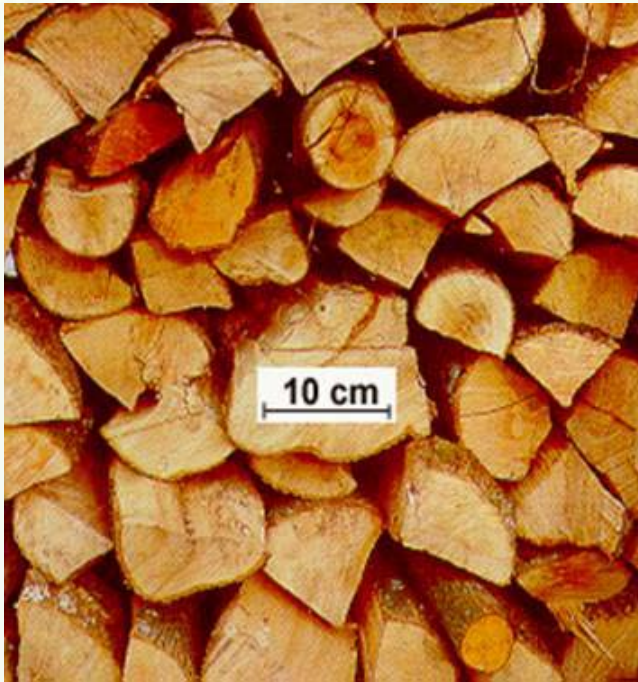
# Current use and future potential of bioenergy

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

<b>Scenario</b>	<b>Year</b>		
	<b>2025</b>	<b>2050</b>	<b>2100</b>
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 & Schratzenholzer (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



# Agricultural dedicated crops for biofuels



Courtesy: SLU, Sweden



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

	Austria	Finland	France	Portugal	Sweden
<b>Resource</b>	230	350	540	70	470
<b>Consumption 1995</b>	122	94	338	36	177
<b>Additional use 2010<sup>1</sup></b>	59/103	55/116	120/168	24/34	81/202

<sup>1</sup> moderate/high scenario

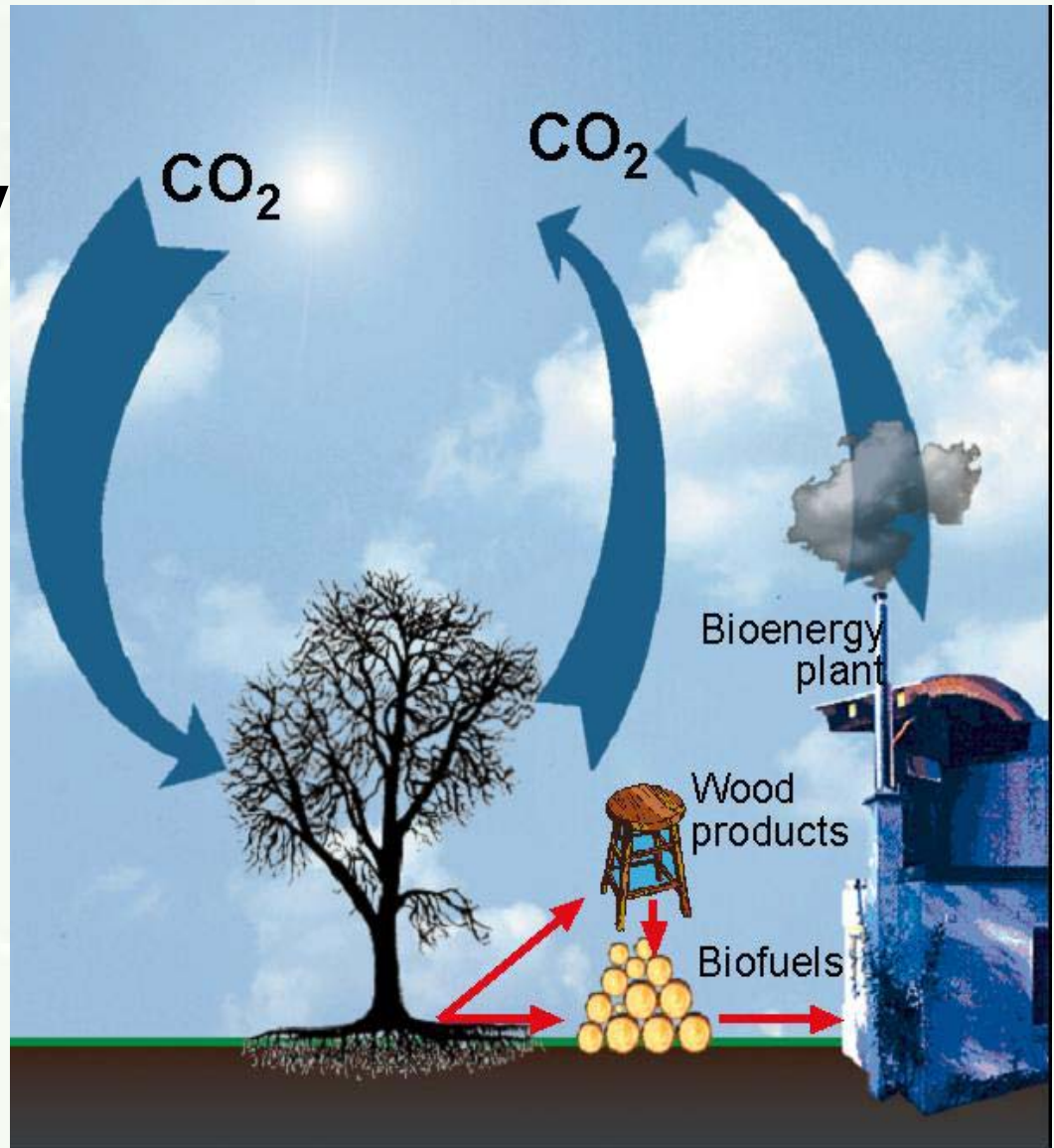
# Bioenergy conversion processes to produce end-use energy: electricity, heat, fuels

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

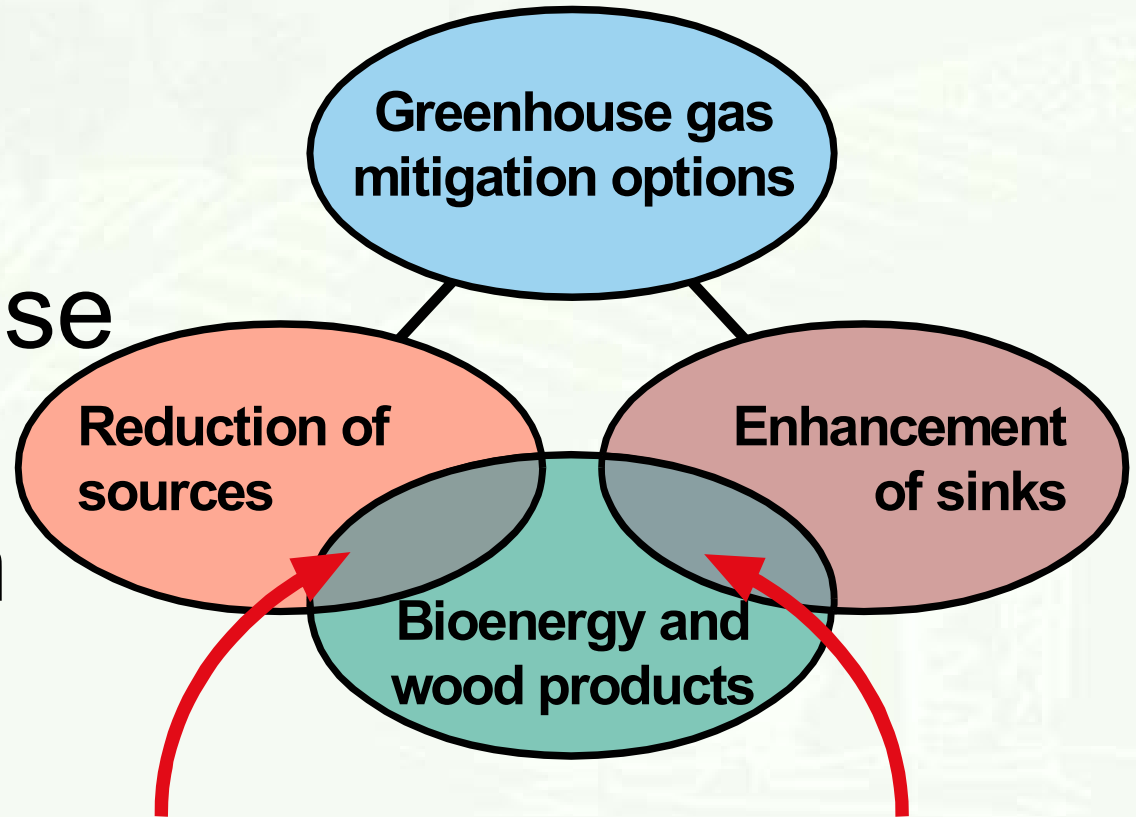
# Bioenergy and the environment

- “Standard” emissions: CO, NO<sub>x</sub>, C<sub>x</sub>H<sub>y</sub>, part.
  - Feedstock production, conversion
  - Need for further reduction
- Greenhouse gas emissions: CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, ...
  - CO<sub>2</sub>: neutral
  - CH<sub>4</sub>: benefits
  - N<sub>2</sub>O: if fertilized production
- Sustainability
  - Nutrient recycling
  - Avoid stock changes

# Bioenergy and the carbon cycle



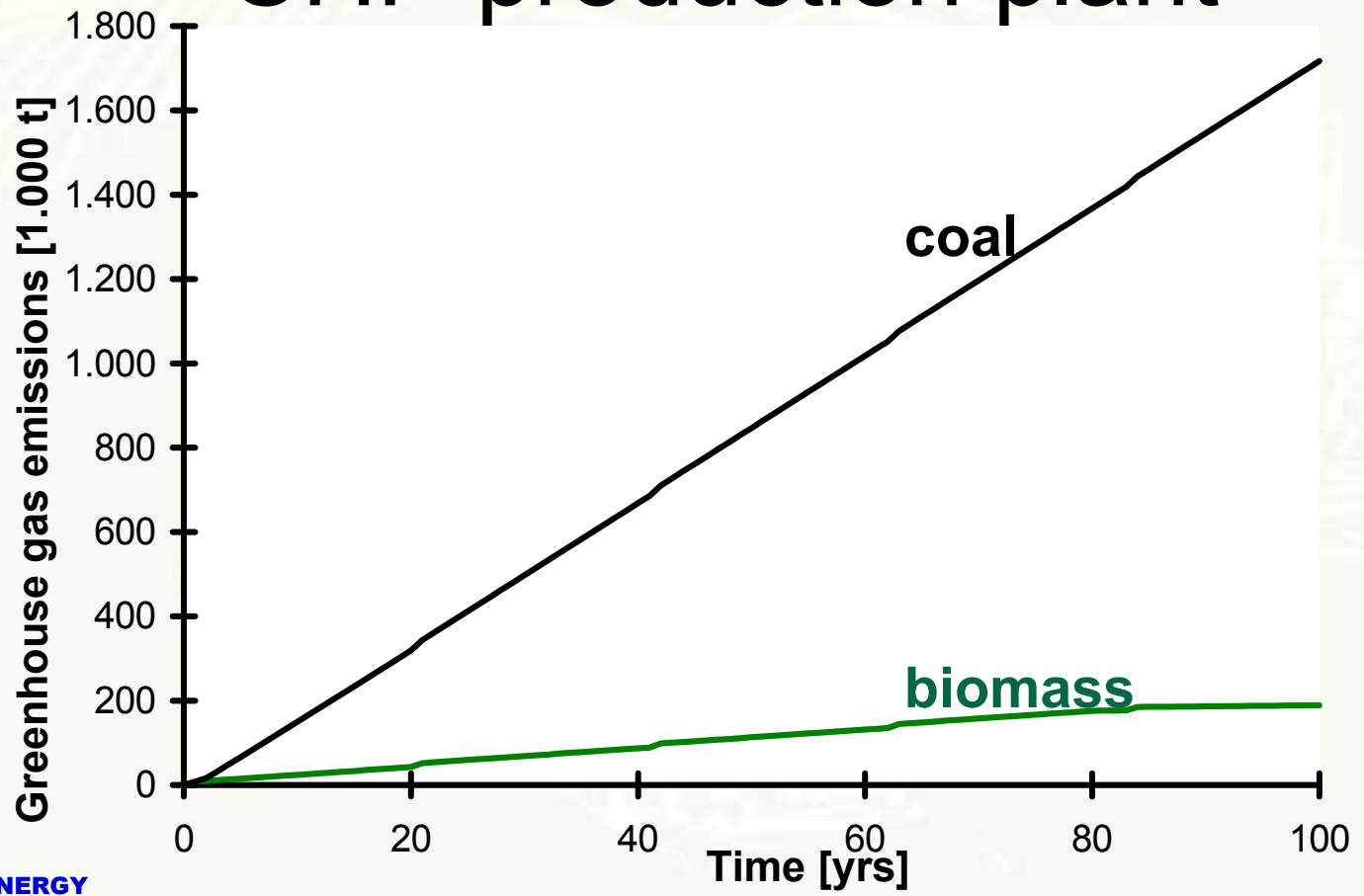
# Biomass and greenhouse gas mitigation



- Fossil fuel substitution
- Product substitution
- etc.

- Afforestation and harvest
- Durable wood products
- etc.

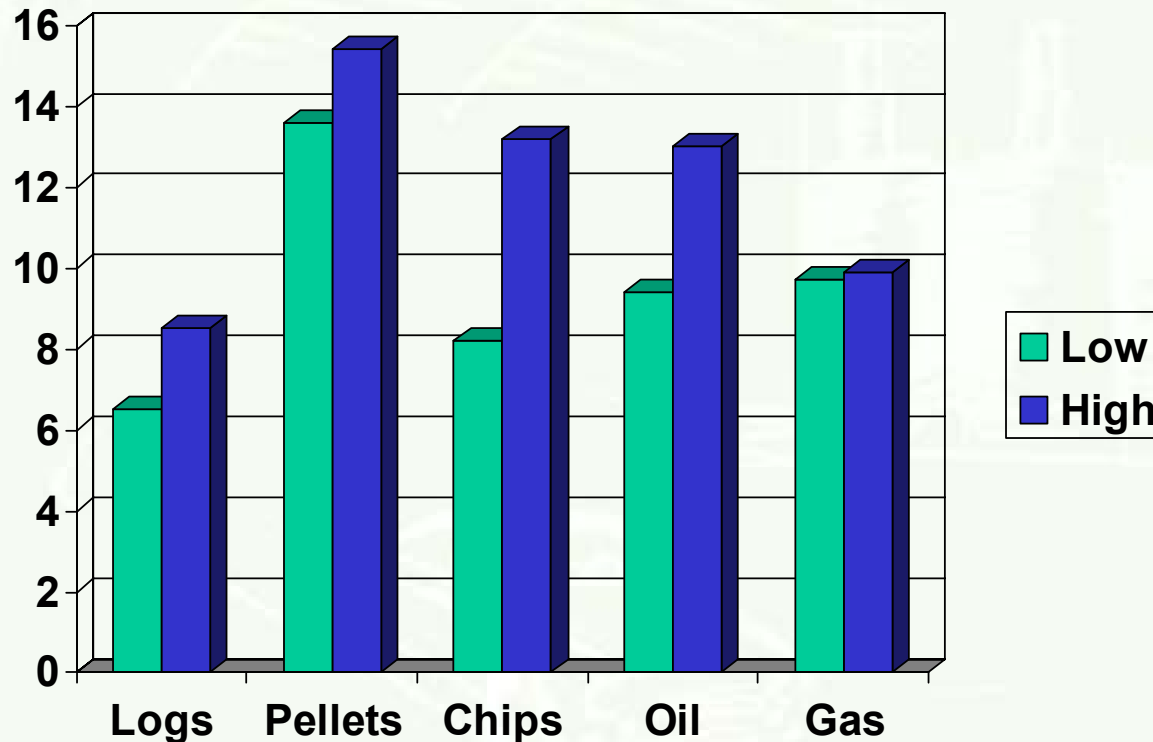
# Cumulative greenhouse gas emissions of a 10 MW<sub>el</sub> CHP production plant



# 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

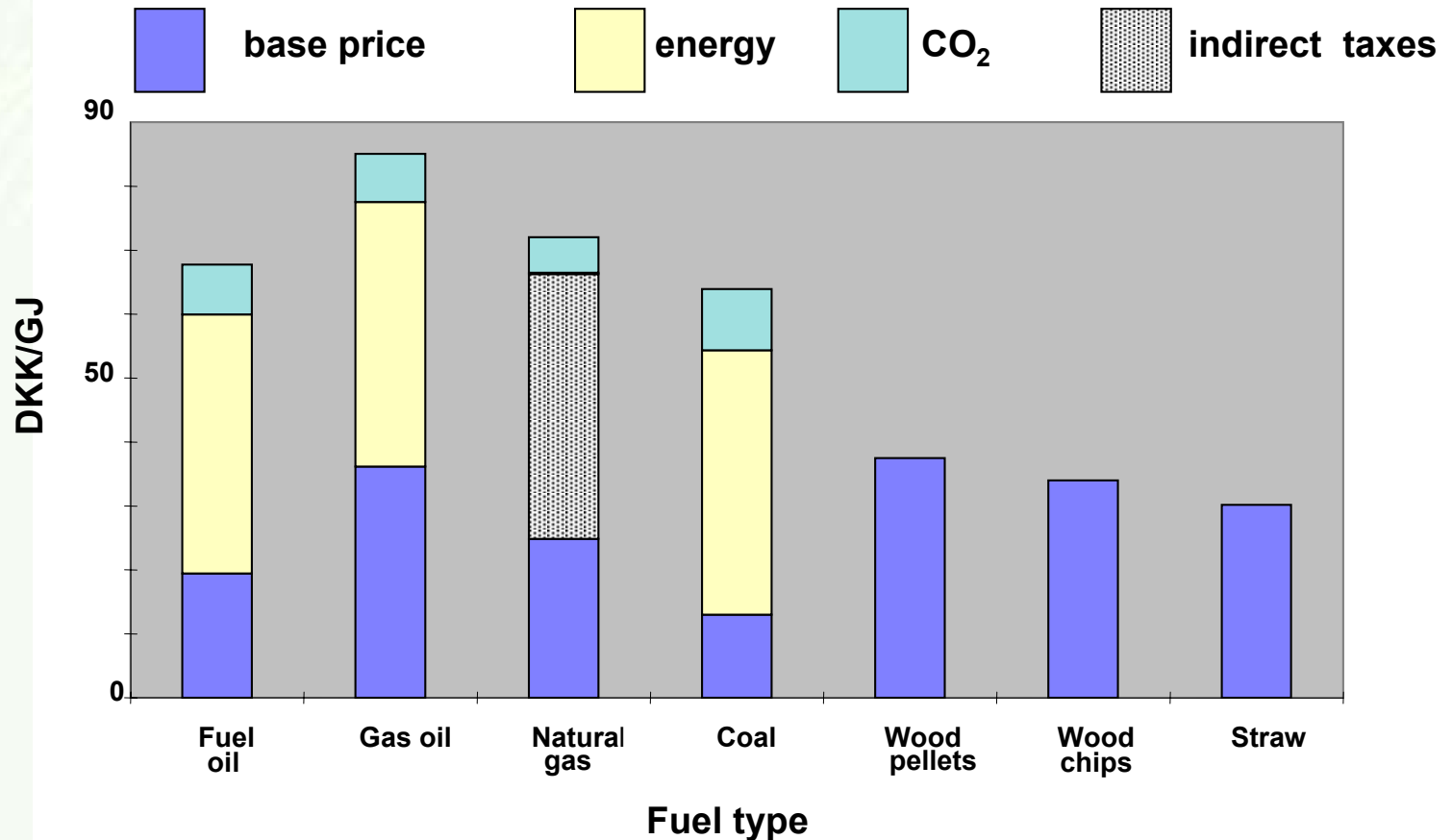
# Cost of heat from a 15 kW boiler with biomass and fossil fuels (€/kWh, 2002)





# 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



# Biomass heating plant

## Passail, Austria

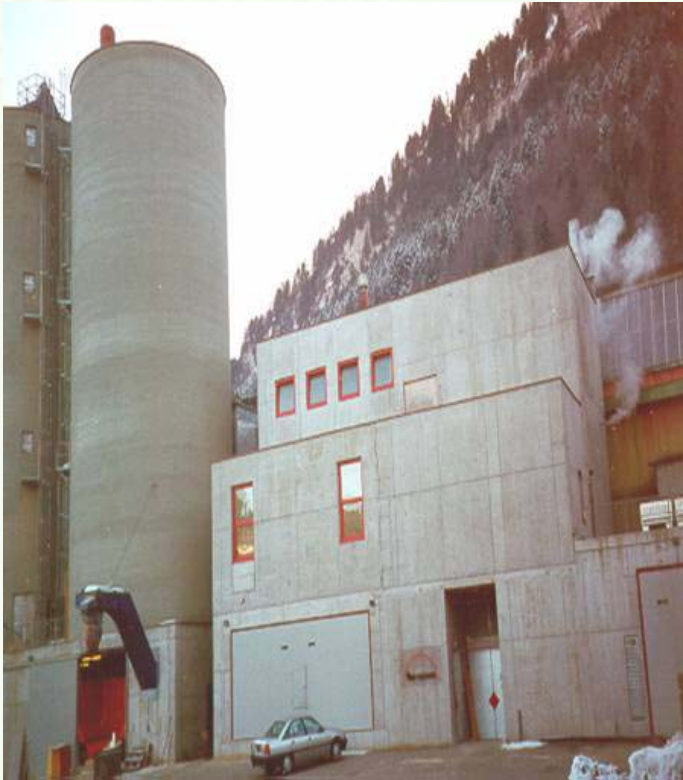


# Wood chip store



# 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<sub>el</sub> gas engine Güssing, Austria





# Flash pyrolysis plant

VTT Finland

