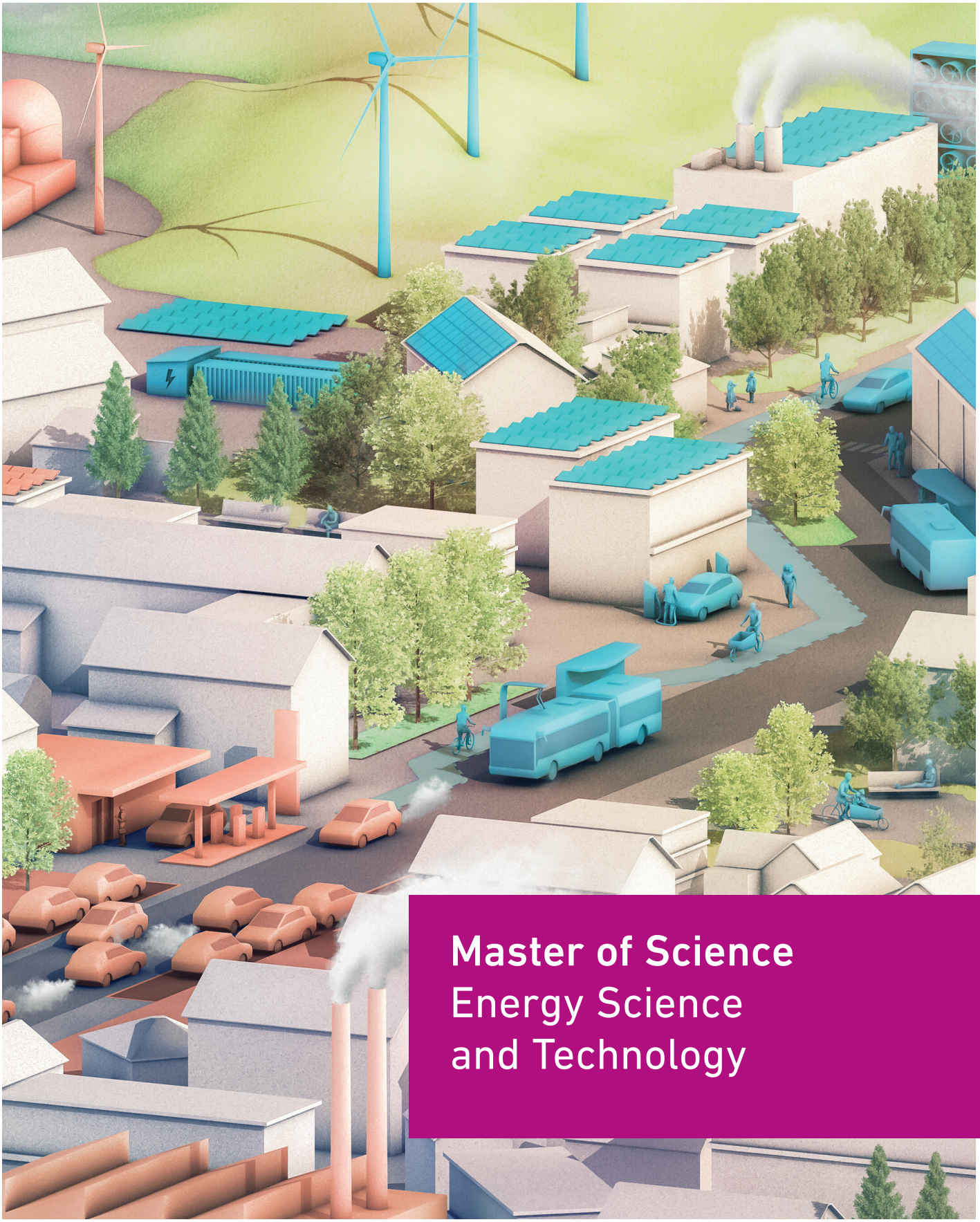
ETH zürich

Department of Information Technology
and Electrical Engineering



Master of Science
Energy Science and Technology

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Welcome

On behalf of the Department of Information Technology and Electrical Engineering, the Department of Mechanical and Process Engineering, the Energy Science Center and all the professors involved in the Master's degree programme in Energy Science and Technology (MEST) at ETH Zurich, I would like to thank you for your interest in our programme.

This booklet will provide you with information about the MEST degree programme, including its organization, the target professional profile, ETH Zurich and life in Zurich.

The MEST degree programme is inspired by the need for solutions to tackle the challenges the world will be facing in realizing a sustainable energy system, i.e. environmentally friendly, reliable, of low risk, economically viable, socially compatible, and resilient in the face of natural risks. The many aspects involved in this task need to be addressed comprehensively, be they technical, environmental, economic, societal or political.

In this programme you can realize your own educational aim by shaping your profile and tailoring your own career in the area of energy sciences, selecting from a wide variety of courses and interacting with a highly motivated and international group of colleagues coming from various fields.

We invite you to rise to this challenge and look forward to receiving your application.

With regards,

Prof. Christian Franck
MEST Programme Director

Curriculum Structure

A clean, affordable and reliable energy supply is crucial for the well-being of industrialized economies and the development of emerging ones. Developing future sustainable energy systems requires education in a large number of scientific disciplines.

To enable future engineers to rise to this challenge, ETH Zurich offers a Master's degree programme in Energy Science and Technology (MEST), coordinated across several departments *(www.master-energy.ethz.ch).*

MEST is a full-time study programme for four to five semesters. The programme consists of core courses, elective courses, a semester project, an internship in industry and a final Master's thesis. All the courses and the semester project are usually completed in two to three semesters. The internship and the Master's thesis usually take an additional six months (full-time) each. At least 120 credit points ECTS must be acquired (1 credit point corresponds to 25–30 hours of work).

Most of the examinations take place in January/February and in August (between semesters).

All aspects of the programme are in English. Knowledge of German is not required.

A highlight is a (compulsory) team-work course, designed specifically for MEST students, analyzing a real-world challenge proposed by industry experts, covering technical, economic and/or regulatory aspects and elaborating a potential solution.

Each student can shape their own individual curriculum by choosing from a wide variety of courses on offer at ETH Zurich. This is done in conjunction with a selected tutor (an ETH professor in the field of energy science) who must approve the course selection within four weeks of commencement of the first semester.

A list of authorized professors can be found under:
www.master-energy.ethz.ch/people/tutors

Courses (64 + 2 credit points)

With the exception of the compulsory core courses (a minimum of 23 credit points), topics can be selected freely, subject to approval by the tutor. The courses and their credit points are listed in the course catalogue *(www.vvz.ethz.ch).* Elective courses must account for at least 24 credit points. In addition, 2 credit points must be obtained from the Science in Perspective courses offered by the Department of Humanities, Social and Political Sciences (D-GESS).

Semester Project (12 credit points)

The semester project offers students hands-on research experience and the opportunity to improve their experimental, programming skills, etc. The semester project should take up about half of a student's time during one semester. The projects are offered by individual laboratories of the departments involved in MEST.

Internship in Industry (12 credit points)

There is a compulsory 12-week internship in industry (inside or outside Switzerland) to be completed at any time before the beginning of the Master's thesis. However, it is recommended that students do it as early as possible (even before the first semester).

Master's Thesis (30 credit points)

The Master's degree programme culminates in the Master's thesis (six months full-time). The semester project and the internship in industry must be completed before beginning the Master's thesis, as should be the courses. Theses are offered by individual laboratories of the departments involved in MEST.

"Our goal is to enable a smooth and secure transition from an energy system primarily based on fossil fuels to one that, within 25 years, will be 100% sustainable and climate neutral."

Prof. Anthony Patt, Climate Policy Laboratory, D-USYS

Future Challenges

The transition towards a more sustainable supply and use of energy requires drastic change within the energy sector. This poses significant challenges across all aspects of integrated energy production, distribution, the economic context and the global interdependencies. The MEST programme provides you with the fundamentals needed to tackle these complex challenges.

Integrated Energy Production and Distribution
Traditionally for many years, power generation simply followed load demand. Storage units were used mainly for techno-economic optimization, allowing large base-load power plants such as nuclear or coal-fired power plants to operate at a constant and full-load operation point despite the fluctuating pattern of load demand. The remaining variations between scheduled generation and actual real-time load demand, caused by stochastic effects on both generation and demand side, were balanced via reserve capacities.

In recent years this has changed due to a number of reasons:

1. The widespread deployment of variable renewable energy sources (RES) (solar, wind, thermal, biomass) in many countries has led to a significant share of highly fluctuating power generation that is not easily controllable.
2. The growing energy market activity on the increasingly integrated national and transnational energy markets has led to more frequent changes in the operating setpoint schedules of power plants.
3. The emergence of smart grids as a driver for change in power system operation at all grid levels.

Collectively, these developments constitute a major paradigm shift in the management of energy generation and load portfolios: in the future, load demand will increasingly have to follow the fluctuating power generation of RES.

Economic Implications
As this transition will require drastic changes in the energy sector, it is critical to understand, evaluate and quantify the micro- and macro-economic implications of such a transition. Effective and robust energy policies in today's market economies have to recognize the role of economic incentives in determining the energy supply and demand decisions of firms and households in various sectors of the economy as well as in international markets.

Future market environments should be designed to ensure adequate investment incentives for electricity generation and transmission capacity and to guarantee sufficient temporal and spatial flexibility of power generation in light of fluctuating renewable energy sources. The dynamic aspect of the energy transition further entails an analysis of the macroeconomic drivers and mechanisms for economic growth and their interrelationship with specific aspects of the energy sector such as, for example, technological innovations, resource costs, capital intensity and market structures.

Global Dependencies
In addition to these regional challenges, the supply of energy is becoming increasingly dependent on global interdependencies. For instance, the discovery and exploration of shale gas in the U.S. has an influence on the price of globally traded and transported coal, which in turn influences the price of electricity produced in coal-fired power stations in Europe. Understanding the energy challenges of tomorrow means understanding these interactions between different energy producers and carriers in different spatial and temporal dimensions.

Professional Life

Johanna Vorwerk, Doctoral Student
Power systems worldwide are undergoing massive changes due to the urge to tackle climate change, the increasing integration of renewable energy resources, and the electrification of mobility and heating technologies. This development not only adds complexity but also increases operational flexibility. These challenges have always motivated me to study and advance my knowledge in this field. As a researcher, I focus on the redefinition of control and operation procedures to ensure stable grid operations. At the same time, I have the exciting possibility of supervising current students during their research projects, and of collaborating with inspiring minds from diverse and international backgrounds.

Ifigeneia Stefanidou, Head of Product Management
I finished my Master's degree in Energy Science and Technology in 2010. The programme was an excellent preparation for my professional life, allowing me to choose the topics that were most relevant to me and to broaden my knowledge. During my career I was able to directly apply insights I gained during my studies. The "thinking out of the box" we trained at ETH Zurich helped me to move ahead and grasp complex engineering problems. As head of product management I am responsible for a highly skilled team in the area of electric grids. I continue to profit from my time during the Master's studies by having all necessary fundamentals available.

Gianni Hotz, MEST Alumnus
Because of my interests in energy systems and energy transmission, I chose to continue my studies with the Energy Science and Technology programme at ETH. I am convinced that mastering the energy transition and reducing global GHG emissions require a holistic view on the technologies running the energy systems. During the study programme, I was able to deepen my understanding of the technological, economic and social aspects of these technologies. This is of great advantage for my current position as consultant for companies in the energy sector.

Daniel Biek, MEST Student
During my Bachelor's studies in Electrical Engineering I realized that I wanted to deepen my interest and knowledge in energy science. MEST has been an amazing opportunity to explore all different aspects of energy-related topics. Gaining fundamental knowledge in electrical, mechanical and economical subjects helped me setting up a solid foundation to tackle energy-related problems/challenges. In the future, I would like to further expand my expertise and to do research to find new solutions for the serious climate resource challenges we are currently facing.

Prospective Students

Who Can Apply?

MEST strives to accept students from diverse backgrounds, but it is mainly the students holding a Bachelor's degree in engineering or natural sciences with a strong academic performance from a nationally or internationally reputed university who have a good chance of being admitted to the course. To be considered, the candidate's Bachelor's degree should comprise the following courses (although a deviation of up to 6 ECTS credit points is allowed):

- **Mathematics:** an equivalent of 26 credit points or more
- **Physics:** an equivalent of 10 credit points or more
- **Engineering Sciences:** an equivalent of 24 credit points or more (mechanical/electrical engineering, informatics, systems/control, etc.)
- **Economics:** an equivalent of 3 credit points or more

How to Apply?

All candidates must submit an application online. All applications will be subject to individual evaluation. For successful applicants additional courses may be required (up to 60 credit points). Please refer to the Admissions Office *(www.admission.ethz.ch)* for details on the required documents, the online application process and the deadlines for submitting your application.

Tuition and Cost of Living

The tuition fee is 730 Swiss francs per semester. However, students need to budget about 22,000 Swiss francs per year for living in Zurich (accommodation, living expenses, health insurance, etc.). A very limited number of scholarships are available for applicants with outstanding academic records. For more detail see: *www.ethz.ch/en/studies/financial*

Continuing with Doctoral Studies?

Good Master's students may consider continuing their studies towards a doctoral degree. Doctoral students are generally well paid. Applications should be made directly to a professor.

ETH Zurich

ETH Zurich is one of the leading international universities for technology and the natural sciences. It is well known for its excellent education, groundbreaking fundamental research and for implementing its results directly into practice. To researchers, it offers an inspiring working environment, to students, a comprehensive education.

Founded in 1855, ETH Zurich today has more than 22,000 students from over 120 countries, including 4,200 doctoral students. About 500 professors currently teach and conduct research in engineering, architecture, mathematics, natural sciences, system-oriented sciences, and management and social sciences. ETH Zurich regularly appears at the top of international rankings as one of the best universities in the world. 21 Nobel Laureates have studied, taught or conducted research at ETH Zurich, underlining the excellent reputation of the university.

Student Life

Zurich enjoys an excellent reputation as one of the best places in the world to live. The city is situated on beautiful Lake Zurich with the mountains less than an hour away. Zurich is clean and safe and has an excellent public transportation system and high standard of living. The city has an international flair, a wealth of cultural activities and a vibrant nightlife. Most Swiss are multilingual and English is often the language of choice.

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