Influences of bioenergy production and use on the agribusiness in Northwest Germany

Henning Müller
ISPA

Presentation on 10-10-2007
Biomass Collaborative
UC Davis
Contents

I. ISPA - a short introduction

II. Bioenergy - backgrounds

III. Forms of bioenergy production

IV. Bioenergy production in the EU

V. Bioenergy production in Germany

VI. Biogas production

VII. Summary
I. ISPA - a short introduction

II. Bioenergy - backgrounds

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VII. Summary
Institute of Spatial Analysis and Planning in Areas of Intensive Agriculture (ISPA)

Departments (Director Professor Dr. Hans-Wilhelm Windhorst)

- Comparative spatial analysis
- Geo- and agroecology with main focus soil science
- Learning in rural areas and environmental education

Main research activities (selection)

- Comparable analysis of the socioeconomic structure of rural areas, especially areas with intensive agriculture in northwest Germany, Germany, the European Union and the USA

- Basic research in the field of socioeconomic and geoecological problems in regions with very intensive production of crops and animals, development of concepts and strategies to reduce the occurring problems, especially the surplus of the biotic waste, the increasing epidemic risk and the production of bioenergy
Institute of Spatial Analysis and Planning in Areas of Intensive Agriculture (ISPA)
## Live stocks in the County of Cloppenburg in comparison

<table>
<thead>
<tr>
<th>Animal Type</th>
<th>Cloppenburg County</th>
<th>Lower Saxony total</th>
<th>Germany total</th>
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<tbody>
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<td>Cattle (total)</td>
<td>(4) 164,440</td>
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<td>6,516,428</td>
<td>10,611,000</td>
</tr>
</tbody>
</table>

*Lower Saxony epizootic cash register, 2005*
### Live stocks: Communities in comparison (rang 1-10 in Lower Saxony)

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<th>Boesel</th>
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<td></td>
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<td>(2) 642,430</td>
<td>(1) 935,618</td>
<td>(3) 425,462</td>
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<tr>
<td>Livestocke unit per ha agricultural area</td>
<td>(2) 5.08</td>
<td>(1) 5.14</td>
<td></td>
</tr>
</tbody>
</table>
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III. Forms of bioenergy production
IV. Bioenergy production in the EU
V. Bioenergy production in Germany
VI. Biogas production
VII. Summary
Background – German perspective

- Seventies: Oil crisis and its global effects
- End of the last century
  - Increasing prizes for energy
  - Green party „Die Gruenen“ together with the SPD leads Germany
- 2001: IPCC publishes scenarios about global warming and climate change
- October 2006: Nicholas Stern publishes his report: Review on the Economics of Climate Change
- February 2007: IPCC publishes scenarios about the development of the climate in this century
Consequences

- Climate change is the main topic – other global changes are loosing importance

- Politicians, scientists and especially the media outperform each other in climate change scenarios

- Bioenergy is pronounced to be the „climate saver“ and according to the green party „Die Gruenen“ the farmer is „tomorrows oil sheik“

- Promotion of renewable energies and especially of biomass, without estimating the possible influences on existent structures

- „Planless planned economy“ in the field of energy policy
Arguments for bioenergy

- **Strategic aspect**
  - Independent on oil imports

- **Ecological aspect**
  - Climate protection

- **Economic aspect**
  - Additional income for farmers

- **Psychologic aspect**
  - Image of the agriculture in the public
I. ISPA - a short introduction

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VII. Summary
Bioethanol

- Bioethanol
  - Ethanol, from renewable resources (plant material (sugary, starchy), but also waste and residual materials)
  - 1 l bioethanol substitutes 0.65 l petrol (lower heating value)
  - Production in large-scale facilities

- Main production
  - USA:
    - legal regulations (mandatory blending)
    - broad basis of raw materials
  - Brazil:
    - well-engineered technology and infrastructure
    - excellent basis of raw materials (sugar cane)
### Die zehn führenden Staaten in der Ethanolproduktion (2006)

<table>
<thead>
<tr>
<th>Staat</th>
<th>Produktion (1.000 t)</th>
<th>% der Welterzeugung</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>15.579</td>
<td>39,1</td>
</tr>
<tr>
<td>Brasilien</td>
<td>13.429</td>
<td>33,3</td>
</tr>
<tr>
<td>China</td>
<td>3.041</td>
<td>7,5</td>
</tr>
<tr>
<td>Indien</td>
<td>1.501</td>
<td>3,7</td>
</tr>
<tr>
<td>Frankreich</td>
<td>751</td>
<td>1,9</td>
</tr>
<tr>
<td>Deutschland</td>
<td>604</td>
<td>1,5</td>
</tr>
<tr>
<td>Russland</td>
<td>511</td>
<td>1,3</td>
</tr>
<tr>
<td>Kanada</td>
<td>457</td>
<td>1,1</td>
</tr>
<tr>
<td>Spanien</td>
<td>365</td>
<td>0,9</td>
</tr>
<tr>
<td>Südafrika</td>
<td>305</td>
<td>0,8</td>
</tr>
<tr>
<td>10 Staaten</td>
<td>36.743</td>
<td>91,1</td>
</tr>
<tr>
<td>Welt</td>
<td>40.334</td>
<td>100,0</td>
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</table>
Getreideverbrauch in der Ethanolerzeugung

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<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU (in Mill. t)</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>USA</td>
<td>40</td>
<td>47</td>
<td>55</td>
</tr>
</tbody>
</table>

Sonstige

2005: 57
2006: 67
2007: 78
Weltproduktion von Ethanol– plus 39 Mio. m³ (85 %) in 10 Jahren
Biodiesel & plant oil

- **Biodiesel**
  - Transesterification of plant oil with methanol → glycerin separation
  - Oil plants e.g. rape seed oil, sunflower oil, soy bean oil, palm-oil, castor-oil
  - 1 l biodiesel substitutes 0.91 l diesel (lower heating value)

- **Main production**
  - Germany:
    - legal regulations
    - well-engineered technology and infrastructure
  - „Renewable Energy Law“ promotion for oil plant CHP
  - Use in buses and trucks
Projektion des Welt-Biodieselverbrauchs im Jahr 2010
(Annahme: Nutzung aller angekündigten Kapazitäten)

- Australien
- Indien
- China
- Indonesien
- Malaysia
- Argentinien
- Brasilien
- USA
- EU-25

+15 Mio. t

<table>
<thead>
<tr>
<th>Jahr</th>
<th>Australien</th>
<th>Indien</th>
<th>China</th>
<th>Indonesien</th>
<th>Malaysia</th>
<th>Argentinien</th>
<th>Brasilien</th>
<th>USA</th>
<th>EU-25</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009/10</td>
<td>8.362</td>
<td>2.010</td>
<td>2.710</td>
<td>7.347</td>
<td>1.510</td>
<td>2.010</td>
<td>2.268</td>
<td>2.200</td>
<td>2.710</td>
</tr>
</tbody>
</table>

(15 Mio. t = 15,000,000 Tonnen)
<table>
<thead>
<tr>
<th>Jahr</th>
<th>Biodieselverbrauch (1.000 t)</th>
<th>Benötigtes Ackerland (1.000 ha)</th>
<th>Zunahme (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005/06</td>
<td>5.055</td>
<td>3.220</td>
<td>-</td>
</tr>
<tr>
<td>2006/07</td>
<td>8.267</td>
<td>5.266</td>
<td>63,5</td>
</tr>
<tr>
<td>2007/08</td>
<td>14.082</td>
<td>8.969</td>
<td>70,3</td>
</tr>
<tr>
<td>2008/09</td>
<td>17.990</td>
<td>11.459</td>
<td>31,8</td>
</tr>
<tr>
<td>2009/10</td>
<td>20.906</td>
<td>13.316</td>
<td>16,2</td>
</tr>
<tr>
<td>Zunahme (%)</td>
<td>314,6</td>
<td>313,5</td>
<td>-</td>
</tr>
</tbody>
</table>
Biogas

- **Biogas**
  - Product of the anaerobic fermentation of organic material (e.g. energy plants (maize, sorghum, crop,...), manure, slaughter waste)
  - 50-60 % methane, 40-50 % carbon dioxide
  - 1 kg biomethane substitutes 1.5 l petrol and 1.3 l diesel
    (1 m³ substitutes 0.94 l petrol und 1.08 l diesel)
  - Use as fuel by gas purification or in a CHP for the production of electricity and heat

- **Main production**
  - Germany:
    - legal regulations („EEG“)
    - well-engineered technology
    - up to now high acceptance
### Biogas production

- **Legal basis** *(Renewable Energy Law („EEG“) from 2000 resp. 2004)*

<table>
<thead>
<tr>
<th></th>
<th>Allowance in [Euro Cent/kWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
</tr>
<tr>
<td>up to 150 kW</td>
<td>11.5</td>
</tr>
<tr>
<td>from 150 to 500 kW</td>
<td>9.9</td>
</tr>
<tr>
<td>from 500 to 5 MW</td>
<td>8.9</td>
</tr>
<tr>
<td>from 5 MW to 20 MW</td>
<td>8.4</td>
</tr>
</tbody>
</table>

**Biomass-bonus**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 500 kW</td>
<td>6</td>
</tr>
<tr>
<td>from 500 kW to 5 MW</td>
<td>4</td>
</tr>
</tbody>
</table>

- **Amendment* of the „EEG“:**
  - Use of manure (more than 30% excrements: additional 3 Ct/kWh

* Agrar Europe
I. ISPA - a short introduction

II. Bioenergy - backgrounds

III. Forms of bioenergy production

IV. Bioenergy production in the EU

V. Bioenergy production in Germany

VI. Biogas production

VII. Summary
## Biodiesel und Ethanolherstellung in ausgewählten Staaten der EU (2003/05)

<table>
<thead>
<tr>
<th>Staat</th>
<th>Biodiesel (1.000 t)</th>
<th>Ethanol (1.000 t)</th>
<th>Gesamt (1.000 t)</th>
<th>Anteil (%) an EU (25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deutschland</td>
<td>1.850</td>
<td>200</td>
<td>2.050</td>
<td>64,3</td>
</tr>
<tr>
<td>Frankreich</td>
<td>370</td>
<td>111</td>
<td>481</td>
<td>15,1</td>
</tr>
<tr>
<td>Spanien</td>
<td>65</td>
<td>202</td>
<td>267</td>
<td>8,4</td>
</tr>
<tr>
<td>Schweden</td>
<td>1</td>
<td>147</td>
<td>148</td>
<td>4,6</td>
</tr>
<tr>
<td>Polen</td>
<td>2</td>
<td>60</td>
<td>62</td>
<td>1,9</td>
</tr>
<tr>
<td>Österreich</td>
<td>55</td>
<td>0</td>
<td>55</td>
<td>1,7</td>
</tr>
<tr>
<td>Tschech. Rp.</td>
<td>47</td>
<td>0</td>
<td>47</td>
<td>1,5</td>
</tr>
<tr>
<td>Dänemark</td>
<td>45</td>
<td>0</td>
<td>45</td>
<td>1,4</td>
</tr>
<tr>
<td>Ungarn</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>0,2</td>
</tr>
<tr>
<td>Niederlande</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>0,1</td>
</tr>
<tr>
<td>Slowakei</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0,1</td>
</tr>
<tr>
<td>Lettland</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>0,1</td>
</tr>
<tr>
<td>EU (25)</td>
<td>2.460</td>
<td>726</td>
<td>3.186</td>
<td>100,0</td>
</tr>
</tbody>
</table>

*USDA, FAS: GAIN Report E 36122*
Scenario 2010 for the biofuel production and demand of crop land in the EU (27)

- **Biofuel production 24 Mill. t**
  - Perspective: 50 % own production, 50 % imports
  - Aimed fraction of biofuels: 5.75 % (EU-Regulation 2003/30/EU)

- **Total demand (crop land) 15 - 18 Mill. ha**
  - Fraction of crop land of the EU (27): 13-15 %
  - 50 % own production: 8.25 Mill. ha ~ 7 - 8 % of total crop land of the EU (27)

- **8.25 Mill. ha – from where?**
  - 4 Mill. ha set-aside of agricultural land
  - 3 Mill. ha new cultured crop land
  - 1.25 Mill. ha former sugar beets
Scenario 2020 for the biofuel production and demand of crop land in the EU (27)

- Target 20% of the total fuel production
- Total demand (crop land) 57 - 60 Mill. ha
  - Fraction of crop land of the EU (27): 50 - 55%
  - 50% own production: 30 Mill. ha ~ 25 - 27% of total crop land of the EU (27)
- 30 Mill. ha – from where?
  - ???

- In comparison*
  - In the EU (25) there lie 7.3 Mill. ha idle, thereof 2.8 Mill. ha voluntarily set-aside agricultural land
  - On estimated 1 Mill. ha thereof grow renewable resources

USDA, FAS: GAIN report E 36122
Windhorst, ISPA *Bickert, DLG
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VI. Biogas production

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Bioenergy production in Germany

- **Renewable Energy Law („EEG“):**
  - Grants are the basis for the fast development of renewable energies in Germany

- **Fraction of renewable energies on the energy supply (2006):**
  - 5.3 % on the primary energy consumption
  - 11.85 % fraction of gross power consumption (target 12.5 % for 2010)
  - around 6 % fraction of the total heat production
  - 5.8 % fraction of the fuel consumption (EU-target 5.75 % until 2010)

*BMWi (2007), Kaltschmitt (2007)*
Thought experiment

- Thought experiment:
  - Review of the claims of environment minister S. Gabriel

- Framework:
  - The input materials are only taken from Germany
  - State-of-the-art technology is assumed
  - Numbers are not to be analysed by the absolute value, but more by the tendency

- Claims (2020)
  - Biofuels: 17 % fraction of the total fuel consumption
  - Biogas: 10 % of the power consumption by biogas
  - Cultivation of special energy plants and alternative cultivation methods
<table>
<thead>
<tr>
<th>product</th>
<th>harvest [l/t FM bzw. m³/t FM]</th>
<th>energy [kWh/t FM]</th>
</tr>
</thead>
<tbody>
<tr>
<td>crop (bioethanol)</td>
<td>360</td>
<td>2,117</td>
</tr>
<tr>
<td>rape-seed (biooil)</td>
<td>344</td>
<td>3,788</td>
</tr>
<tr>
<td>maize (biogas)</td>
<td>105</td>
<td>1,048 elec.: 419</td>
</tr>
</tbody>
</table>
Energy demand to achieve claims of the environment minister:

<table>
<thead>
<tr>
<th>form of energy</th>
<th>consumption [bill. kWh/year]</th>
<th>target (%) for fraction of biofuel and biogas</th>
<th>necessary production [bill. kWh/year]</th>
</tr>
</thead>
<tbody>
<tr>
<td>petrol*</td>
<td>188.6</td>
<td>17</td>
<td>32.1</td>
</tr>
<tr>
<td>diesel*</td>
<td>341.4</td>
<td>17</td>
<td>58</td>
</tr>
<tr>
<td>elect. **</td>
<td>570</td>
<td>10</td>
<td>57</td>
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crop land demand to achieve claims of the environment minister:

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<tbody>
<tr>
<td>crop</td>
<td>15.2</td>
<td>7.0</td>
<td>2.2</td>
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<tr>
<td>rape-seed</td>
<td>15.3</td>
<td>3.5</td>
<td>4.4</td>
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<tr>
<td>maize</td>
<td>136</td>
<td>40</td>
<td>3.4</td>
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Thought experiment

- **Conclusions**
  - By using state-of-the-art technology 10 Mill. ha crop land would be necessary to fulfill the claims
  - The total crop land in Germany is about 12 Mill. ha
  - This is a fraction of around 83%!
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II. Bioenergy - backgrounds

III. Forms of bioenergy production

IV. Bioenergy production in the EU

V. Bioenergy production in Germany

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VII. Summary
Biogas in Germany

- **Biogas production (2006)**
  - 3300 biogas plants with around 1 GW elec. power
  - 6.5 TWh/a potential annual power production
  - 5.4 TWh/a effective annual power production
  - Fraction of german power production 0.9 %

- **Biogas production (2020) – „Fachverband Biogas e.V.“**
  - Biogas production with around 9.5 GW elec. power
  - 76 TWh/a annual power production
  - Fraction of german power production 7 %

*Kaltschmitt, IUE Leipzig (2007)*
Biogas in Germany

- **Crop land for maize**
  - 400,000 ha (2006) – 3.3% of the total crop land
  - 3.8 Mill. ha (2020) - 32% of the total crop land

- **Crop production on this area**
  - 2.8 Mill. t (2006)
  - 26.6 Mill. t (2020)

- **In comparison**
  - German animal feed imports in 2006 approx. 6 Mill. t*
  - Official statistics for the cultivation of energy maize in 2006 approx. 162,000 ha (Deutsches Maiskomitee e.V.) – 1.4% of total crop land

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*Windhorst, ISPA*
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</tbody>
</table>

| Livestock unit per ha agricultural area | (2) 5.08 | (1) 5.14 |   |

*Lower Saxony epizootic cash register, 2005*
Biogas in our region

- Biogas plants in the County of Cloppenburg
  - 80 biogas plants approved, 68 biogas plants at work

<table>
<thead>
<tr>
<th></th>
<th>Friesoythe</th>
<th>Garrel</th>
<th>Bösel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas plants</td>
<td>29</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>power [kW]</td>
<td>13,587</td>
<td>2,883</td>
<td>2,830</td>
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<td>Ø [kW]</td>
<td>468.5</td>
<td>411.8</td>
<td>471.7</td>
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<td>crop land demand</td>
<td>5,434.8</td>
<td>1,153.2</td>
<td>1,132</td>
</tr>
<tr>
<td>maize [ha]</td>
<td></td>
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</tbody>
</table>

- Biogas plants in the County of Vechta
  - 12 biogas plants approved, 11 biogas plants at work

Building authority Cloppenburg (04/2007), Vechta (09/2007)
Outlook

- **Bio-Biogas – Biogas from ecologically farming**
  (requests for a better promotion)

- **Voluntary agreements of the natural gas economy**
  (transport sector)
  - until 2010 substitute 10% natural gas by biomethane
  - until 2020 substitute 20% natural gas by biomethane
Biokraftstoffe im Vergleich
So weit kommt ein Pkw mit Biokraftstoffen von 1 Hektar Anbaufläche

- **Biomethan**: 67 600 km
- **BtL (Biomass-to-Liquid)**: 64 000 km
- **Rapsöl**: 23 300 km + 17 600 km*
- **Biodiesel**: 23 300 km + 17 600 km*
- **Bioethanol**: 22 400 km + 14 400 km*

*Biomethan aus Nebenprodukten (Rapskuchen, Schlempe, Stroh)

Pkw-Kraftstoffverbrauch: Otto 7,4 l/100 km, Diesel 6,1 l/100 km

Quelle: Fachagentur Nachwachsende Rohstoffe e. V. (FNR)
I. ISPA - a short introduction

II. Bioenergy - backgrounds

III. Forms of bioenergy production

IV. Bioenergy production in the EU

V. Bioenergy production in Germany

VI. Biogas production

VII. Summary
Positive aspects for bioenergy

- **Bioenergy production and use can**
  - reduce the import dependence from oil exporting countries
  - reduce the energy-based greenhouse gas emissions
  - offer farmers an additional and higher income
  - result in a sustainable use of natural resources
  - create innovations and job opportunities
  - create regional supply chains (e.g. Bioenergy Village Juehnde in Lower Saxony)
Negative aspects for bioenergy

- **Bioenergy production and use can**
  - create a import dependence to biomass exporting countries
  - reduce the crop land available for bread and animal feed
  - result in increasing prices for mineral fertiliser, animal feed, land and lease as well as food
  - hurt developing countries disproportionally high
  - result in negative ecological impacts:
    - clearing of tropical rain forests
    - spreading of plant diseases and vermins
    - soil damages
    - threat to the groundwater quality
Biogas production in renewable resource biogas plants

- „EEG“ resulted in a biogas-boom based on renewable resources
- relatively high crop land demand (and costs)
  - production of input materials 40-50 ha / 100 kW → purchase
  - output of digester material → manure transports
- high investment needs 3000 €/kWₑ → because of the interest payments farmers cannot invest in other branches and modernise these!
- dependent on promotions
- In the centers of „animal production“
  - „Battle for crop land“ → high prices for land and maize, bad crop rotation (specialised crops!), increased animal feed,…
  - increasing epizootic risk → increasing number of vermins,…
  - animal body removal → some biogas plants are approved for the use of slaughter waste, companies have problems to run there factories economically (results in problems in case of a disease)
Concluding words - Requests

- Perception of the problem „climate change“ is biased
  - reasonable basis for discussions
  - other global changes have to be considered
  - cost-benefit analyses for further promotions

- „Energy economy as a planless planned economy“
  - development of a strategic concept for the future energy supply in Germany
  - energy future – intensify research
  - instruments like electricity exchange market and emission certificates market have to be reformed

- Estimation of consequences about the impacts of promotions, e.g. „EEG“
Concluding words - Requests

- Onesided discussion about the use of renewable energies – energy reduction and energy efficiency!
- Bioenergy production and use have to be sustainable and the growing world population has to be taken into account
- Farmers should not launch themselves into new dependencies
Thank you for your attention!

M.Sc. Henning Mueller
Institute for Spatial Analysis and Planning in Areas of Intensive Agriculture (ISPA)
University of Vechta
Driverstr. 22
49377 Vechta
Phone: +49 4441/15-405
hmueller@ispa.uni-vechta.de