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Pellet: O recurso, o processo e o mercado em Portugal e no Mundo

Departamento de Engenharia Geográfica, Geofísica e Energia

MIEEA – Energia da Biomassa

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Heating with biomass

- Wood has been used for heating for thousands of years with low efficiency rate. Modern combustion plants and biomass boilers with an efficiency rate of over 90 percent are much more effective at turning it into heat.
- Less biomass To produce the same amount of heat, and also less waste residues. Whether it is in central heating, heat plants or combined heat and power stations, **wood remains the number one biofuel for heating in Germany and others EU north countries**.
- Since wood contains a high proportion of volatile substances, wood burning boilers must be built differently from oil or coal boilers.
- The boilers are also adapted to different types of biofuel in order to operate as efficiently and pollute as little as possible. A different construction is thus required for logs than for woodchips or pellets.

solid biomass Bioenergy

- The largest source of solid biomass are products from wood. These are obtained when the wood is taken from the forests and when the waste is used in the industrial processing of wood products. In many places, other by-products, namely **straw, are used to produce energy from biomass.**
- in addition to the tree forest trunks, which are used for the furniture and construction industries, inferior wood waste is also collected. For each hectare of forest, **0.4 - 0.8 tons of dry firewood** can be obtained from these residues.
- In addition, other amounts of wood waste collected during forest maintenance activities allow an annual fuel yield of about **1.5 tonnes per hectare for a permanent forest area.**

Mechanical wood harvesting

- In forest farms, trees are felled with the help of machines, which use an arm with an electric saw mounted. Additionally, these machines can automatically remove branches from the trunk, remove the dark bark from the wood and cut the trunk into parts.
- This method means that part of the added value of the wood processing is done before the wood leaves the forest.
- When round trunks are turned into planks and beams, large amounts of waste are produced. However, most of these are used in the wood industry for other materials. For example, wood chips that do not have a shell are a raw material for high-quality cardboard processing.

Industrial wood and its sub-products

-A part of these wastes still have impurities and is therefore unsuitable for use as feedstock. These pieces of bark are ideal for energy recycling. Due to the high ash content, these wastes are mainly used in large-scale heat exchangers and in cogeneration plants as co-heating substrate.

Bark - wood processing byproduct

Other significant residues from agriculture include straw and hay (in northern Europe). Post-harvest residues are usually available locally and in large quantities.

One hectare of straw has an energy content of 73 gigajoules, equivalent to 2,000 liters of heating oil. However, straw and other products of this type have combustion characteristics other than woody fuels. Consequently, the melting point of the ashes and the biomass emission behavior require a different technical approach.
So far, it has only been possible to achieve large-scale energy recycling of straw in cogeneration plants.

Straw as a natural waste product

Mechanical harvesting of straw with pressed bale

Mechanically prepared wood

- In addition to the materials mentioned, the products at the end of their life cycle, are ideal for energy recycling. The processing and combustion of old wood is one example.
- Due to its prior use, this biomass may be contaminated with toxic substances, such as chemicals, paints or the like. For this reason, many countries set restrictions on the energy recycling of old wood. Burning the wood in small combustion systems is permitted if the processing of the wood is purely mechanical and if the wood contains only slightly hazardous contaminants.
- In addition to the possible use of old timber, timber harvested during land management activities, including maintenance work on roads and motorways and work in forest parks, should be taken into account. These wood debris are usually a mixture of wood, leaves and logs.
- Energy use also serves as a means of eliminating these wastes. The energy content of these mixtures is relatively low due to the large number of impurities, in particular because of the quantities of soil which generally exist in the mixture, which generates a high ash content. Other impurities such as plastic packaging, bags and other wastes lead to high levels of toxic substances released into the atmosphere.
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Waste from Wood processing

- **industrial Processing**

Biomass heat plants

- As biogenic solid fuels naturally contain less energy in proportion to their weight than fossil raw materials, it is best to use them where they occur. Bioelectricity and bioheat are therfore mainly produced in small or medium-sized decentralised plants. There are now biomass heat plants of between 500 kW (kilowatts) and 30 MW (megawatts) all over Germany, which either supply blocks of flats, schools,
- swimming pools and small companies or are connected to a local heating network. They mostly use woodchips from thinning or left-over wood from industry. These materials are cheap and ensure that biomass heat plants are also a viable alternative from an economic point of view. Many municipalities make use of smallwood and thinnings from their own woodland. They do not necessarily have to prepare it themselves; the chopping is often done by a service provider. For As biogenic solid fuels naturally contain less energy in proportion to their weight
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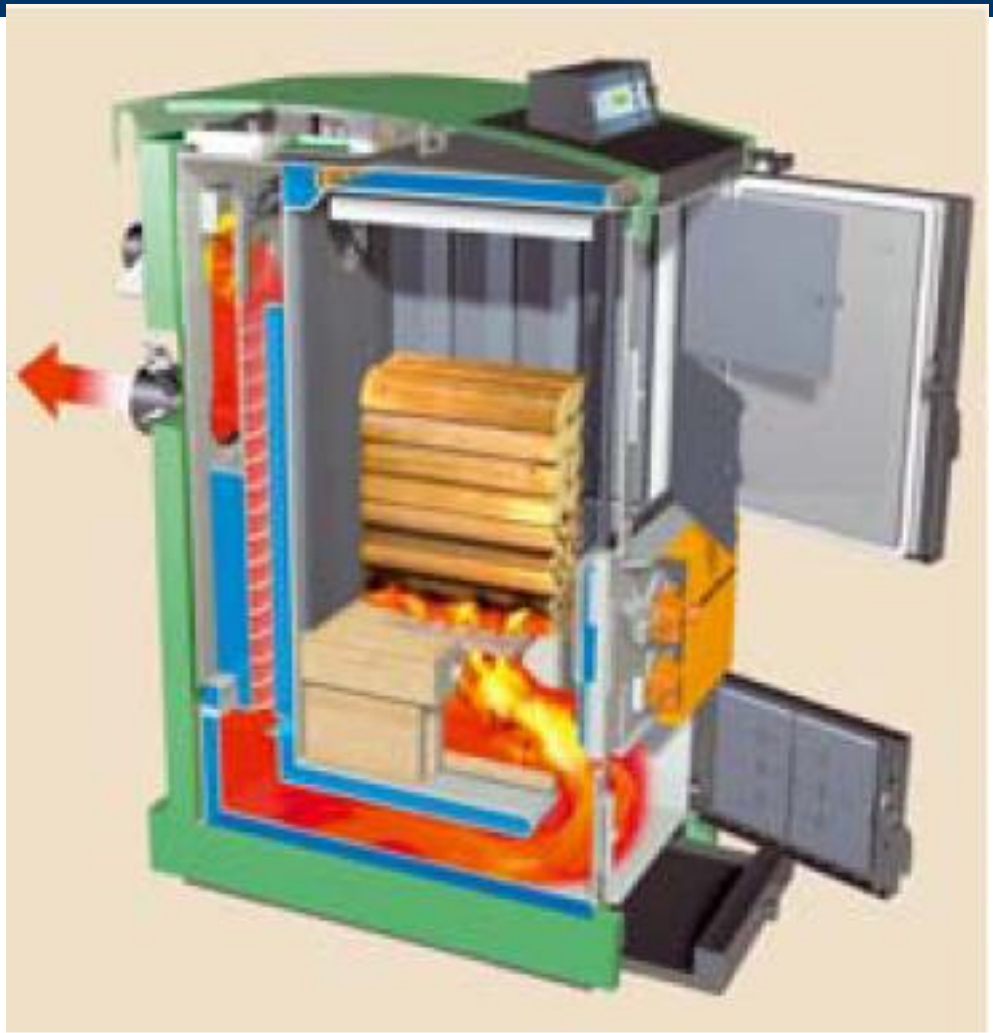
Small-scale biomass boilers

- There are more and more small-scale household biomass boilers in rural areas. This is because consumers have recognized that modern wood burners function efficiently and that there are cost benefits to having a locally available source of fuel. Since the technology to make use of woodchips is relatively complicated and expensive and woodchips take up a lot of storage space, such households generally install log and pellet boilers. Both of thse fuels have their advantages: pellet boilers run fully automatically and earn points for their ease of use. Logs are however the cheapest form of fuel, especially for users who go about getting the wood themselves.
- **Heating with logs**
- Modern log boilers come with a capacity of between five and several hundred kilowatts. Although the wood still has to be put in by hand, latest technology ensures that combustion is much more efficient and cleaner than before so tha there is no problem in complying with strict German legislation regulating emissions. Thanks to a lambda probe and control, there is enough oxygen for the wood to burn completely and far less air pollutants such as carbon monoxide (CO) and hydrocarbons are produced.
- Log gasi fication boilers spatially separate the releasing of light volatile particles (gasification) from the trans formation of these gases into heat (combustion).
- When combined with a staged combustion air stream, the efficiency can reach more than 90%. To make the most efficient use of the heat produced, log boilers are combined with a hot water reservoir which releases heat into the heating system as and when required.

Log gasification boiler



Heating with pellets

- Pellets are produced on an industrial scale from sawdust and wood shavings. These pressed objects are 6 to 8mm thick and about 10 to 30mm long and there is a standard that guarantees consistent quality.
- Pellets are not only little bundles of energy (2 kg of pellets are the equivalent of 1 litre of fuel oil); they are also very easy to transport. Pellet boilers are often preferred for detached houses because the fuel takes up less space. Thanks to modern technology, a pellet boiler equipped with a fan or a screw conveyor can manage the flow of pellets it requires to produce the level of heat the user has determined.
- This is not only comfortable but also particularly efficient and environmentally-friendly. A small reservoir for buffer or hot water for use (boiler) is enough to store the heat produced by combustion.
- To complete the range, there are combination boilers that burn both pellets and logs, as well as pellet stoves.

Pellets

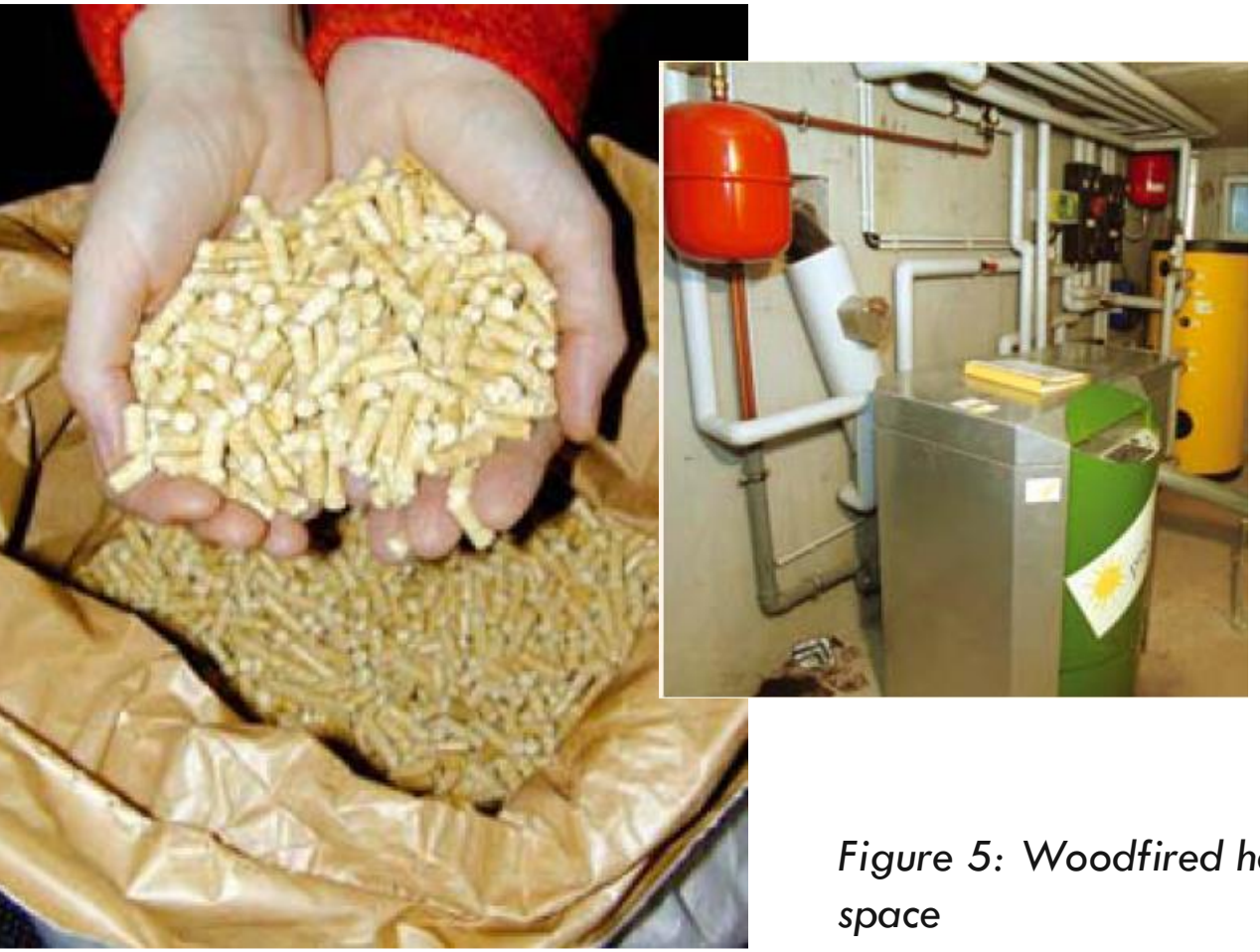


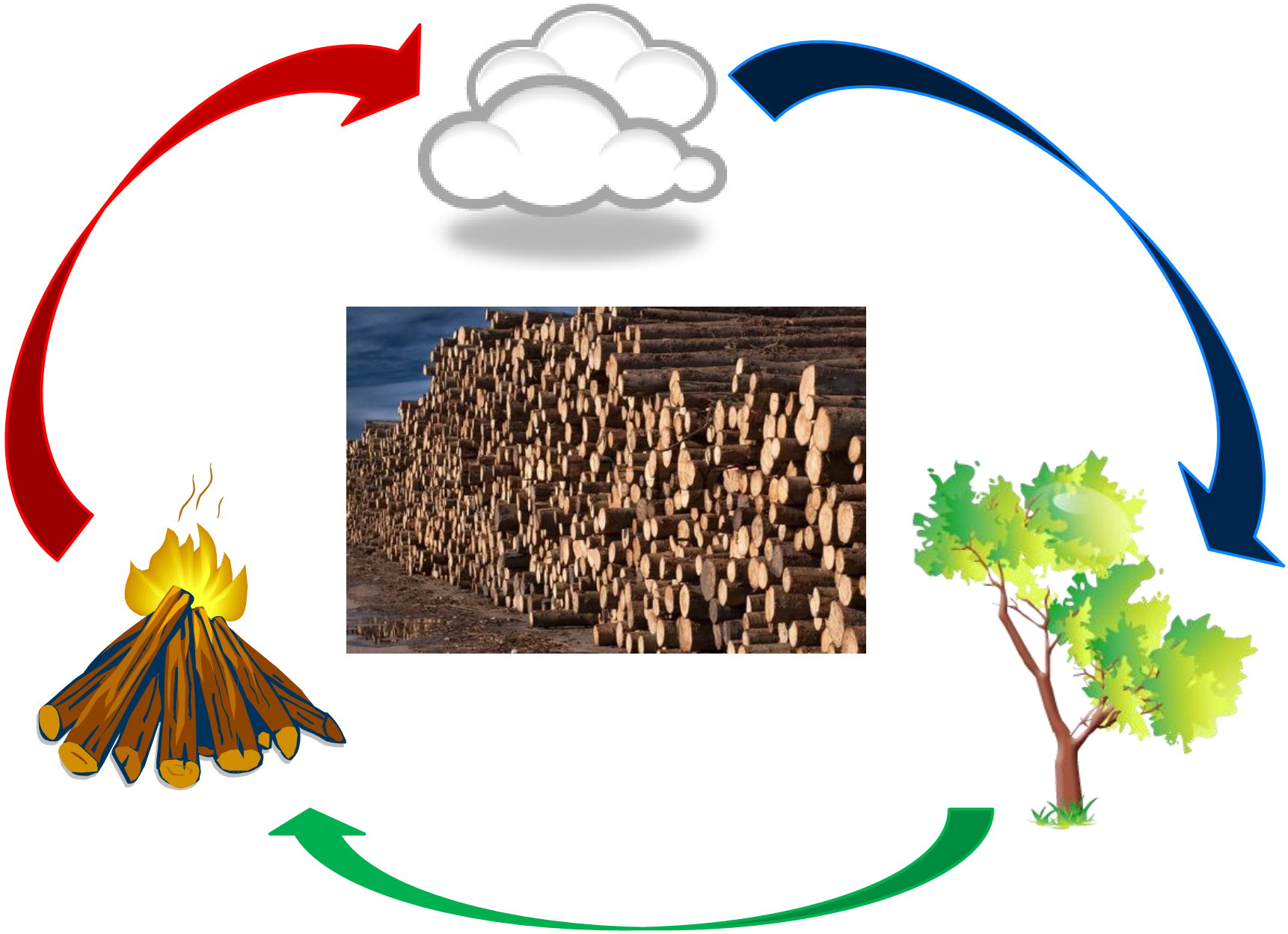
Figure 5: Woodfired heating fitted to save space

Central de Briquetes do CBE

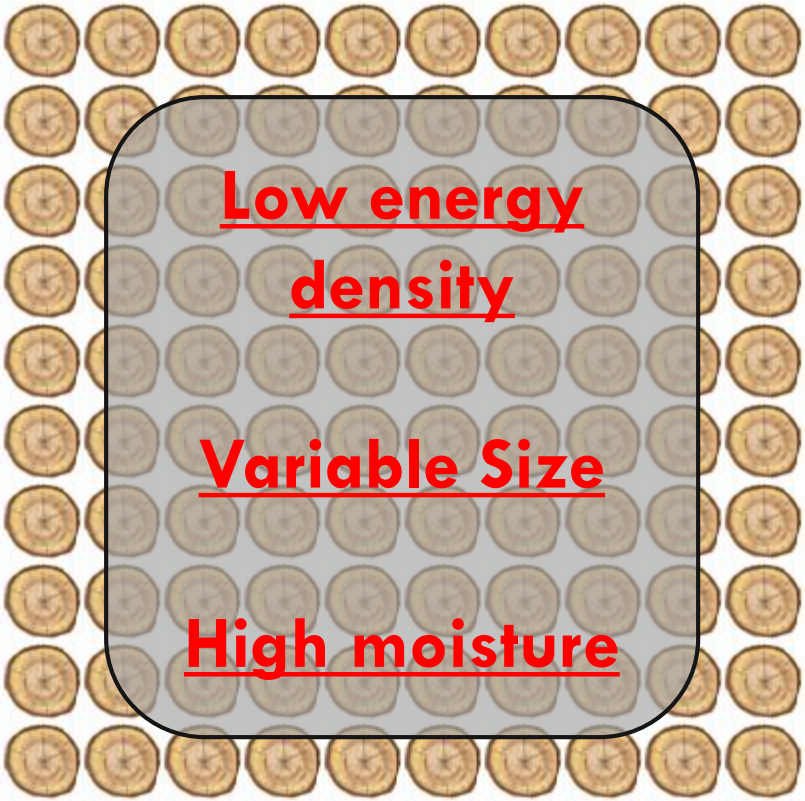
Using straw and grain as fuel

- Grain and straw not only fix similar amounts of energy to wood, they are alsorelatively homogeneous fuels that areavailable all over Germany. They havehowever been little used for energy production until now as some particular rcharacteristics and elements in them can cause problems when they are burnt and therefore require special solutions. The low ash softening point leads to slagging of the ash inside the boiler and the high chlorine content can cause corrosion. Dust and nitrogen oxide emissions willalso have to be controlled. Manufacturers are trying to deal with the problem from a construction point of view as well as by adding cleaning systems.
- Present and future emissions regulations for dust cannot be respected without in stalling air pollution cleaning sys tems. To capture the very fine dust par ticles, tests are being carried out on fil tering or electrostatic separators as well as secondary heat exchangers that cause the flue gases to condense. These not only have to work, they also cannot be too expen -sive so that they represent a viable in vestment for the farmer. Large-scale plants already exist that can fire whole bales of straw, break up bales or use so-called cigar burners to produceenergy from them. Urgent work is being done on the technical adaptation of smaller boilers so that they can use straw and other stalk plants as fuel. Severalboiler manufacturers have already launched promising specialised grain boilers onto the market. One interesting alternative for the future are also straw and stalk pellets. Straw is already being made into pellets and theseare being fired on a small scale.
- As straw and grains offer considerable biomass potential that can make an im -portant contribution to an ecologically sustainable supply of energy, the German federal government supports research in this area.

Since the discovery of Fire that Man makes use of Biomass



Disadvantages???



Low energy density

Variable Size

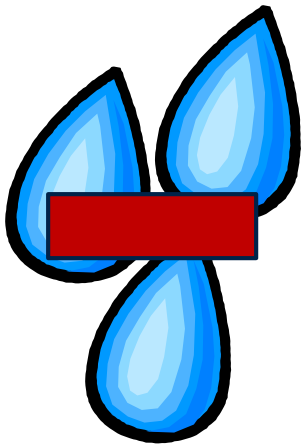
High moisture

η ≈10-12%

Combustion in open Owen (fireplace)

Handicap???

On average the newly harvested firewood may have more than 50% moisture ≈ 2,3kWh / kg



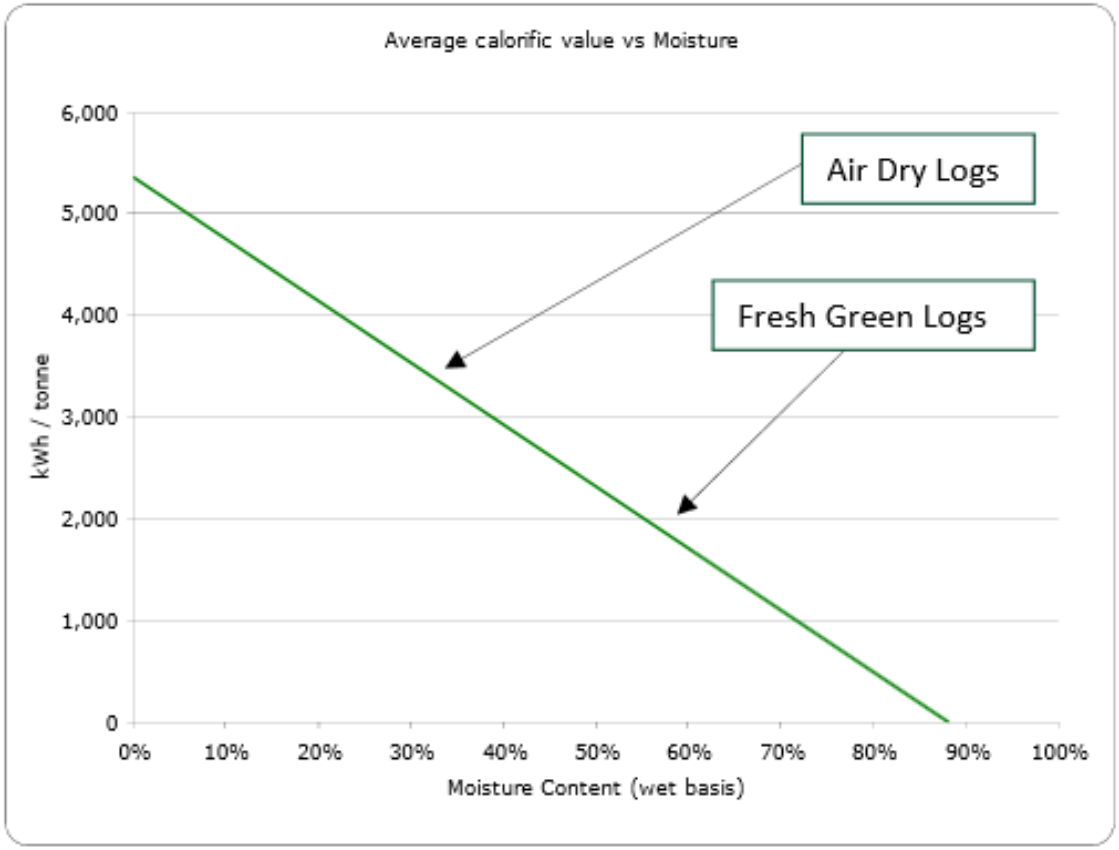


Gráfico 1 – Poder Calorifico em função da Humidade. Fonte: Wood as Fuel Guide

What are Pellets?

Fuel from various types of sawdust, sawdust, forest and agricultural waste

What are Pellets?

This material undergoes a treatment that gives it homogeneous properties of shape, density, ash content and calorific value

Technical Properties

- Length: [38-43mm]
- Diameter: [5-6mm]
- Density:> 650kg / m3
- Moisture Content: <8%
- Gray Content: <1%

Technical Properties

Pellets Premium (Classe A1 e A2)

Calorific power

Pellets Industrial (Classe B)

Gray

Technical Properties

Matéria-prima do pellet	Densidade [kg/m^3]	Poder calorífico [kWh/Kg^{-1}]	Conteúdo em Cinza [%]
Serragem	606	5.6	0.45
Cortiça	676	5.6	3.7
Sobrantes do corte	552	5.8	2.6
Switchgrass	445	5.3	4.5
Palha de trigo	475	4.4	6.7
Palha de cevada	430	4.9	4.9
Palha de milho	550	5.0	3.7

Tabela 1 – Características de diferentes tipos de matéria-prima para a produção de pellets.
Fonte: "Manufacturing Fuel Pellets from Biomass" – Pennsylvania State university

Wood VS Pellet

− Remember that "fresh" wood has P.C ≈2,3kWh / kg
The P.C of the pellet is on average two and a half times larger !!! +

− Energy density more than fivefold!
It goes from approximately 540kWh / m3 to more ≈ 3000kWh / m3 +

− The combustion of the pellet creates less smoke, less gray and allows more efficient combustion (small furnaces with yields ≈ 90%) +

Pellet

Technical Properties

- 2.1 ton of pellet are equivalent to close to 1000 liters of heating oil

➢Gasoil price for heating =1,32€/Lt*

➢Average pelle cost = 0,24€/kg*

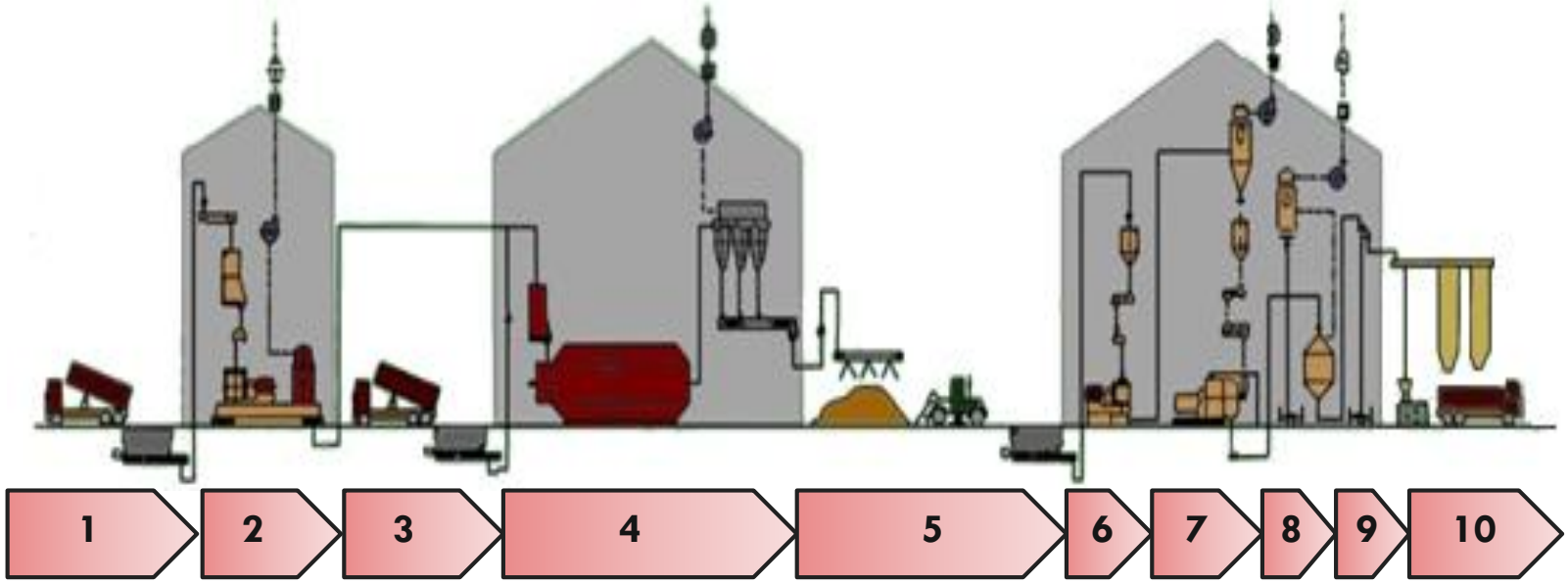
Balance (for the same heat produced 10.56MWh):

Diesel = 1320 € vs Pellet = 502,6 €

2.6 times cheaper!

*preços a 21/05/13

Pelletizing process



1 – Entrada de matéria-prima

2 – Moagem

3 – Injeção de matéria-prima e serragem

4 – Secagem

5 – Carregamento

6 – Moagem fina

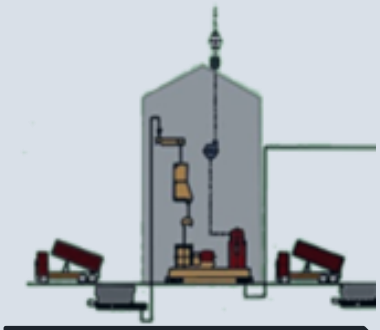
7 – Pelletização

8 – Arrefecimento

9 – Peneiração

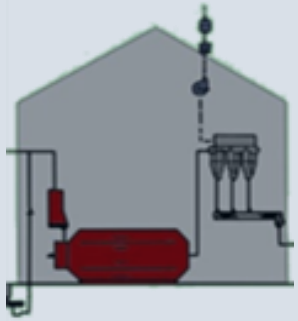
10 - Carregamento

Processo de pelletização



Calibração

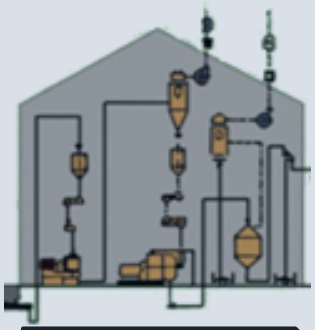
- Homogeneização da granulometria da matéria-prima – dimensões inferiores a 3 mm.
- Materiais mais densos passam pelo triturador antes de passarem pelo moinho de martelos.
- Materiais menos densos podem ser diretamente introduzidos no moinho.



Secagem

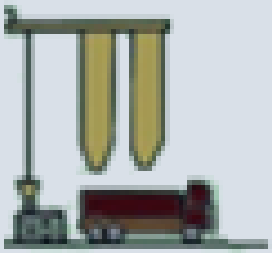
- Redução da humidade da matéria-prima para valores abaixo dos 10% - máximo de humidade que o material pode ter quando entrar no pelletizador.

Processo de pelletização



Pelletização

- Pelletização da matéria-prima.
- Arrefecimento dos pellets.
- Peneiração do produto final – controlo de qualidade.



Acondicionamento

- Armazenamento em silos.
- Pequenos consumidores – armazenamento em sacos de 15 a 25 kg.

Mercado Europeu

- Europa é o maior Mercado (80% do total)
- Onde se concentram maiores produtores (11Mton. em 2012) e consumidores (15Mton. em 2012)

???

Local de maior tradição para a indústria

Disponibilidade considerável do recurso (tendo em conta a área)

Aposta nas renováveis. Compromisso 20/20/20 da CE

Mercado Europeu

- Bigger Producers:

Suécia

Alemanha

Áustria.

- Bigger consumers:

Dinamarca

Suécia

Alemanha

Bélgica

Países Baixos

Quick facts:

✓ More than 670 Producers

✓ Imports grew 50% between 2010-11 and 60% between 11-12

✓Market continues to grow

✓New players (Italy, Spain, United Kingdom)

European Market

Despite the large investment in solar and wind, biomass remains the largest renewable source in Europe.

AEBIOM (European Biomass Association) forecasts a growth in pellet consumption of 2.5 Mtoe / year in 2008 to 32 Mtoe / year in 2020

50-80 Millions Tons*

* Obviously I depend on the incentives, European policies and market conditions

North American Market

- Second largest market
  Great production / export dynamics
  Great growth in the last 10 years

Production

Aproximadtely 10M ton/year (and growing!)

Consume

Aproximately 6,2M ton/year

Nort-American Market

- United States 
- Canada 

Quick facts:

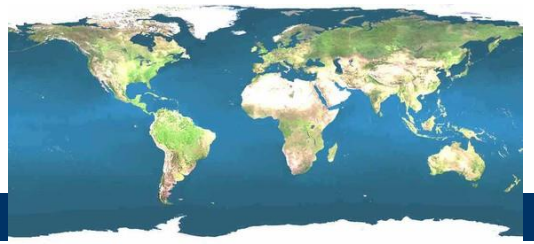
✓ The US has 150 producers.

✓ 20% of US production is for export (+/- 400M $)

✓ Canada has fewer producers but has huge potential for growth

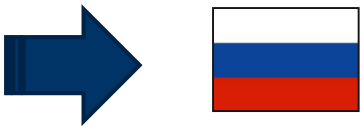
✓80% of Canada's output is for export

Market in the rest of the world



- Slightly developed markets
- Some countries stand out in Africa and South-East Asia as producers
- Low demand

Highlight for China as the largest producer of assembly lines and parts (turn-key solution) of pelletizing factories



Highlight for Russia, a country of great potential and that has just installed the world's largest factory with an annual capacity of 900 thousand tons in St. Petersburg

Portuguese Market

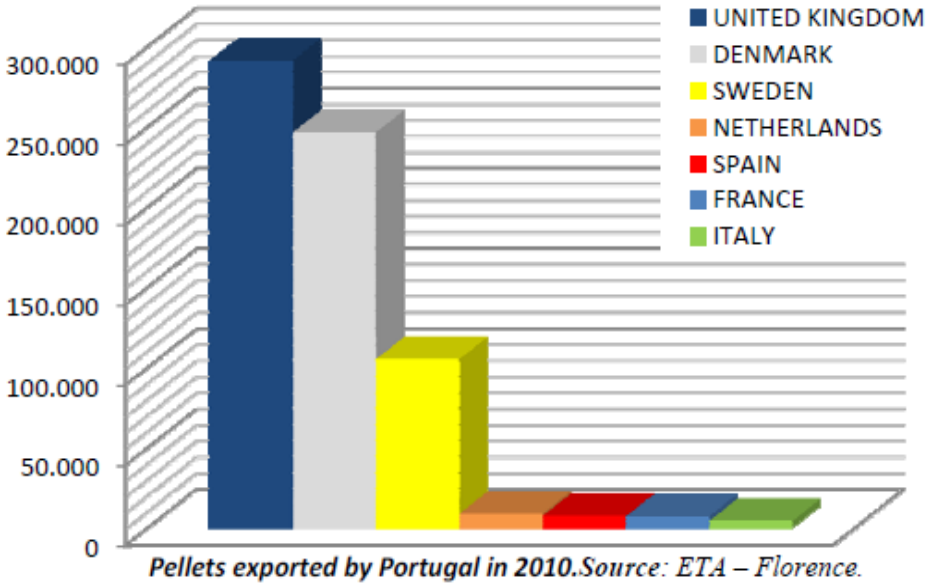
- Recent Markets (developed since 2005)
- Little domestic consumption (50,000 tons / year), export market
- Typical consumer is the domestic sector, public buildings, services and small industries

Quick facts:

- ✓There are currently 16 pelletizing factories
- ✓91% of production is for export
- ✓Significant growth with a production around 650,000 tonnes / year
- ✓The maximum production capacity is close to 1.2M ton / year

Portuguese Market

- Exports are great added value for national industry
- Endogenous and quality produc
- Growth potential due to growth in consumption in Europe
- Creation of employment, both ir the production and cleaning of forests and forests



Pellets exported by Portugal in 2010.Source: ETA – Florence.

Discussion

- Simple process that increases the energy density of the resource.
- Prevention of fires / cleaning of forests.
- Valorization of waste - less import of energy resources - reduction of dependence on fossil fuels.
- Exports contribute to economic growth.
- World industry in a notorious growth can reach or surpass an annual production of 60Mton. in 2020.