Effect of steam explosion pretreatment on the specific methane yield of *Miscanthus x giganteus*

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- Background & Objective
- Material and Methods
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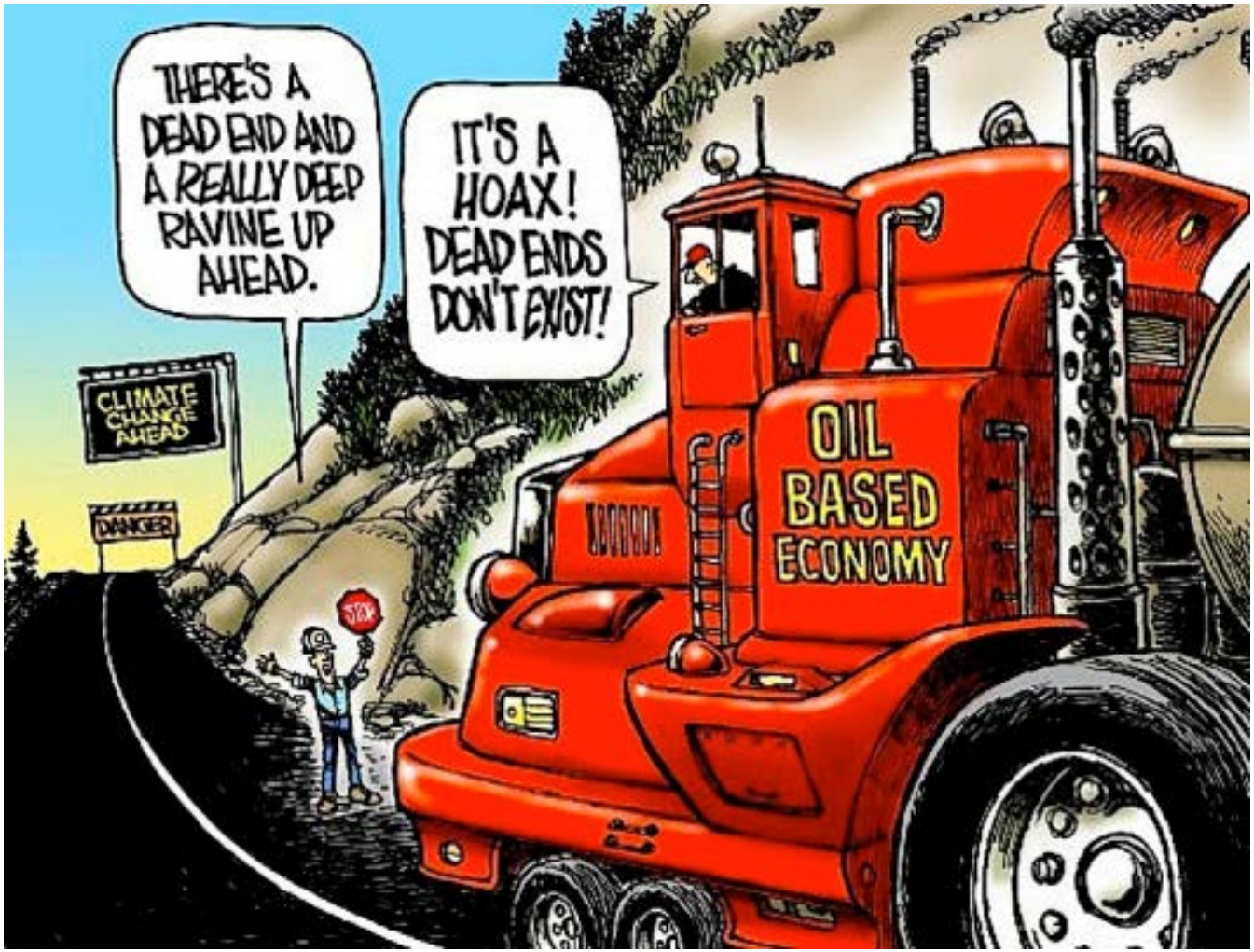
Background & Objective

Future energy production - Quo vadis?



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Future energy production - Quo vadis?

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- Fossil resources are limited
- Fossil based energy production leads to large emissions of greenhouse gases
- Energy from some solar (sun, water, wind) and geothermal sources is difficult to store and convert (electricity, liquid and solid fuels)
- Biomass provides the possibility of an easy physical, chemical or biological conversion to energy carriers with high energy density per volume
- Energy can be produced “on demand”

State of the Art – Cultivation of maize for energy production

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- Good soil quality required for convenient DM yields
- Tillage operations necessary every year
- Water supply is a crucial parameter
- Harvest processing needs good planning as there are some important factors (DM content, compaction, contamination) for production of a good silage
- Direct competition to food and feed production if used as an energy crop

Miscanthus – an opportunity for a sustainable feedstock?

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- Expensive and complex cropping in the first year (nursery plants)
- No further tillage operation necessary
- Harvestable for 15 years until yields decline
- Harvest takes place in the late winter → dry biomass which is easy to store
- Strong lignocellulose complex → pretreatment necessary for biological conversion
- **Not (necessarily) competing with food production if grown on fields with minor soil quality**

Processing lignocellulose from agriculture– cradle to cradle

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Objective

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Which methane hectare yields can be achieved if steam exploded Miscanthus is used for biogas production?

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Materials & Methods

Experimental Setup

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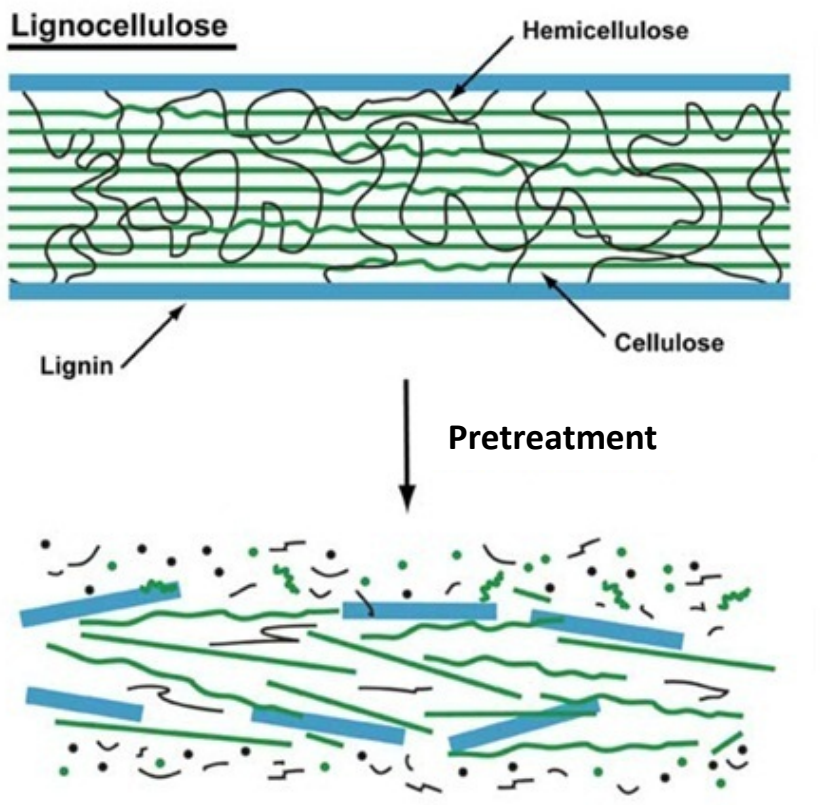
- Miscanthus was grown on a research farm about 10 km east of Vienna; the harvest took place in February 2010
- Pretreatment was carried out on a laboratory scale steam explosion facility in As, Norway
- Anaerobic batch experiments were carried out in Tulln, lower Austria

Steam Explosion pretreatment

- The biomass was treated with hot steam (190°C and 210°C) for a defined holding time (10, 15 and 20 minutes)
- Sudden pressure drop cause an immediate vaporization of water inside the biomass → „popcorn effect“
- Intensity of pretreatment expressed as „severity factor“



Source: http://www.ucl.ac.uk

Analysis of the biological methane potential (BMP)

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- Experiments were carried out at 37.5 °C using 250 ml Eudiometer batch systems
- For inoculation the liquid fermentation residue of a energy plant driven biogas plant was used
- Experiments last around 40 days

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Results

Effect of SE pretreatment on Miscanthus – REM microscopy

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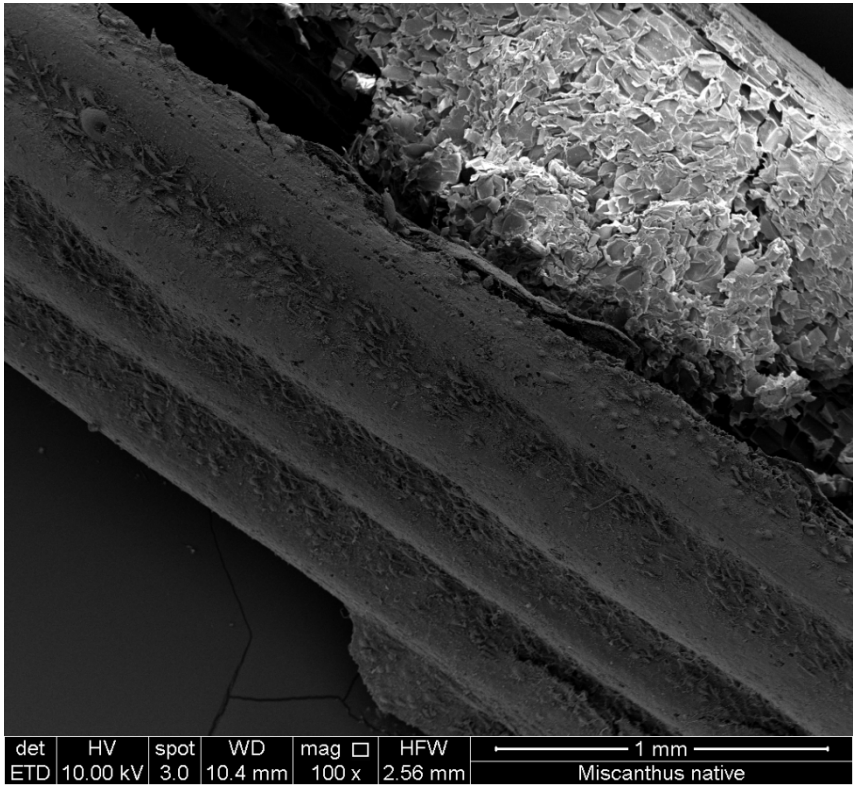

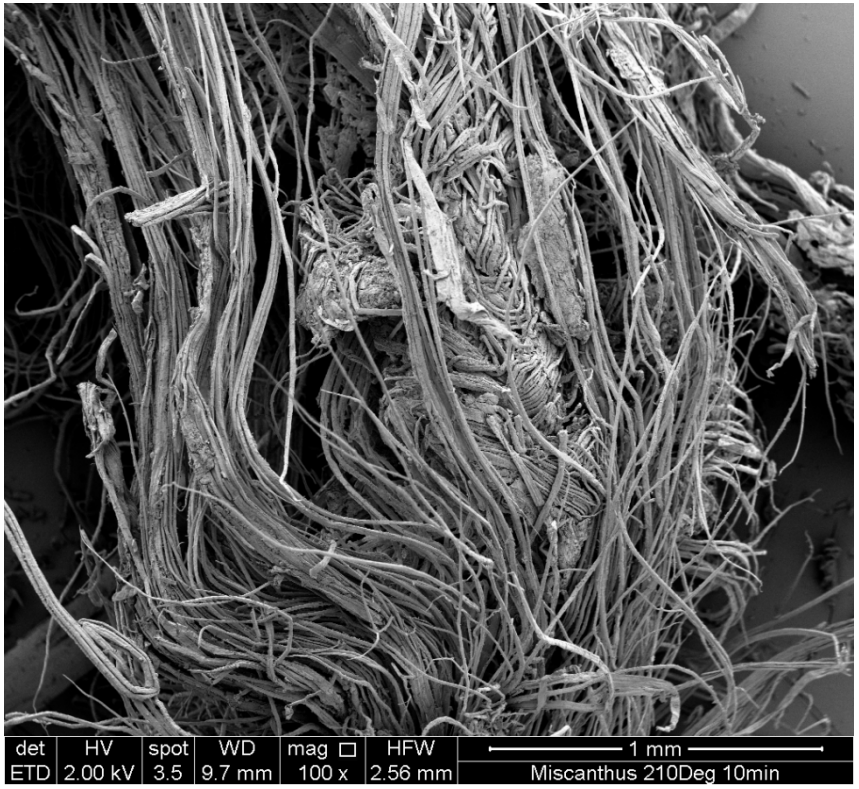

Biogas and methane potential of untreated and steam explosion treated Miscanthus

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	DM [%FM]	VS [% DM]	Severity factor [Log(R0)]	biogas [l_N kg VS^{-1}]	methane [l_N kg VS^{-1}]
untreated	88.4	97.9	-	130	84
190°C, 10 min	32.4	97.8	3.7	363	248
190°C, 15 min	36.0	97.7	3.8	448	279
190°C, 20 min	32.9	97.8	4	466	308
210°C, 10 min	28.0	97.4	4.2	541	345
210°C, 15 min	24.9	97.3	4.4	517	333
210°C, 20 min	24.0	97.6	4.5	511	331

Model for Miscanthus yields all over Europe

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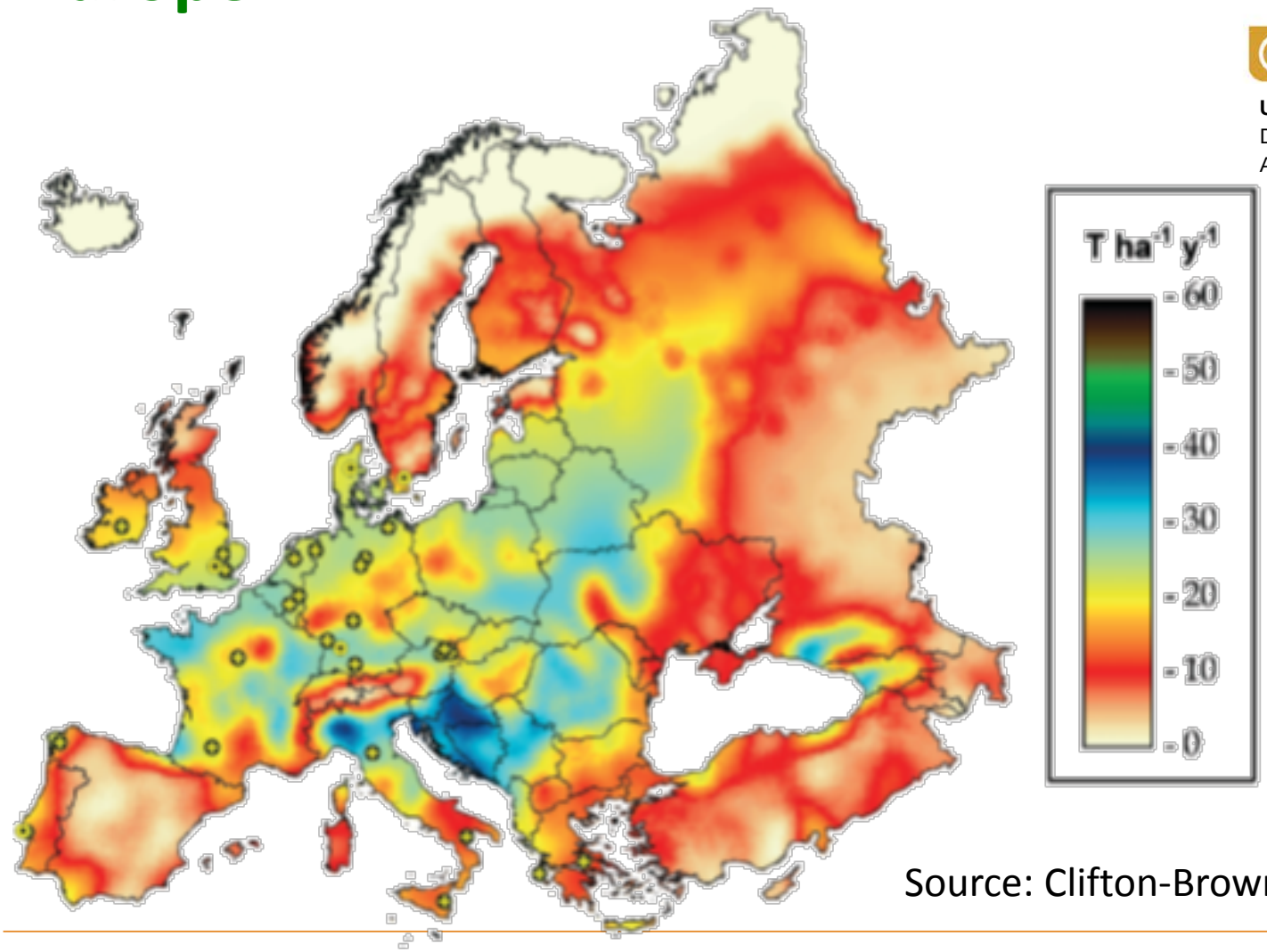
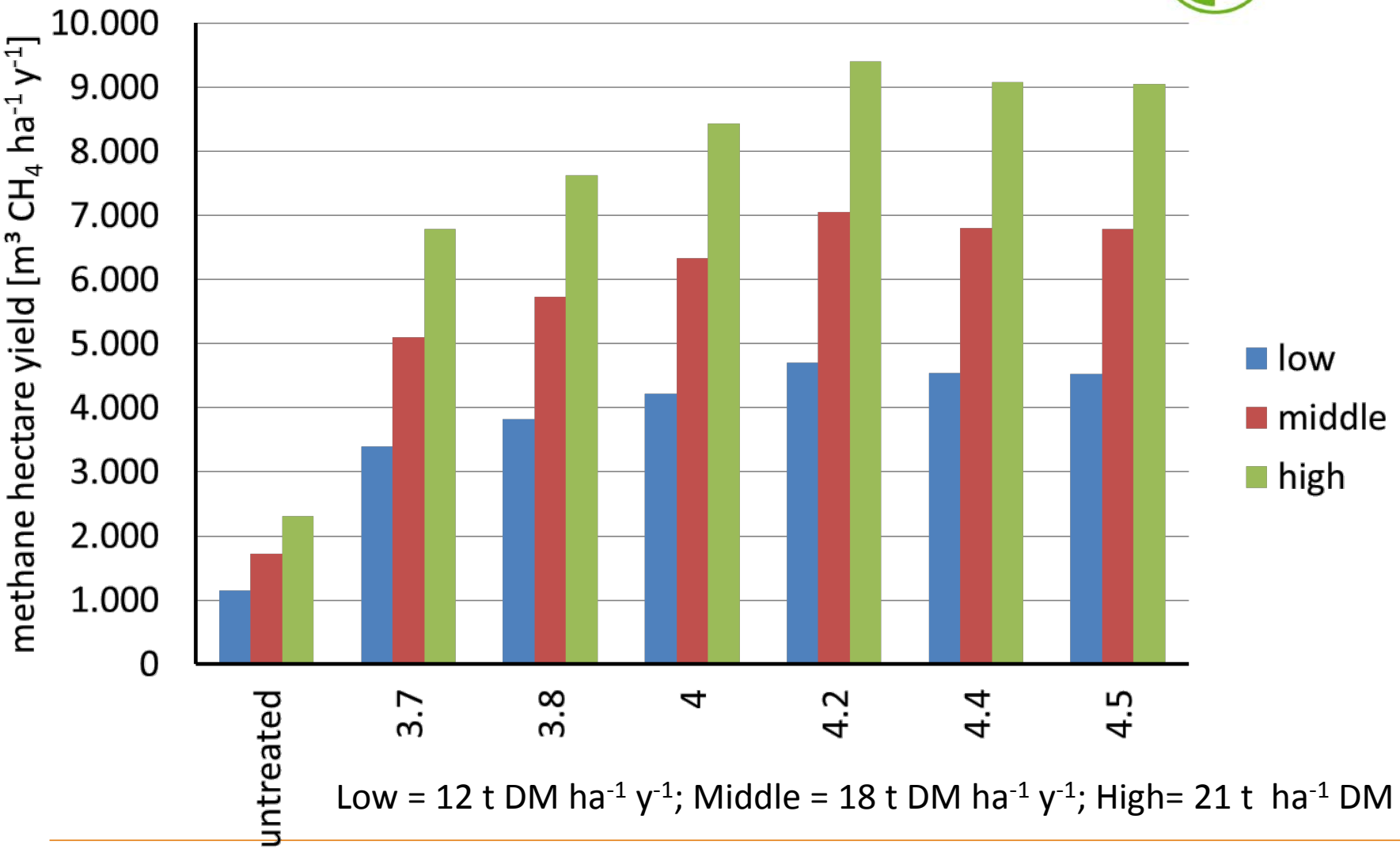


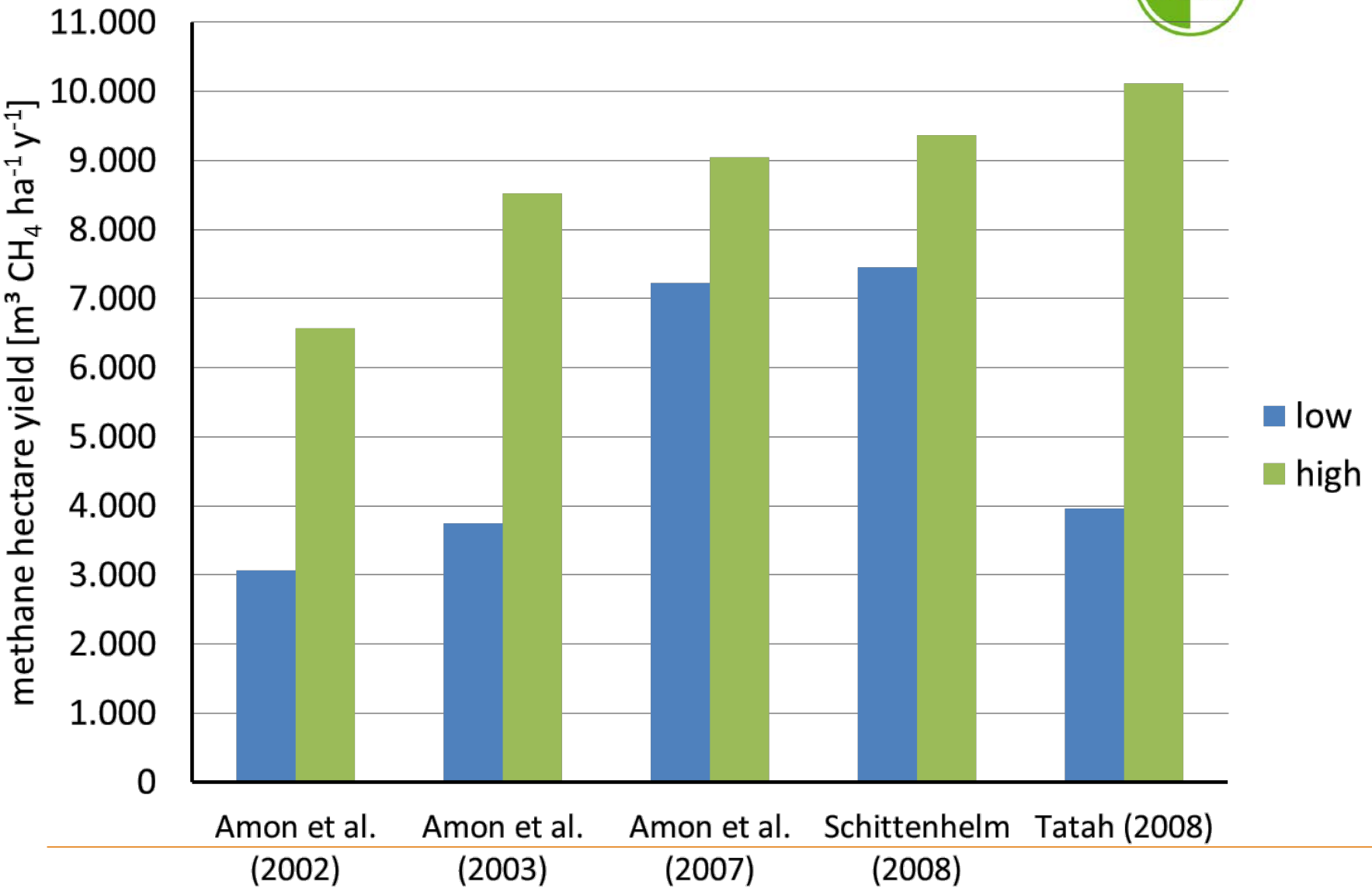
Source: Clifton-Brown et al., 2004

How much methane could be produced from Miscanthus?



Low = 12 t DM ha^{-1} y^{-1}; Middle = 18 t DM ha^{-1} y^{-1}; High= 21 t ha^{-1} DM y^{-1}

Methane hectare yields of maize as reported in literature



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Discussion & Outlook

Discussion & Outlook

- First results show already a high competitiveness of biogas production from steam explosion pretreated Miscanthus to conventional biogas production out of maize
- Further investigations have to be done concerning reliability of Miscanthus yields
- Areas in which miscanthus can be grown without competing to food and feed production have to be identified
- A source of unused thermal energy is crucial for a sustainable application of the steam explosion pretreatment

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Thank you very much for your attention!

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Department for Sustainable Agricultural Systems

Division of Agricultural Engineering

Working area for environmental engineering & bio-refinery