



29 June – 3 July 2015, Wageningen, The Netherlands

4<sup>th</sup> International Advanced Course  
**Sustainability Analysis in  
Food and Biobased Production**

Organised by The Graduate School VLAG, in co-operation with  
Food Process Engineering, Wageningen University, The Netherlands

### Background

Environmentally-friendly and efficient production of high-quality products from our natural (agricultural) resources will be one of the key challenges for the coming decades.

It is surprising however that in the conversion from harvested crops to the products that the consumer uses or eats, the majority of the materials is lost, while large amounts of energy and water are consumed. At the same, large volumes of waste water and solid wastes are generated. That would change if we could process with more efficiency and more effectiveness. But how do you weigh energy consumption against water consumption? Raw materials usage against waste water production?

There are many methods available to obtain an idea of sustainability and efficiency, but many of these require the evaluator to make many arbitrary choices. In this course we will follow a method which does not require that: exergy. This is a well-defined, thermodynamic concept that allows us to objectively judge the efficiency in a system.

The method allows to identify the efficiency of sub-processes on very small scale (heat transfer over one plate; individual reactions inside a cell), but also for a complete unit operation, a processing plant, and even total supply chains. Combined with the ability to connect different in- and outputs (energy, water, raw material, waste), it may be an important instrument to bring the conversion efficiency a step further.

### Course contents

The course will start with mass and energy flow analysis, and after this proceed with the use of the concept of exergy.

This allows the evaluation of food and biobased production systems on all possible levels - from large-scale supply chain, factory level, down to product and unit operation level, on efficient use of raw materials, energy, water and other utilities. Exergy analysis also allows the weighing of water and energy use, raw material use, relative to each other.

We will use Sankey diagrams for visualization of mass, water and energy balances over complex systems. We will then discuss the fundamentals of the concept of the quality of different streams (exergy), which can be visualized with Grassman diagrams.

The theory will be discussed in lectures, but the emphasis will be on application of the theory on practical questions and cases. The participants will work in groups (2 – 4 persons) on analysis of processes, identification of spots of inefficiency, and on evaluation of improvements in processes and process chains. In the final days of the course, we have a look at larger cases. We encourage the participants to bring cases of their own.

### Course aim/Target group

The course is aimed at post-doctorate level: PhD students, researchers, but also at engineers working in industry. It is expected that people have a MSc in Food Technology, Biotechnology, Chemical or Mechanical Engineering or equivalent. We assume Course participants should have a basis on thermodynamics. After the course, the participants should be able to conduct exergetic (and mass and energy) analyses themselves.

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## FACULTY & ORGANISATION

**Wageningen University**  
**Food Process Engineering**  
Prof. R.M. Boom  
Dr A.E.M. Janssen

**Graduate School VLAG**  
Mrs. E.J.M. Oudshoorn-Gijsbertsen, MSc

## Programme Topics

- Sub-process, process, plant and chain analysis
- Comprehensive mass and energy balances
- Sankey diagrams for visualization of mass and energy flows
- Process and chain analysis
- MathCad for process analysis
- The thermodynamics of processes and chains
- The exergy concept for process analysis
- Physical exergy (temperature, pressure and composition)
- Chemical exergy (reactions and conversions)
- Grassmann diagrams for mapping of exergy flows and visualization of inefficiencies in specific spots

## GENERAL INFORMATION

### Duration/Language

The course is scheduled for 29 June - 3 July 2015.  
The course language will be English.

### Location/Accommodation

Lectures will be given at Wageningen University. The town of Wageningen is 5 km from Ede-Wageningen railway station, with transport options being taxi or bus. Ede-Wageningen railway station is about one and a half hours from Amsterdam Schiphol Airport. For train schedules visit: [www.ns.nl](http://www.ns.nl).

A number of hotel rooms have been block booked at Hotel de Wageningsche Berg for course participants, but only until 16 May 2015. Accommodation costs are €85,- (double room; bed & breakfast, excl. tax). Hotel reservation is handled by Hotel de Wageningsche Berg. Participants have to book their own hotel room by sending an email to: [info@hoteldewageningscheberg.nl](mailto:info@hoteldewageningscheberg.nl)  
Please mention booking code SAFBP15.

More information about the hotel:  
<http://hoteldewageningscheberg.nl/en/>

### Course fee

The course fee includes printed materials, coffee/tea during breaks, lunches and one dinner but does not cover accommodation. The course fee depends on the participant's affiliation:

Industry / For-Profit:	€ 2.000,-
University Staff / Non-Profit:	€ 750,-
PhD student:	€ 500,-
VLAG/WU PhD student	€ 200,-

### Registration

The number of participants to the course is limited to 30. You can register on-line at:

<http://www.vlaggraduateschool.nl/courses/sustainability.htm>

The final registration date is 29 May 2015. Registrations are accepted in the order in which the registration form and course fee payment are received.

Applicants will be notified within two weeks on acceptance of their registration and they will be sent instructions for payment, and further course details. Cancellations may be made free of charge until 29 May 2015. After this date the charge will be 25 % of the course fee already paid or due. Substitutions for participants may be made at any time until the start of the course.

### Study load

1.4 ECTS.

### Information

For more information please contact:

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**REGISTRATION and PROGRAMME are available at :**

<http://www.vlaggraduateschool.nl/courses/sustainability.htm>

Registration before 29 May 2015

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