Manual Master Thesis
Sustainable Energy Technology

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1. Introduction

In 2003, the three Dutch Universities of Technology (TUD, TU/e and UT) embarked on a cooperation directed towards the harmonization and coordination of research and educational efforts. The Master's programme in Sustainable Energy Technology (SET) was one of these five new programmes. The three Universities of Technology are in a good position to offer a research-oriented Master's programme, as required by the energy sector. Since 2003 the programs of the three universities are each developed from their own strength and vision, Registration at one location automatically includes registration at the other two.

The two-year English-taught Master's programme Sustainable Energy Technology (SET) at the University of Twente invites students to gain in-depth understanding of (energy) technology and engineering and to supplement that with knowledge and skills related to entrepreneurship and innovation. Building on this broad foundation, SET engineers will rise above technology per se to play a role as enabler, leader and game changer in the transition towards sustainable energy systems. The energy challenges that are faced today call for professionals who are as skilful in engineering as they are in business development and innovation. The SET programme will prepare engineers for this broader, more entrepreneurial role. Students will be trained in chemical, electrical, process and mechanical engineering, as well as economics, business development, innovation, supply chain management and societal change. The programme is research-driven, research in this field is of high importance and it is at a high level at the UT.

The SET programme consists of 120 European Credits (EC) according to Table 1.

Regular SET Track	**EC**	**Bioresource Value Chain Management Track**	**EC**
Core programme (first year)	60	Core programme (first year)	60
Specialisation-linked elective subjects	15	Bioresources characteristics & properties courses	15
Internship / elective subjects	15	Bioresources value chain courses	15
Master's thesis	30	Master's thesis	30
Total	**120**	**Total**	**120**

Table 1: Programme setup SET at the UT

The first year consist of 12 compulsorily courses (60 EC) that provide the student a broad foundation with elements from technology as well as from entrepreneurship and innovation. This combination of knowledge is covered in a well-balanced programme. The core programme of 60 EC in the first year is made up of courses related to four themes

1. Energy sources
2. Technology and sustainability
3. Socio-economics
4. Design and system integration.

In the second and final year the student can complete the regular SET track or pursue the unique track, Bioresource Value Chain Management (BVM). Whichever a student chooses, he will become an authority in implementing technology-driven change in energy markets worldwide.

- The Regular track consists of elective courses (15 EC), an internship[1] (15 EC) and a master assignment (thesis).
- The Bioresource Value Chain Management track consists of courses on Bioresources characteristics & properties (15 EC), Bioresources value chain (15 EC) and a master assignment (thesis).

[1] Bachelors entering from a university of professional education (HBO) who have considerable industrial experience are not allowed to do an internship (stage). Instead of an internship they should follow 15 ec master courses

For the regular SET track elective courses in the second year give students the possibility to acquire in-depth knowledge to effectively carry out a Master's thesis project in one of the research areas of sustainable energy technology. For the Bioresource Value Chain Management track courses related to bioresources provide in-depth knowledge to perform a project in the field of Bioresource Value Chain Management.

The Master assignment (thesis) in both tracks takes 30 EC, which agrees with the duration of 2 quarters of 10 weeks of 42 hours. This individual master's assignment is the completion of the master's program. The main objective of the Master assignment is that the student learns and proves that (s)he is able to define, perform, complete and reflect a research project at a large degree of independence. During the master's thesis work, a student proves his level of understanding and ability to carry out a scientific research or design project, using the acquired competences, i.e. knowledge, skills and attitude. The assignment, containing social as well as technological aspects, is performed in one of the energy related research chairs of the UT under the supervision of a daily supervisor and the responsibility of a chair holder (graduation professor) and a master's graduation committee. Conditionally, the assignment can be done (partially) at an external institute or organization.

This manual gives important information about the general rules for doing the Sustainable Energy Technology master thesis at the University of Twente (UT).

2. Getting started

2.1 Selecting a topic and a research group

The first step to take to get started with the master thesis research is to select the track (Regular or Bioresource Value Chain Management track), the topic and the research group. We advise you to do this at the end of the first year of the programme. This gives you time to think about the (elective) courses in the second year that you need to acquire the in-depth knowledge. In case you choose the regular track you can select a topic from the large offer of the University of Twente. For examples of thesis topics, you can visit our website at www.utwente.nl/set. If you have another idea about a thesis topic related to sustainable energy technology, this is also possible. Examples for areas for the thesis topic are:

- Electrical power engineering
- Energy and society
- Energy from biomass
- Energy storage
- Fuel cells
- Hydrogen technology
- Solar energy
- Sustainable energy in the built environment
- Wind energy

The MSc.-assignment has to take place in one of the chairs of the university that is involved in sustainable energy related research. An external assignment is only possible by exception, to be judged by the Exam Committee. In case of an external assignment, a UT-chair professor has to take the responsibility for the assignment and should officiate as the professor in the MSc.- graduation committee.

2.2 Elective courses (regular track only)

When you have found a research topic and a research group, including a supervisor, you make a list of elective courses for your in-depth knowledge and fill it in in the "Study Programme form". You do this together with your supervisor who will help you. This list needs the approval of both the chair holder of your supervisor and the director of education of SET. You can find this list on the website www.utwente.nl/set and in Annex 1.

2.3 Approval thesis topic and appointment MSc. graduation committee

Next, you need the approval of your thesis topic. For this you fill in the form "Approval form Master Assignment Sustainable Energy Technology". See Annex 2 and the form on the website. Next, the professor of the chair forms your graduation committee. It includes at least three scientists with a different background related to the topic of research. The committee includes:

- A chairman: the professor of the chair in which the student graduates or a representative (professor or UHD);
- The daily supervisor, who is a member of the permanent scientific staff (professor, UD or UHD);
- A member of the permanent scientific staff of a UT-chair different from the graduation chair (professor, UD or UHD). This member is added to committee to:
    i. ensure that committees assess MSc.-assignments objectively;
    ii. add additional knowledge and views from other scientific fields;
    iii. exchange ideas between chairs.

When the supervisor is a PhD-student, then preferably the staff member who is the supervisor of the PhD-student should be added to the committee. He can monitor the interests of the master student concerned. Scientific experts from outside the programme in which the assignment takes place may be part of the MSc. Graduation committee in addition to the above group of three persons.

The establishment of this interdisciplinary committee makes it possible to guide the student effectively through the process and judge the Master's thesis from different perspectives. Moreover, the composition of the committees contributes to equal standards across different committees. You give the members of het committee on the form. The form needs the approval of the director of education.

2.4 Agreements with the research group

The student has to perform a substantial research or design project that meets scientific criteria. The level of profundity and complexity is defined by the chairman of the MSc. graduation committee, the chair holder of the research group. The SET student adds to the research topic of the selected research group the broad perspective of Sustainable Energy Technology.

When you have found your thesis topic and research group, you make agreements with this group. The chair holder of the group, the graduation professor, is responsible for the thesis work. Often, you will have one daily supervisor, sometimes more, who are not necessarily a professor. However, the chair holder has the final responsibility. Before getting started with the actual thesis work, the student and his or her supervisors make a time table of when to get started, end day and deliverables during the thesis work. Also there are agreements about the supervision, who is doing what, and the intensity of supervision. When the actual thesis work is done outside the UT, the research group assigns a supervisor in the outside organization. The UT supervisor and chair holder remain responsible for the content and scientific level of the thesis work. Moreover, they are responsible that the work can be finished within the time given to do the work. The student completes the assignment with a written report (the MSc.-thesis) an oral public presentation and a defense.

The research group pays a limited number of hard copies of the master thesis. These copies are distributed among the members of the graduate committee and the secretary of the research group at least two weeks before the final defense. A digital version in PDF format needs to be send to BOZ-WB (BOZ-WB-CES@utwente.nl).

3. Administrative formalities

The following administrative formalities are needed:

- Approval of the list of courses, including elective courses (*see form Annex 1*);
- Approval of the research topic (*see form Annex 2*);

- Approval of the graduation committee (*see form Annex 2*);
- Documentation of agreements with the research group;
- Inform BOZ-WB about the starting date, research group and location. As soon as you have found a thesis assignment, you are *obliged* to register this in Mobility Online. You can register by creating a new assignment called 'Graduation' ("Afstuderen") and filling in a so-called 'Assignment' form ('Opdracht'). Print the form, get a signature for approval from your graduation professor and hand the form over to BOZ-WB (Or: Send the signed form as a pdf to BOZ-WB-CES@utwente.nl);
- Within two weeks after you started with your thesis work you are *obliged* to fill in a so-called 'Notification' form ('Melding');
- Agreements about finishing courses. All courses need to be finished before the master thesis can be finalized!
- Assessment of working hours with the research group;
- Agreements with the supervisors about the evaluation meetings;
- Information of supervisor in case of problems during the trajectory;
- Information of BOZ-WB in case of temporarily delay, e.g. in case of illness, holiday, exams, etc.;
- Hard copies two weeks before the defense to committee and secretary group, digital copy to BOZ-WB (BOZ-WB-CES@utwente.nl).

In case of disagreement, the director of education of SET can provide assistance.

4. Assessment

The assessment of the master thesis is based on the interdisciplinary analyzing capacity, creativity, self-reliance, written report, oral presentation of 45 minutes (including question round) and discussion for a broad audience and the separate, final one hour defense for the graduation committee. The assessment criteria are given in Table 2, the assessment checklist.

Table 2. Assessment Checklist MSc.-thesis SET

Assessment research qualities	
• Problem analysis: o Definition of the research goals and research questions, o Use of relevant scientific literature, o Applying a multidiscipenary framework to put the problem in the proper energy related context • Execution of the MSc.-assignment: o Application of research methodology, o Theoretical skills, o Experimental skills, • Analysis of the results: o Application of data analysis, o Complexity of the research, o Feedback to the research goals, • Accessibility and usefulness of the results: o The most important indicator is the degree of publishability[2] the results.	
Assessment of the reporting and general aspects	
• Report (thesis): o Contents and structure, o Design and lay-out, o Language, o Discussion of results, conclusions and recommendations, o Literature references, list of symbols, description of laboratory set-up, etc. • Colloquium: o Contents, o Message, and connection to public[3], o Explanation about methods and results (clearness), o Style of presenting and use of audio-video support tools, o Discussion and response to questions. • General aspects: o Independence of student, o Originality and creativity, o Attitude, effort, pace, dedication, commitment, o Co-operation with “problem owner” and with co-workers.	

[2] Degrees of publishability: independent article by student / with additional results / as a part of other work / non-publishable.

All committee members make an individual assessment of the final grade based on the criteria of Table 2. Based on these grades, the chair proposes the final grade.

5. Procedure

5.1 Announcement of colloquium

The announcement of the colloquium is arranged by the secretary of the research group where you did the thesis work. The colloquium room is also arranged by the secretary. Next, you inform BOZ-WB as well as the secretary of SET (S.Y. Kloost-Zimmerman van Woesik) who take care of the announcement of the colloquium.

The student notifies BOZ-WB at least 4 weeks (20 working days) before the colloquium using the form 'Aanmelden masterdiploma' (registration master certificate). And the form 'colloquiumformulier' signed by the daily supervisor.

5.2 Graduation

The certificate of the master SET is given when the following constraints are met:

- The student has completed all courses and fulfilled all requirements of the master programme SET. This is controlled by BOZ-WB when they have received the notification. Next, BOZ-WB informs CSA (Central Student Administration)
- The grades of all courses, apart from the master thesis, need to be registered at BOZ-WB at least 3 weeks before the graduation.
- The student is registered at the UT the day of the graduation. This is controlled by CSA.
- The student sends a digital version of the thesis to BOZ-WB at least 1 week before the graduation.

When the constraints above are met, the student is allowed to do the final exam, i.e. colloquium and defense. When this is done successfully, the certificate, signed by the chair of the Exam committee of SET-ME, as well as by the chair of the committee is given to the student. The student also receives the grades list.

All forms can be downloaded at: www.utwente.nl/set.
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Annex 1

2017-2018 Master study programme Sustainable Energy Technology

Regular Track

NAME STUDENT: **STUDENT NO:**

SPECIALISATION:

GRADUTION PROFESSOR:

Compulsory subjects: (60 EC)		Credits:	
THEME 1: ENERGY SOURCES (15 EC)			
201700023	Energy from Biomass (Q2) - Brem / Bramer	5,0	EC
201700024	Wind Energy (Q4) - Venner	5,0	EC
201700025	Solar Energy (Q3) - Reinders	5,0	EC
THEME 2: TECHNOLOGY AND SUSTAINABILITY (15 EC)			
201600019	Energy Conversion Technology (Q1) - Brem / Pozarlik	5,0	EC
201600252	Energy Storage (Q3) – Brem / Mul	5,0	EC
191102010	Life-Cycle Strategy (Q1) - Toxopeus	5,0	EC
THEME 3: SOCIO-ECONOMICS (15 EC)			
201700029	Energy, Sustainability and Society (Q3) - Arentsen	5,0	EC
201700030	System Innovation and Strategic Niche Management (Q4) - Coenen	5,0	EC
201500448	Designing Business Models (Q4) - Gelhard / Henseler	5,0	EC
THEME 4: DESIGN AND SYSTEM INTEGRATION (15 EC)			
201700026	Electrical Power Engineering and System Integration (Q2) - Dhalle	5,0	EC
192850840	Sources of Innovation (Q1) - Reinders	5,0	EC
193735010	Thermodynamics and Flowsheeting (Q2) – v/d Ham	5,0	EC
		60,0	**EC**

Internship or elective subjects (15 EC)			
			EC
			EC
			EC
195799152	Internship (15 EC)		EC
		0,0	**EC**

Specialization subjects (15 EC)			
			EC
			EC
			EC
			EC
		0,0	**EC**

Graduate (30 EC)			
201700027	Master assignment (30 EC)	30,0	EC
		30,0	**EC**
	Total master programme at least 120 EC:	**90,0**	**EC**

Additional subjects (beyond the 120 EC)

		EC
		EC
		EC

Approve of:

Graduation Professor:	Student:	Director of Education SET
date	date	date

2017-2018 Master study programme Sustainable Energy Technology

Bioresource Value Chain Management Track

NAME STUDENT: **STUDENT NO:**

SPECIALISATION:

GRADUTION PROFESSOR:

Compulsory subjects: (60 EC)		Credits:	
THEME 1: ENERGY SOURCES (15 EC)			
201700023	Energy from Biomass (Q2) - Brem / Bramer	5,0	EC
201700024	Wind Energy (Q4) - Venner	5,0	EC
201700025	Solar Energy (Q3) - Reinders	5,0	EC
THEME 2: TECHNOLOGY AND SUSTAINABILITY (15 EC)			
201600019	Energy Conversion Technology (Q1) - Brem / Pozarlik	5,0	EC
201600252	Energy Storage (Q3) – Brem / Mul	5,0	EC
191102010	Life-Cycle Strategy (Q1) - Toxopeus	5,0	EC
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THEME 4: DESIGN AND SYSTEM INTEGRATION (15 EC)			
201700026	Electrical Power Engineering and System Integration (Q2) - Dhalle	5,0	EC
192850840	Sources of Innovation (Q1) - Reinders	5,0	EC
193735010	Thermodynamics and Flowsheeting (Q2) – v/d Ham	5,0	EC
		60,0	**EC**

Bioresources courses (30 EC)			
			EC
			EC
			EC
			EC
			EC
			EC
			EC
		0,0	**EC**

Graduate (30 EC)			
201700027	Master assignment (30 EC)	30,0	EC
		30,0	**EC**
	Total master programme at least 120 EC:	**90,0**	**EC**

Additional subjects (beyond the 120 EC)

		EC
		EC
		EC

Approve of:

Graduation Professor:	Student:	Director of Education SET
date	date	date

Annex 2

Approval form Master Assignment Sustainable Energy Technology

Student name | Student number

Track/specialisation | Research group | Date

Title thesis

Members graduation committee	
Name	
Chair	
Supervisor	
Member other group	
Other members	

Abstract research proposal including 5 keywords (max 600 words)

Approval

J.B.W. Kok, director of education Sustainable Energy technology (SET)