# Fast growing tree species and energy grain in Austria

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**Facts renewable energy in Austria**

•Kyoto agreement 1998: until the period 2008 – 2012 reduction of discharge of $CO_2$, $CH_4$, $N_2O$ around 13 % to 1990

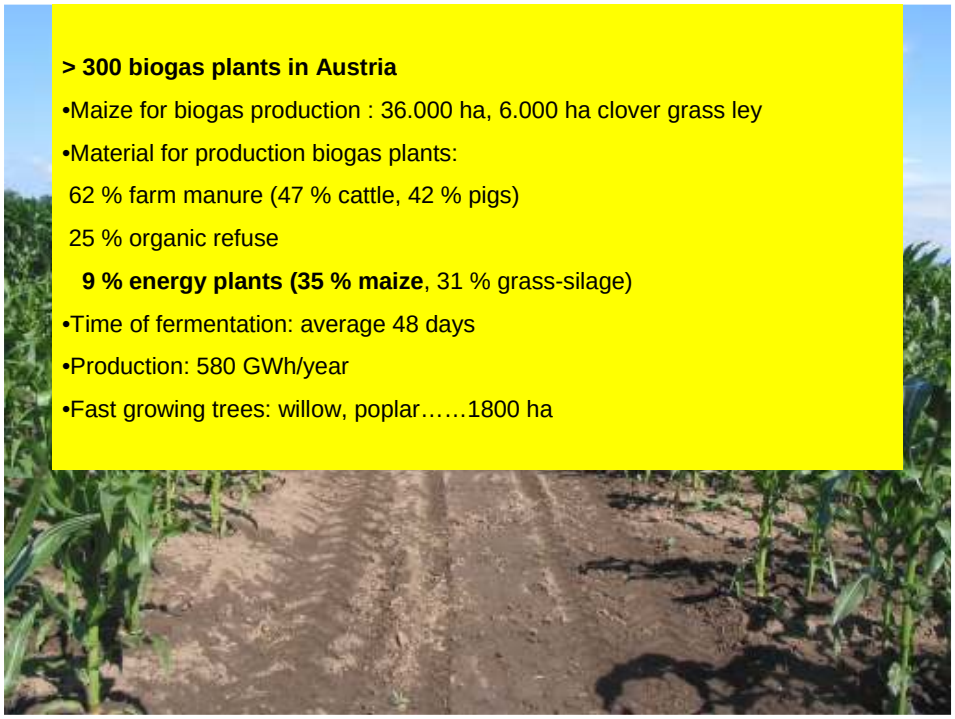
•1990 emission 77 Mio.t/year $CO_2$ equivalent ⇨ 1998 80 Mio.t, ⇨ 2013 83 Mio.t; goal of the Kyoto agreement are 67 Mio.t/year……16 Mio.t reduction of gasemission requested

•Renewable bioenergy needed

•Defile in timber production and increasing demand

| | prediction 2010 |
|---|---|
| •Demand 1997 → 2002…….+ 23 % sawn timber | |
| + 8 % pulp and paper industry | + 27 % |
| + 47 % wood board | + 50 % |

Increasing demand 2 – 2.5 Mio. cubic metre timber for bio energy



**> 300 biogas plants in Austria**

•Maize for biogas production : 36.000 ha, 6.000 ha clover grass ley

•Material for production biogas plants:

62 % farm manure (47 % cattle, 42 % pigs)

25 % organic refuse

**9 % energy plants (35 % maize**, 31 % grass-silage)

•Time of fermentation: average 48 days

•Production: 580 GWh/year

•Fast growing trees: willow, poplar……1800 ha

## Biofuel:

**•Oilseedrape……..1.500 – 2.000 l/ha**

**•Biodiesel……1.400 l/ha**

**•Bioethanol……2.500 l/ha**

**•BTL…… 4.000 l/ha**

**•Costs for ethanol in Brasil……200-250 €/t**

**•Costs for Ethanol Europe……600-650 €/t**

**•➔ with cereals and maize we can produce 40 % of the energy need in Europe – 20 Mio. ha arable land**

**•Calculation:**

**Austria has ~ 2 Mio. Cars……∅ 15.000 km per year, fuel consumption 6l/100 km ⇨ 900 l fuel per year per car**

**Oilseedrape produces 1.500 l oil per year ⇨ 1.200.000 ha oilseedrape**

**Total arable land in Austria: 1,38 Mio ha……87% of arable land needed for fuel production (without fuel oil ….heating)**

**Fast growing tree species (poplar, willow)**

**➔Production of timber on arable land**

•Austria 1.800 ha fast growing trees – poplar and willow

•2 – 2.5 kg timber replaces 1 kg heating oil

•Harvest full mechanized

•Recultivation possible and aimed at

•Renewable energy with high potential of yield

•Energy production with hold open of the countryside

•Long term change to BTL (biomass to liquid) – produced from organic matter like timber

**•Energy balance – energy input:output**

Ethanol from wheat……..1:2.7

Etahnol from sugar beets……1:1.6

Rape-seed oil……1:3.4

Rape methylic ester……1:3.1

Cereal – total plant……...1:12 – 14

**Fast growing trees……..1:16 - 24**

**Production technology**

•On almost every arable land growing

•Annual rainfall > 600 mm

•pH 5.5 – 7

•Average temperature > 8.5 ℃

•One year old Cuttings (20 cm) or rods (2 m), diameter 1.5 cm

•Plantation: end of April – middle of May

•Plant spacing:

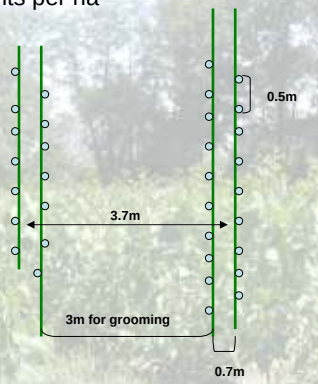
•**Poplar**: row spacing……..3m spacing in the row…..0.5m

6.666 plants per ha


Tested varieties: AF2, Monviso, Pegaso, Sirio…….Italien hybrids

**Willow**: double row, row spacing 3.7m spacing in the row 0.5m

10.811 plants per ha




Tested varieties: Inger, Sven, Tora, Tordis….Swedish hybrids

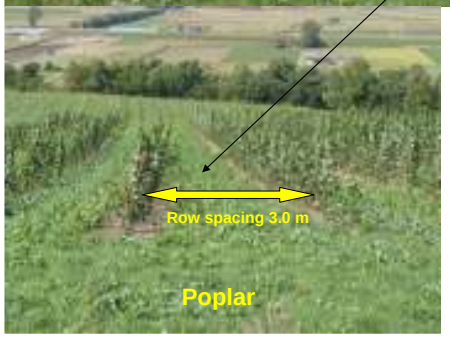
Planter with discs

1 year cuttings


Cover crops to prevent soil erosion

Xeric grassland communities

Grooming to save soil moisture

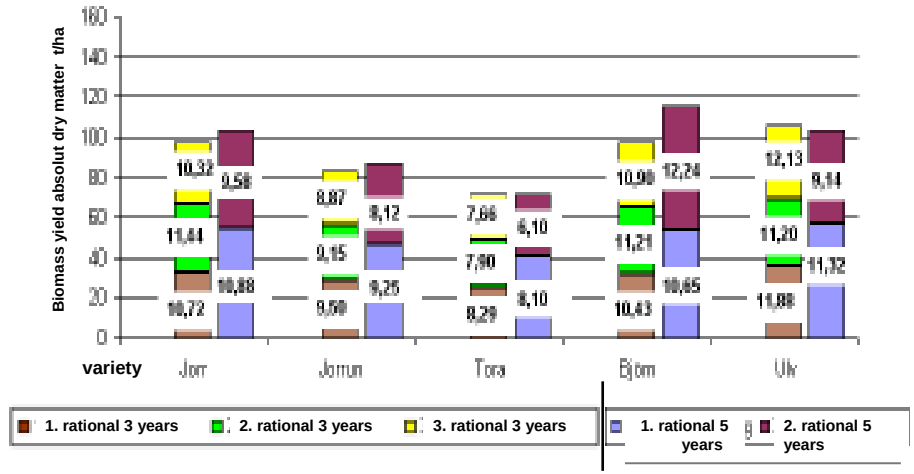




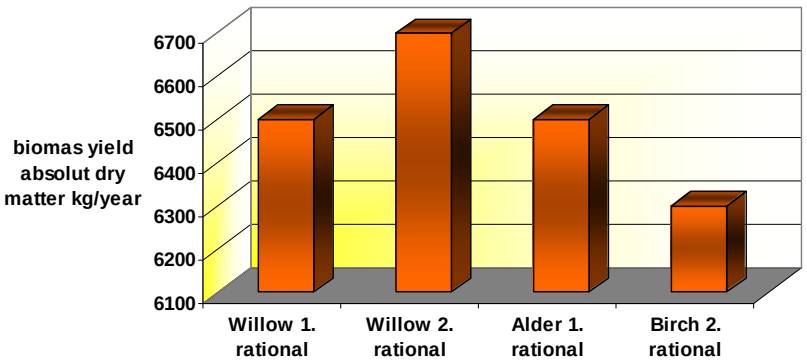
Test of varieties willow and poplar August first year after planting

**Results test of varieties willow and poplar Lower Austria – moderate transition climate (Amstetten – 100 km west of Vienna)**

**•Start 1996**



## Fast growing trees Edelhof - Zwettl (120 km northwest Vienna, cold climate conditions)




**Yield Poplar Amstetten 1996 - 2006**

variety

Harvest every 3 years……Jap 105……1.700 kg/ha/year dry matter  harvest every 5 years……1.100 kg/ha/year

Panonia.....5.900 kg  5.100 kg/ha/year


Growth after harvest

**Fast growing tree species**

•Poplar (populus)

•Willow (Salix)

•Frequency of harvesting:

Poplar ……4-5 years

Willow…….3-4 years

Expected yield…..8-**12**-15-20 t/ha/year

**willow**

1 st year after plantation in early summer time


Basta (Glyphosinate) under leaf spraying

**2nd year after plantation**

**Dry and hot period – damage on willow**


Growth 1st year


Growth 1st year after 3rd harvest


Willow 10 years old, 1st year after harvest


Willow 10 years old, 4th year after harvest ⇨harvest next winter

**Poplar 10 years old, 4th year after harvest ⇨harvest next winter**

**Wood shavings**

## Herbicide tests

Plot sprayer with special spray booms and band spraying

## Herbicide test 2007

| Herbicide | appointment | active substance | application rate | efficiency of herbicid % effect | | | Phyto toxicity | | 1 no Phytotox |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Lamium | Amaranthus | Echonochloa | 1 to 9 | | 9 total |
| | | | | amplexicaule | retroflexus | crus galli | Willow | Poplar | perisihing |
| **Nozomi** | pre emergency | Flumioxazin | 1.2 kg | 98 | 100 | 62 | 1 | 1 | |
| **Flexidor** | pre emergency | Isoxaben | 1.0 kg | 54 | 33 | 57 | 1 | 1 | |
| **Callisto** | pre emergency | Mesotrione | 1.5 kg | 92 | 22 | 25 | 1 | 1 | |
| **Chikara +** | pre emergency | Flazasulfuron | 0.2 kg | 88 | 75 | 88 | 1 | 1 | |
| **Break Thru** | | adjuvant | 0.3 l | | | | | | |
| **Chikara +** | pre emergency | Flazasulfuron | 0.15 kg | 80 | 72 | 83 | 1 | 1 | |
| **Break Thru** | | adjuvant | 0.3 l | | | | | | |
| **Bacara** | BBCH 14 | Diflufenican + | | 100 | 68 | 50 | 3 | 4 | |
| | | Flurtamone | 1 l | | | | | | |
| **Lontrel** | BBCH 25 | Clopyralid | 1.2 l | 33 | 22 | 28 | 1 | 1 | |
| **BAS 65903** | pre emergency | nn | 4 l | 50 | 22 | 52 | 1 | 1 | |
| **Stomp CS** | pre emergency | Pendimethalin | 4.4 l | 78 | 47 | 78 | 1 | 1 | |
| **Goltix SC +** | pre emergency | Metamitron | 2.5 l | | | | | | |
| **Goltix SC** | BBCH 14 | Metamitron | 2.5 l | 88 | 58 | 52 | 1 | 2 | |
| **Stomp CS +** | pre emergency | Pendimethalin | 3 l | | | | | | |
| **Aramo** | BBCH 25 | Tepralxydim | 2 kg | 77 | 63 | 100 | 1 | 1 | |


Phytotoxicity Bacara
Poplar

Bacara 1l/ha

2l/ha

Phytotoxicity Willow

# Deseases and Pests

**Polacia saliciperda**

**(variant Venturia Saliciperda)**

•Perishing of the tips of the sprout

•Infection in springtime 1. by Ascospores – from leafes on the soil or 2. infected tips from last year with Konidia, encouraged by wet conditions

Konidia

**Polacia**

Uredospurs
Melampsora larici populina

**Polpar rust** – spurs produced in summer

Teleutospurs
**Poplar rust**

**Willow weevil**

(Chrysomelidae)
feeds on leafes

Damage by game (deer) – **game bite** ⇨ fence

Control with Glyphosinate (Basta) under leaf spraying

**Clematis vitalba**

**Harvest with double chop harvester**

**Recultivation with rotary cultivatior – rotary brushwood chopper**

**Energy cereals (grain) for combustion**

•Maize Yield 9.000 kg/ha corresponds 3.500 l oil/ha

•Cereal yield 6.000 kg/ha corresponds 2.500 l oil/ha

•Fast growing trees yield 9.000 kg/ha corresponds 3.500 l oil/ha

•2,5 – 3 kg grain (cereals, maize) compensate 1 kg fuel oil

maize – 2,6 kg, barley – 2,7 kg, wheat – 2,9 kg, triticale – 3 kg, rape – 1,7 kg, sunflower – 1,7 kg, safflower – 2 kg

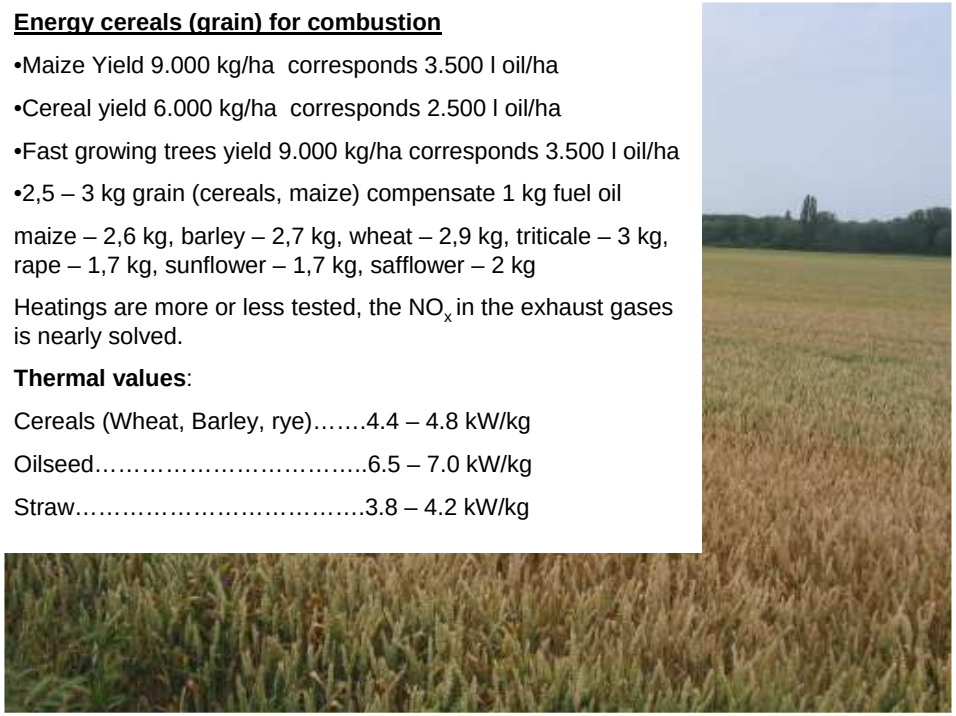
Heatings are more or less tested, the $NO_x$ in the exhaust gases is nearly solved.

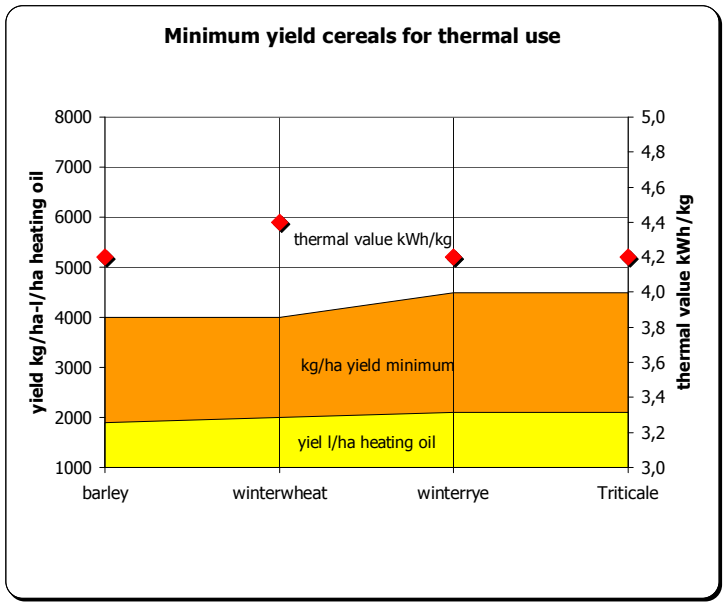
**Thermal values**:

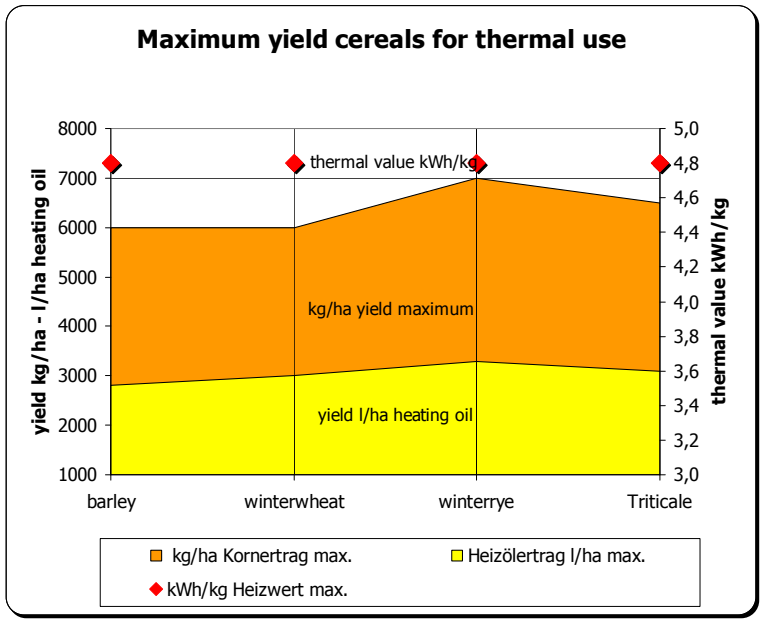
Cereals (Wheat, Barley, rye).....4.4 – 4.8 kW/kg

Oilseed.....6.5 – 7.0 kW/kg

Straw.....3.8 – 4.2 kW/kg



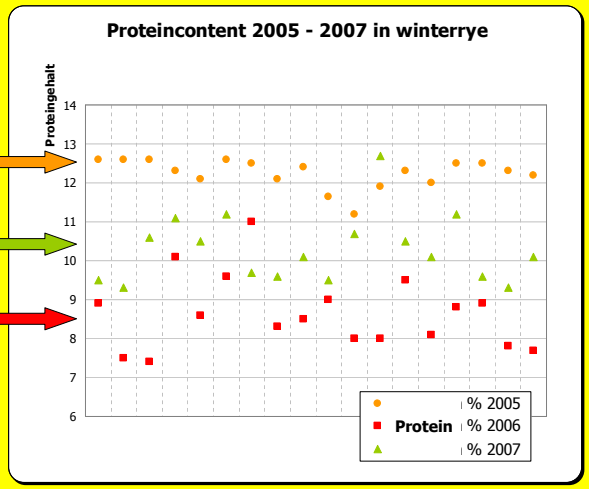


| variety | Winter rye | Protein % | Protein % | Protein % |
|---|---|---|---|---|
| | | 2005 | 2006 | 2007 |
| Kier | | 12,6 | 8,9 | 9,5 |
| Avanti | | 12,6 | 7,5 | 9,3 |
| Picasso | | 12,6 | 7,4 | 10,6 |

Same fertilisation

**Protein content depends much more from the year ( weather conditions) than from the agricultural measure**




Austria:

480 ha reported for energy cereals

250 boilers reported for energy cereals in Lower Austria, 0 in the other 8 Provinces

1.700 boilers for renweable energy ⇨ biomass for fuels – furnace reported


# conclusion

- Renewable bio energy has limits in available agricultural land
- Fast growing trees (polar, willow) have an enermous positive energy balance
- 2.0 – 2.5 kg timber replaces 1 kg heating oil
- Hybrids have a higher potential than varieties from conventional natural selection
- Plant protection is necessary, especial weed control in early growth and against Clematis vitalba
- Harvest full mechanized
- Recultivation after 10 – 20 years with rotary cultivator practicable
- Energy grain for combustion is possible, a cereal yield of 6.000 kg/ha corresponds 2.500 kg heating oil
- Energy grain can be produced on poor arable land – winterrye is superoir and has a low protein content ⇨ low $NO_x$ in the exhaust fumes
- Rivalry food – feed – renewable energy in the future