Energy crops in a nutshell

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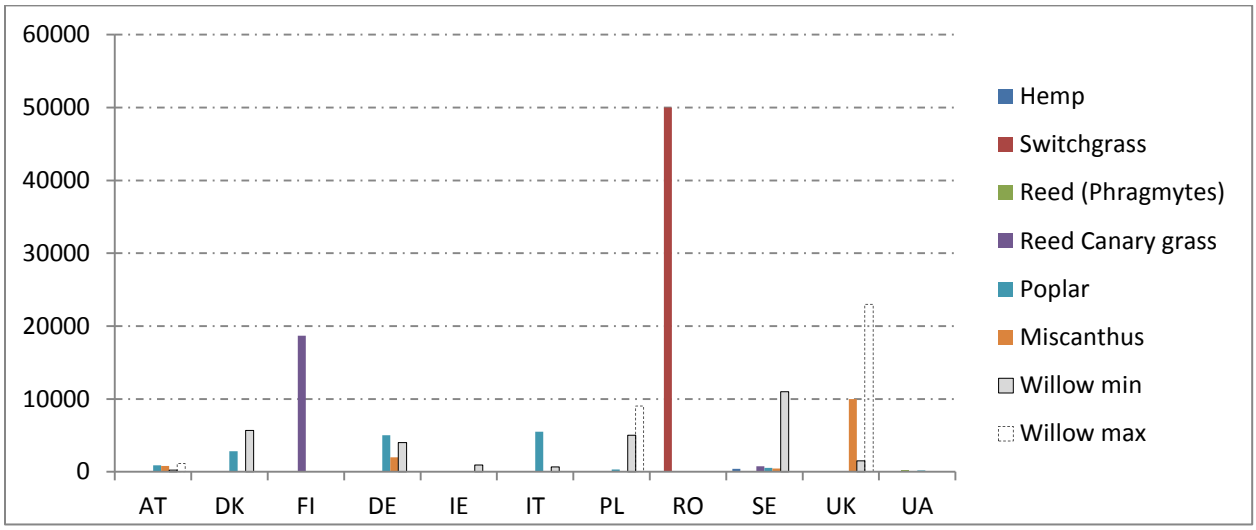
Energy crops are grown on agricultural land for energy purposes. A wide range of crops can be used for the production of energy: oilseed crops (for biodiesel), sugar and starch crops (for bioethanol) and lignocellulosic crops (for heat and power and advanced biofuels production or bioproducts). Lignocellulosic crops refer to plants which contain an element called lignin in their cell wall. They include straw, woody biomass, and some perennial grasses such as miscanthus. This factsheet will focus on lignocellulosic crops.

According to AEBIOM estimations, about 130,000 hectares are dedicated to the cultivation of energy crops in Europe. The largest areas of lignocellulosic crops can be found in Romania (switchgrass), Finland (reed canary grass), Sweden (mainly willow), the UK (mainly miscanthus and willow) and Germany (miscanthus, willow, poplar).



Energy crops cultivation in Europe in 2011 in hectares (Source: AEBIOM)

New dedicated energy crops would contribute to mobilize biomass resources - thereby increasing security of supply - and would contribute to achieving
Moreover, perennial energy crops are multifunctional crops that can help to improve water quality, enhance biodiversity, prevent erosion and reduce the use of pesticides in comparison with traditional annual crops. The promotion of energy crops would also offer an opportunity for European farmers to diversify their income sources.

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The primary bioenergy potential analysis carried out by the European Environmental Agency (EEA) shows that the main growth potential for additional biomass is seen in the agricultural sector (residues and energy crops) and that currently largely unexploited. However, current policy debates on sustainability and indirect land use change compromise the full exploitation of this potential.

Environmentally compatible primary bioenergy potential in Europe (EEA 2012)[1]

Various factors need to be taken into account when determining the most adequate types of energy crops for a given area, such as yields, harvesting moments and economical benefits for farmers. The energy input/output per hectare, the ash content and ash melting point as well as the moisture content at harvest are also important characteristics to be taken into account when cons9 489.count

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Annual plant species (planted and harvested every year)
Perennial grass species (planted once usually every 12 - 25 years and harvested annually)
Short rotation coppices (planted once every 20-30 years and shoots harvested from the stools every 2 to 8 years)

ANNUAL PLANT SPECIES

Example 1: Fibre sorghum (*Sorghum bicolor*)

Sorghum are grassy C4 plants from topical origin with a large genetic variability. Several types are identified: grain-, forage-, sugar- or fibre sorghum. Yields can reach 10 to 20 tons dry matter per hectare depending on soil and climate conditions. Thermal requirement is particularly high, especially during establishment, while water availability can also limit the yield. Harvest happens at the end of the flowering period, while the seed weight is increasing the lodging risk. Being an annual crop sorghum can be easily integrated into a crop rotation.

PERENNIAL SPECIES

Example 1: Miscanthus (*Miscanthus giganteus*)

Miscanthus species are perennial grasses of Asian origin. Miscanthus plants develop underground storage organs called rhizomes and the shoots can grow up to 3.5 meters. Miscanthus grows in a temperate climate and on many types of arable land. An annual harvest of up to 30 tons dry matter per hectare (excluding the first couple of years) can be expected depending on the amount of sunshine, water availability, soil quality and temperature. Miscanthus is usually planted in March or April, starts drying by autumn and is harvested in winter or spring. Once established, the crop can be harvested annually for at least 15 years. Harvesting of miscanthus should be carried out after the crop has senesced, when the moisture content is lowest and before regrowth begins in the following spring. In south Europe the humidity of miscanthus at harvest can be as low as 15%. However, in Germany and in the UK a minimal moisture content of 16-25% can be expected.

Example 2: Reed canary grass (*Phalaris arundinacea*)

Reed canary grass is perennial C3 plant which usually grows in damp areas, along the margins of rivers, streams, lakes and pools. Reed canary grass is a native plant in temperate regions, like Scandinavia, and is currently mostly grown in Finland. This rhizomatous grass grows naturally to between 60 cm and 2 m high. Flowering occurs in June to August and harvesting usually takes place annually in spring. The advantages of the specie as energy crop are its tolerance of both drought and wet conditions due to its excessive large root system, its ability to be established from seed and its attainment of high dry matter content (85-90% of dry matter at harvest). Reed canary grass needs relatively little fertilizer. An average

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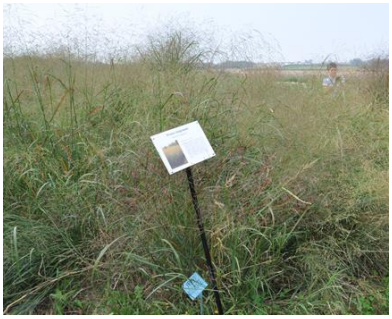
yearly yield of 6-8 tons dry matter per hectare can be expected, with a maximum of 11 tons dry matter per hectare. Crop duration of 12-15 years is possible.

Example 3: Switchgrass (*Panicum virgatum L.*)



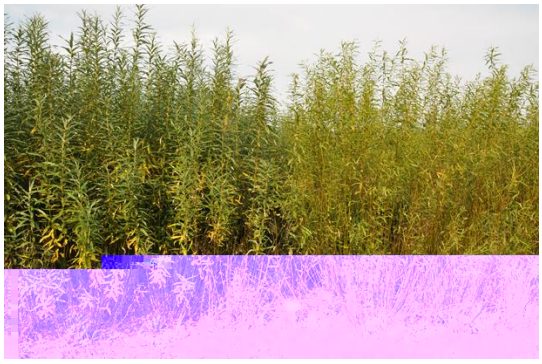
Switchgrass is a C4 lignocellulosic perennial rhizomatous grass which is usually grown as a prairie grass in North America on marginal lands. Switchgrass can grow to more than 3 m height and develop roots to a depth of more than 3.5 m. A normal switchgrass stand has a life span of ten years. The harvest activities start in the second year of the stand life if there has not been any reseeding. Harvest is done during the autumn period. Yields of up to 18 tons dry matter per hectare were found in North West Europe and up to 25 tons dry matter per hectare in Southern Europe.

Example 4: Giant Reed (*Arundo donax L.*)

Giant reed is a wild C3 plant growing in southern Europe regions. Although Giant Reed grows best in a warm climate, certain genotypes can be adapted to cooler climates and can be grown in countries like Germany or the UK. Giant Reed is one of the most productive crops as its yield reaches more than 30 tons of dry matter per hectare (only in Southern Europe with sufficient water availability) as well as one of the most cost-effective energy crops because it is perennial with low annual inputs after establishment of the crop. Giant reed is one of the largest grass species that can be grown in cool temperatures and it can grow up to 5 meters tall and 3.5 cm in diameter. Giant Reed is usually harvested in late winter to make sure that the moisture content is not over 50%. Depending on its use, giant reed is either harvested each year or every second year.

SHORT ROTATION COPPICES

Example 1: Willow *(Salix spp.*)



Willow comprises about 300 different species and is mainly found in northern Europe, Asia, and North America. Salix species are very dependent on water availability, with a water consumption reaching up to 4.8 mm/day in summer. To a certain degree willows are tolerant of waterlodging (not a permanent one). The planting of willow is carried out in spring. The plants grow rapidly in the first year reaching up to 3-4 meters height. The harvesting of the wood takes place at the vegetative rest (November to February). At this time of the year the wood has a water content of around 50%. Yield range from 8 to 12 tons of dry matter per hectare and can in some cases reach up to 20 tons per hectare. Good weed control is very important during the first years for a good development of the plant. Fertilisation requirements are low due to the fact that harvesting occurs in winter when the leaves containing the biggest amount of nutrients have fallen off the trees.

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Example 2: Poplar (*Populus spp*.)

Poplars are more frost sensitive than willows and, therefore, are not usually planted in northern European countries. Poplar can grow on wide range soils however shallow soils and sites that remain waterlogged should be avoided. Yearly yields of up to 22 tons dry matter per hectare can be reached in in Central European countries. Planting should take place as early as possible in the spring but avoiding frost. Weed control is very important in the establishment year. The rotation period of poplar is usually 5-7 years longer than for willow. Harvesting poplar requires heavier machinery as it produces fewer and heavier stems.

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