## Module Handbook
### Sustainable Fuel Systems for Mobility - Groningen

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<tr>
<th>Fakultät 5: Mathematik und Naturwissenschaften Institut für Physik</th>
<th>Category:</th>
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<tbody>
<tr>
<td>Subject: European Master in Renewable Energy Summer Term 2017</td>
<td>- Master Module</td>
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<td>Degree award:</td>
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<td>- Master</td>
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<tr>
<th>Emphases:</th>
<th>Sections:</th>
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<thead>
<tr>
<th>Module reference number/Title:</th>
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<tr>
<td>pre381 - Processes, Models &amp; Modelling</td>
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<thead>
<tr>
<th>Duration: 1 semester</th>
<th>Type of program:</th>
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<tr>
<td>Cycle: once a year</td>
<td>Lecture, Laboratory, Excursion</td>
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<tr>
<td>Type of module: mandatory</td>
<td>Language: English</td>
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<tr>
<td>Level: MM (master module)</td>
<td>Attainable credit points: 10,00 CP</td>
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<tr>
<td>This module should be taken in 2nd semester</td>
<td>Workload: 280 hours</td>
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<td>Required attendance: 100 hours</td>
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<tr>
<th>Person responsible for the programme:</th>
<th>Person responsible for this module:</th>
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<tbody>
<tr>
<td>Ir. G. Kuiken</td>
<td>Prof. Dr. J. Dam</td>
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<tr>
<th>Alternative person(s) responsible for this module:</th>
<th>Examiner(s):</th>
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<tbody>
<tr>
<td>Dr. Ir. J. Bekkering</td>
<td>Prof Dr. J. Dam, dr A Perl, Dr. Ir. J. Bekkering</td>
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**Objective of the module / skills:**
To have demonstrated knowledge and understanding of
- Theoretical concepts
- Material Aspects
- Control & Measurement aspects
- Gas: Production/Conversion/ Treatment/Storage (Hydrogen, BioGas, Green Gas, LNG)
- Liquid: Gas to Liquid; Ethanol, Hydrogen, LNG
- Solid (Clean Coal, BioMass)

To be able to:
- Present an overview of the processes
- Understand the processes for fuel production with a focus on downstream
- Apply theory and concepts in models with a set of constraints for optimizing production and supply chains production and supply

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<th>Content of the module:</th>
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<tbody>
<tr>
<td>Theoretical concepts</td>
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<td>Combustion</td>
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</table>
- Electromagnetics
- Fluid dynamics
- States (static, transients, phase change)

Materials
- Elaboration of subtopics

Control & Measurement
- Pressure, Heat, Temperature, Flow
- Equipment (valves, pipes, storage, pumps, compressors, Exchangers, Cooling)
- Instrumentation for measuring (Symbols, process diagrams, sensors)

Gas: Production/Conversion/ Treatment/Storage (Hydrogen, Bio Gas, Green Gas, LNG)
- Hydrogen: production (electrolysis, Sabatier, P2G)
- CBG & CNG: compression, storage, application
- Application of Sustainable Gasses in mobility
- Sustainability of gas supply chains
- Liquid: Gas to Liquid; Ethanol, Hydrogen, LNG
- Elaboration of subtopic lectures and lab work

Solid (Clean Coal, Biomass)
- Biochemical
- Thermochemical
- Chemical

Storage
- Introduction
- Overview non electrochemical storage devices (Compressed Air, Pumped Hydro, Fly Wheels, Superconducting magnetic energy storage, Capacitors, Comparison technologies)
- Overview electrochemical storage (Batteries, Hydrogen, Methane)

Suggested reading:
To be announced at the beginning of the lecture period

Comments:
- 

Weblink:
- 

Prerequisites for admission:
- 

Helpful previous knowledge:
- 

Associated with the module(s):
- 

Maximum number of students / selection criteria:
- 

Types of examinations:
Theoretical Concepts (20%): Written exam (1.5 hours)
Measurement & Control (20%): Assignment (written report and presentation)
Fuels (20%): Assignment (written report and presentation)
Storage (20%): Written exam (1.5 hours)
Supply Chain Design (20%): Assignment (written report and presentation)
Examination periods:
Theoretical Concepts: April
Measurement & Control: March
Fuels: March
Storage: March
Supply Chain Design: April
Registration procedure:
-
**Fakultät 5: Mathematik und Naturwissenschaften**  
Institut für Physik  
*Subject: European Master in Renewable Energy*  
Summer Term 2017

| **Category:** |  
| - Master Module |
| **Degree award:** |  
| - Master |

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**Module reference number/Title:**  
*pre382 - Biochemical Conversion*

| **Duration:** | 1 semester |
| **Cycle:** | once a year |
| **Type of module:** | mandatory |
| **Level:** | MM (master module) |
| **This module should be taken in 2nd semester** |  

| **Type of program:** | - Lecture, Laboratory, Excursion, Tutorial  
**Language:** | English  
**Attainable credit points:** | 10,00 CP  
**Workload:** | 280 hours  
**Required attendance:** | 100 hours |

| **Person responsible for the programme:** | Ir. G. Kuiken  
**Person responsible for this module:** | Dr. J.P. Nap, Dr. F. Faber, Dr. M. Ciepliek (ECN) |

| **Alternative person(s) responsible for this module:** | -  
**Examiner(s):** | Dr. F. Faber, Dr. M. Barankin, Dr. M Ciepliek (ECN) |

**Objective of the module / skills:**  
To have demonstrated knowledge and understanding of  
- Chemistry to calculate the thermodynamic outcome of various (bio-) chemical reactions.  
- Distinguishing the many choices in biological conversion processes  
- The practical challenges that influence availability and reliability of a plant  
- Unit operations that are required for a given process  
To be able to  
- Make mass and energy balances in biological conversion processes  
- Set up a biological conversion experiment (e.g. anaerobic digestion or photo bioreactors)  
- Model a biofuel production plant and calculate energy conversion efficiencies  
- Contribute to discussions with experts

**Basic biochemistry**  
- Molecule concept (Basic chemistry)  
- Thermodynamics (calculations on energy and work of chemical reactions)  
- Metabolism: various metabolic processes related to biofuel production  
  - Photosynthesis: energy efficiencies and energy content  
  - Biomass: sources and availability, composition

**The making of renewables**  
- Types of biofuels (Bio-ethanol, Bio-methane, Bio-diesel, Bio-hydrogen, Bio-kerosene and bio-oil,  
  Power to biofuel, Comparison with fossil)
- Biological conversion techniques
  - Anaerobic Digestion (Bio-methane)
  - Fermentation (Bio-ethanol)
  - Fermentation (Bio-hydrogen)
  - Transesterification (Bio-Diesel)
- Pre-treatment technology: increasing conversion efficiencies
- Modelling: calculations on microbial growth and biofuel production
- Bioreactor design and operation, bio-methane, bio-ethanol and algal oils (foto bioreactors)
- New technologies in biofuel productions (increasing efficiencies by genetic engineering)
- Economy: modelling and LCA analysis for cost effect biofuel production

The use of biofuels
- Bio refinery and upgrading
- End-use specifications (combustion properties, energy density, storage properties, logistics)
- Mobility
  - Fuel suitability
  - Engine types
  - E-bike; hybrid car, other
  - Infrastructure
- Energy balance
- Evaluation business cases

**Suggested reading:**
To be announced at the beginning of the lecture period

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**Maximum number of students / selection criteria:**

- **Types of examinations:**
  - Basic Chemistry (20%): Written exam (1.5 hours)
  - Making (30%): Written exam (1.5 hours)
  - BioEthanol (20%): Assignment (written report and presentation)
  - Aspen Programming (30%): Assignment (written report and presentation)

**Examination periods:**

- May

**Registration procedure:**
-
### European Master in Renewable Energy

**Summer Term 2017**

**Subject:** European Master in Renewable Energy

**Category:** Master Module

**Degree award:** Master

**Module reference number/Title:**

**pre383 - Thermochemical Conversion**

**Duration:** 1 semester  
**Cycle:** once a year  
**Type of module:** mandatory  
**Level:** MM (master module)  
**This module should be taken in 2nd semester**

**Type of program:** -  
**Lecture, Laboratory, Tutorials**

**Language:** English  
**Attainable credit points:** 5,00 CP  
**Workload:** 140 hours  
**Required attendance:** 50 hours

**Person responsible for the programme:**  
Ir. G. Kuiken

**Person responsible for this module:**  
Prof. Dr. J. Dam

**Alternative person(s) responsible for this module:**  
-

**Examiner(s):**  
Prof. Dr. J. Dam

**Objective of the module / skills:**

- To have demonstrated knowledge and understanding of  
  - distinguishing between many choices in thermochemical conversion processes  
  - unit operations that are required for a given process  
  - the practical challenges that influence availability and reliability of a plant  
  - literature being published in the field

- To be able to  
  - make mass and energy balances  
  - evaluate new concepts in terms of efficiency and economics  
  - set up a conversion experiment  
  - contribute to discussions with experts

**Content of the module:**

1. **Conversion techniques:**  
   - Combustion  
   - Torrefaction  
   - Pyrolysis  
   - Gasification  
   - Hydrothermal Upgrading

2. **Reactor design / modelling**
**Suggested reading:**
To be announced at the beginning of the lecture period

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**pre384 - New Business**

| **Subject:** European Master in Renewable Energy  
| **Summer Term 2017** |
| **Category:** - Master Module  
| **Degree award:** - Master |

**Module reference number/Title:**

| **pre384 - New Business** |

| **Duration:** 1 semester  
| **Cycle:** once a year  
| **Type of module:** mandatory  
| **Level:** MM (master module)  
| **This module should be taken in 2nd semester** |

| **Type of program:** -  
| **Lecture, Laboratory, Excursion, Tutorials**  
| **Language:** English  
| **Attainable credit points:** 5,00 CP  
| **Workload:** 140 hours  
| **Required attendance:** 50 hours |

| **Person responsible for the programme:**  
| Ir. G. Kuiken  
| **Person responsible for this module:**  
| Dr. M. Schoondorp  

| **Alternative person(s) responsible for this module:**  
| -  
| **Examiner(s):**  
| Dr. M. Schoondorp |

**Objective of the module / skills:**

To have demonstrated knowledge and understanding of:
- The various context factors and issues around sustainable fuel systems, mobility and system integration
- Working with energy concepts and issues around sustainable fuel systems and mobility

To be able to:
- Evaluate legal and social issues around sustainable fuel systems, mobility and system integration
- Judge and provide argumentation turning theory into practice
- Integrate concepts and new developments in solutions
- Perform a basic LCA (hands-on) and interpret the outcomes of more complex LCA

**Content of the module:**
- Concept of Algae Fuels
- Business Model Theory
- Life Cycle analysis, regulation, risk assessment, finance
- Development of own concepts
- The art of elevator pitches

**Suggested reading:**
Algae Biofuels (pdf)
Outline Business Model Canvas (provided)
### Scientific Articles (provided)

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**Maximum number of students / selection criteria:**
-  

**Types of examinations:**
- Concepts of Algae Fuels (20%): Assignment (written report and presentation)
- Business Model Theory and LCA Regulation (40%): Assignment (written report and presentation)
- Development of own concepts & the elevator pitches (40%): Oral presentation

**Examination periods:**
- May

**Registration procedure:**
-  
