DALARNA UNIVERSITY

# Programme Syllabus

## Master Programme in Solar Energy Engineering 120 Credits*

Masterprogram i solenergiteknik 120 högskolepoäng

### 1. Objectives of the Educational Programme

1.1 Objectives, as Specified in the Higher Education Act (1992:1434), Chapter 1, section 9:

Second level education shall essentially build on the knowledge that students acquire in first level education or corresponding knowledge. Second level education shall involve a deepening of knowledge, skills and abilities relative to first level education and, in addition to what applies to first level education, shall

- further develop the students' ability to independently integrate and use knowledge,
- develop the students' ability to deal with complex phenomena, issues and situations, and
- develop the students' potential for professional activities that demand considerable independence or for research and development work.

1.2 Degree Objectives, as Specified in the Higher Education Ordinance (1993:100), appendix 2:

Knowledge and Understanding

For a Master of Arts/Science (120 credits) the student shall have:

- demonstrated knowledge and understanding in the main field of study, including both broad knowledge of the field and a considerable degree of specialised knowledge in certain areas of the field as well as insight into current research and development work, and
- demonstrated specialised methodological knowledge in the main field of study.

Competence and Skills

For a Master of Arts/Science (120 credits) the student shall have:

- demonstrated the ability to critically and systematically integrate knowledge and analyse, assess and deal with complex phenomena, issues and situations where there is limited information
- demonstrated the ability to identify and formulate issues critically, autonomously and creatively as well as to plan and, using appropriate methods, undertake advanced tasks within predetermined time frames and so contribute to the formation of knowledge as well as the ability to evaluate this work
- demonstrated ability in speech and writing to report clearly within a national and international context and discuss his or her conclusions and the knowledge and arguments

on which they are based in dialogue with different audiences, and
- demonstrated the skills required for participation in research and development work or autonomous employment in some other qualified capacity.

Judgement and Approach
For a Master of Arts/Science (120 credits) the student shall have:
- demonstrated the ability to make assessments in the main field of study informed by relevant discipline, social and ethical issues and also have demonstrated awareness of ethical aspects of research and development work
- demonstrated insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used, and
- demonstrated the ability to identify the personal need for further knowledge and take responsibility for his or her ongoing learning.

## 1.3 Objectives of the Programme

After completing the program the student will be able to:

Knowledge and Understanding

- show in-depth understanding of various solar energy technologies´ physical processes and mathematical models for energy output in converting solar radiation into electrical or thermal energy

- show detailed knowledge regarding the components of importance in solar power systems and how their function depends on solar radiation and other climatic factors

- show detailed knowledge of how heating, cooling, ventilation and daylight needs in both buildings and communities are affected by solar radiation and other climatic factors

- show a broad knowledge of and conditions for the role of different solar technologies in a major energy perspective and how these interact with other technologies for the production of electricity, heat and cooling

- show knowledge on a general and comprehensive level and in specific areas on a deeper level of current research and development in solar technology.

Competence and Skills

- demonstrate ability to with a scientific approach theoretically and experimentally to understand and analyse both individual components in and whole solar energy system,

their functions and interrelations

- demonstrate ability to independently design efficient solar energy systems from technical components, climate, energy demand, and other relevant conditions

- demonstrate the ability to use different types of advanced software for modelling, dimension, optimize and analyse different types of solar energy systems

- demonstrate the ability to measure, process and analyse relevant data for solar energy applications, and evaluate the usefulness of data

- demonstrate the ability to calculate the investment, operating and life cycle costs of solar thermal and solar electric systems

- demonstrate ability to with a scientific approach theoretically and experimentally treat solar energy-related problem areas

Judgement and Approach

- critically evaluate existing facilities for both solar electricity and solar thermal and propose measures to improve performance or correct deficiencies
- demonstrate the ability to evaluate the technical, social, economic and ethical barriers and drivers for the introduction of solar energy technologies in different types of communities

- be able to evaluate how solar solutions can contribute to a transition to a sustainable society from a social, economic and environmental and climate perspective

- Demonstrate the ability to from an engineering science perspective independently evaluate the role various solar energy technologies can play in energy security in both the heating system, electrical system for the building‘s energy

- analyse problems by integrating knowledge of renewable energy from new or complex knowledge sources, and make judgments based on incomplete or limited information

- be able to communicate project results, methodologies and underlying motives for specialists and non – specialists.

**2. Main Structure of the Programme**

The programme is designed for three areas: solar thermal technologies and systems, solar electricity technology and systems, and buildings and energy. The emphasis is on active solar technology, i.e. the first two areas. The majority of the courses are compulsory, but

there is eligibility in the two opening and two closing courses in year 1, i.e. the student chooses one of two given parallel in the program.

The two introductory courses in Applied Thermodynamics and Fluid Dynamics and Fundamental Principles of Electrical Engineering aims to ensure students‘ skill levels. These two courses are therefore at a basic level and it assumes that students have gained knowledge of at least one of the courses in their undergraduate studies. The course Solar radiation and Other Energy Resources brings up modalities for utilizing solar energy and provides the basis of solar radiation geometry and physics and how solar insolation data is used for calculations in various solar energy applications. The courses Solar Thermal, Photovoltaics and Passive Solar Energy Technology offers the technical basics of components and subsystems for use of solar energy for the production of heating, cooling and electricity and how it can be used directly in buildings. The course Economics and Financing of Solar Energy provides a broadening of the knowledge of the economic aspects of investment in solar energy technology. The course treats also LCC (Life Cycle Cost) analysis.

To prepare students for more advanced laboratory exercises and projects, not least the thesis, begins semester 2 with the course Measurement Techniques and Data Processing of Energy Systems to provide the ability to plan series of experiments, to determine the appropriate method, to critically analyse the results and determine the impact of measurement error and accuracy the measurement data. The courses Solar Thermal Design and PV and Hybrid Systems Design deepens knowledge about how solar energy systems can be designed for heating / cooling and electricity generation. These two courses are project based in the form of group projects and provide students with freedom to independently apply the knowledge they learned from the first semester.

During the period 4 courses of broadening character are given: The Social Context of Energy Systems provides a sociological perspective on how technological systems can be implemented, with particular focus on solar energy and energy efficiency in buildings. The course Sustainable Energy Systems aims to provide a broad overview of how renewable energy utilised today and has the potential to be utilized in the future in a sustainable way. This course is optional and as an alternative Energy Efficient Buildings can be selected. This course is aimed at students who want to immerse themselves in buildings and energy, which is the third small area for the program.

Year two includes both advanced specialization courses that further builds on the solar energy technology, and systems both for the production of heating / cooling and electricity and also courses that prepares students for thesis work and any further studies at the graduate level. The courses are inherently project-based, in the form that the students do them individually and contain besides predetermined literature also own literature search.

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The course Scientific Communication and Information Processing will be provided in parallel with the courses Energy Storage and Project Course in Solar Energy Systems or Energy Efficient Buildings, thus providing support for literature search, writing of reports and presentations in these two courses which are in the form for self-studies. Project in Solar Energy Systems or Energy Efficient Buildings will give the student specialization in one of the three areas (solar thermal technologies and systems, solar electricity technologies and systems or buildings and energy). The course Energy Storage provides students with deepening of possible storage types for heating / cooling and electricity which is important in solar energy systems because these technologies do not provide on-demand production. The course in Solar Thermal Power gives deepening in solar applications, in this case, the electricity can be generated through heat as in conventional power plants, but here the focus is on components and systems to concentrate solar radiation. In the course, Dynamic Simulation of Energy Systems students use their knowledge of solar energy technology and systems from previous courses in Years 1 and 2 in order to design systems for different applications. An important part of this course is to learn how to use advanced computational tools for dynamic simulation of the system where the solar technology integrated.

The thesis work can be carried out in the university / college, or, by agreement, in a business or other organization in Sweden or abroad. Students are encouraged to find an interesting assignment for the thesis and by themselves contact appropriate organizations.

### 3. Courses of the Programme

All courses at advanced level belong to the main field Solar Energy Technology

**YEAR 1**

***Period 1 and 2:***

Applied Thermodynamics and Fluid Dynamics, 5 cr (G1)
Fundamental Principles of Electrical Engineering, 5 cr (G1)
Solar Radiation and other Energy Resources, 2.5 cr (A1)
Solar Thermal, 7.5 cr (A1)
Economics and Financing of Solar Energy, 5 cr (A1)
Passive Solar Energy Technology, 5 cr (A1)
Photovoltaics, 5 cr (A1)

***Period 3 and 4:***

Measurement Techniques and Data Processing of Energy Systems, 5 cr (A1)
Solar Thermal Design, 5 cr (A1)
PV and Hybrid Systems Design, 5 cr (A1)
Social Context of Energy Systems, 7.5 cr (A1)
*Students must choose one of the two following courses:*
Sustainable Energy Systems, 7.5 cr (A1)

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Energy Efficient Buildings, 7.5 cr (A1)

**YEAR 2**

***Period 1 and 2:***

Scientific communication and information management, 7.5 cr (A2)
Project in Solar Energy Systems or Energy Efficient Buildings, 7.5 cr (A2)
Energy Storage, 5 cr (A2)
Dynamic Simulation of Energy Systems, 5 cr (A2)
Solar Thermal Power, 5 cr (A2)

***Period 3 and 4:***

Thesis Work in Solar Energy Technology, 30 cr (A2)

**4. Degree Awarded**

Students who fulfil the objectives of the programme and pass all the courses will – upon application – receive a Master of Science, 120 Credits, with the main field of study: Solar Energy Egineering.

**5. Required Entry Qualifications**

Bachelor of Science degree in engineering (mechanical, electrical, energy, engineering physics) of at least 180 credits and English 6

**Approved:**

Approved by the University Faculty Board 26 September 2013
Valid from Autumn semester 2014