M.Sc. Information Technology for Energy
Energy is of crucial importance to global development. Challenges in the power sector are nowadays more far-reaching than to any other point in time, facing significant political, economic, social and ecological consequences.

In order to tackle these complexities, highly qualified engineers with awareness of the true scope of most recent needs of the energy sector are urgently required. The Campus El Gouna of Technische Universität Berlin provides young passionate engineers with most necessary skills to achieve excellence.

Pursuing a master program at TU Berlin Campus El Gouna offers the exceptional opportunity to study at two very distinct locations that differ tremendously not only in size but also in their social, cultural, and ecological characteristics.

The campus houses apart from the energy department, a water department and urban development department. Consequently, students from more than 20 nations are exposed to a true interdisciplinary and international surrounding.

This unique set-up constitutes ideal conditions for the students of IT for Energy to apply their newly gained knowledge to a wide number of diverse conditions, environments and applications.

In great hopefulness, that this brochure can not only reveal the true potential of the master program IT for Energy but also catch your personal interest. In any case we succeeded in reaching your curiosity, we are very much looking forward to your application and meeting you soon at the campus.

Sincerely,

Prof. Tetyana Morozyuk
Dean of Energy Engineering Department
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I. Why study IT for Energy?

Information technologies and their implementation in the energy sector is a challenging topic that grasps more and more attention as it is urgently needed for implementation in energy industry. The Information Technologies for Energy program at TU Berlins’ off-shore Campus El Gouna is a newly introduced master program, unique in its kind in the MENA region. The ITE program deals with the design, development, optimization and realization of fossil fuel- and renewable energy-based energy-conversion plants with the support of information technologies. Meanwhile the ITE Program covers the application of information technologies developed in the energy domain. Main application areas are within electricity generation, energy storage and consumption. Students will learn how to analyze, design, and implement information technologies to the needs in the energy sector. Increasing energy efficiency, cost- and environmental effectiveness of energy conversion processes are most significant and complex urgencies in the field of energy. Both winter terms of the 2-year program take place at the brand new Campus in El Gouna. In summer the whole campus travels to Berlin. Students are thus exposed to two very different study environments, offering a unique interdisciplinary and intercultural experience.
II. Why Campus El Gouna?

On 28 October 2012, the Technische Universität Berlin has initiated its first satellite campuses in El Gouna, a touristic town in Egypt. With three departments: Energy Engineering, Urban Development and Water Engineering the campus scientific focus addresses the main issues of the MENA (Middle East and North Africa) region at present. Acting as the scientific hub of TU Berlin in the MENA region. As a scientific field office of Technische Universität Berlin in Egypt, the campus provides a fully equipped environment for studying, research and development as well as for cultural and scientific events.

The practical orientation of the master's programs offered at the Campus El Gouna necessitate high quality equipment. The large technical hall of the energy department along with different laboratories, field and testing equipment offers a wide range of research opportunities. The Campus El Gouna allows lab-scale testing of most recent technologies, such as a solar thermal energy assisted absorption chiller or a fuel cell training system. As well an extraordinary variety of education plants and test benches is available (e.g. desalination unit, ice stores in refrigeration, steam power plant).
Apart from the photovoltaic (PV) test field comparing eight different PV panel technologies and various system configurations, the campus is equipped with its own weather station. Recently the installment of a combined power system on campus ground started (PV, Wind, Battery storage and variable consumer). Furthermore all computers in the campus’ PC pool are equipped with latest software such as (Aspen, Dymola, EbsilonProffessional, Matlab, Modelica, Meteonorm, Polysun etc.) extending the analysis and performance tests with simulation and calculation tools.

Not only the brand new campus and its facilities offer unique study environment but as well its location. As TU Berlin’s professor are flown in only for the purpose of teaching their module in intensive classes, students are awarded an out of the ordinary attention. In addition, classes are kept at about 30 students, allowing a large variety of most effective teaching method and a personal contact to most renowned professors.
III. Why TU Berlin?

The Technische Universität Berlin counts to Germany’s internationally renowned technical universities. With nearly 32,000 students at Technische Universität Berlin, the main campus is not only a significant contrast to the off-shore Campus El Gouna but also one of the largest and most traditional universities in all Germany. Technische Universität Berlin not only stands out in its size but rather with its exceptional education and outstanding research achievements. TU Berlin’s core goal is “to facilitate the development, implementation and transfer of innovative technologies”. The seven faculties of Universität Berlin bridge the gap between natural and technical science, planning, economics and social science and humanities. About 100 different programs are offered by a total of 40 institutes.

Main Campus of Technische Universität Berlin
(study hall, main building, light hall of main building, study area at math building marstraße)

Berlin, Germanys Capital city, is at “the heart of Europe” and thus TU Berlin has a broad international outreach. Berlin houses headquarters to many high-ranked international companies enabling TU Berlin to ensure a close cooperation between science and industry.
Moreover, Technische Universität invests large effort into promoting gender equality and increasing the involvement of women in study and research. There are a lot of initiatives at TU Berlin supporting e.g. women, young families, young entrepreneurs and entry level graduates. Students of TU Berlin Campus El Gouna are able to take part in all activities offered in TU Berlin being considered and matriculated as regular students.

This includes entrance to most modern libraries, personal internet access at most universities across Europe, career advisory services, as well as leisure at TU Berlin Sports, discount prices for most activities (e.g. cinemas, concerts, museums etc.), free public transportation in Berlin, foreign language training and much more. Number of famous scientists and researcher graduated from TU Berlin such as Konrad Zuse (1910-1996) First Process-Controlled Calculating Machine.

Activities offered at TU Berlin main campus
(Power-Fitness-Mix class, Berlin Long Night of Science, Berlin Firmenlauf 2015, TU Berlin gym)
IV. Study content

The Master's degree program IT for Energy at Campus El Gouna focuses on fundamental aspects of energy engineering and the application of information technology on energy challenges, including both conventional and renewable energies. Energy engineering is considered, including most recent issues such as integration of renewable energies and energy storage. Students are able to choose according to their preferences which Energy Engineering Electives they want to gain a deeper understanding in. While the study program integrates the latest scientific developments and methods, it also pays attention to the economic, ecological, social and industrial applicability.

Moreover energy systems design, evaluation and optimization with the help of information technology belongs to the core learning goals and thus builds the compulsory module area.

Energy Engineering (1 and 2) along with Intercultural Competence, completed by an internship and the master's thesis are mandatory. A total of 120 European Credit Transfer and Accumulation system (ECTS) will be awarded. After successful completion the Master of Science of the Technische Universität Berlin will be granted.

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In order to tackle the most current challenges within the energy sector, students need to firstly need a detailed knowledge of energy conversion system design and operation on system and component level. The module “Energy Engineering I” emphasizes applied and advanced thermodynamic as well as economic and environmental aspects for analysis and optimization of energy-conversion systems. Within the module Information Technology for Energy, the mindset of the students shall be tackled, introducing them to the widespread opportunities of IT within the field of energy. The compulsory module Advanced Information Modeling is aiming to increase the students’ ability for finally applying IT technology.

The Energy Engineering Electives are formed of the following core study areas: Energy Engineering and Components, Energy Systems, Electrical Engineering. The student can freely decide upon which energy topics to focus on: Energy Engineering II, Integration of Renewable Energy, Conversion Technologies for Renewable Energies, Energy for Buildings, Refrigeration and Air Conditioning, Photovoltaics, Energy Storage and Conversion, Components of Energy Conversion Systems. The program thereby aims to target issues most common in the MENA region, covering on the one hand fundamentals and on the other hand advanced application.

Generally the study area IT, Economics and Law is the most diverse aiming to provide students with knowledge about the wide scope of energy, its challenges and the application areas for information technology. Energy Systems and Economics for instance debates the challenges and obstacles while applying energy technologies. IT technology can be applied within within the complex structure of diverse energy markets, economic calculation, fundamentals of energy trade and market incentives or within the power grid challenges.
Social skills, intercultural competence, fruitful group work, managerial and presentation skills along with analytical thinking in problem solving are core competencies essential for a successful career. Obviously, soft skills cannot be learned by the book. At TU Berlin Campus El Gouna more than 20 nations and most diverse backgrounds meet, offering an exceptional exposure. The modules Project Management and Intercultural Communication as well as Interdisciplinary Project take advantage of the unique multicultural and diverse environment in order to encourage students to learn essential skills while independently carrying out, managing and finally presenting project work.

The German higher education system is dominated by learning of self-management and organization along with an independent and systematic approach to scientific tasks. Thus students have the opportunity to choose among electives, locate the company for their two month industrial internship and independently select the subject of their projects and their Master's thesis topic, supervising institution and professors individually.
a. Compulsory Modules

Energy Engineering I and II

Modern energy systems need to be on the one hand energy efficient and on the other hand cost efficient without compromising environmental restrictions. A competent energy engineer must be able to design and optimize an energy system accordingly, the module energy engineering aims to provide the students with necessary understanding and skills set to do so.

The module Energy Engineering is dissected into fundamentals and advanced energy engineering. Both modules have a capacity of six credit points, the modules take place in the first and second semester. The Module Project Energy Systems continues the content taught in Energy Engineering I and II in a term project in third semester.

Students familiarize themselves with modern methods of analysis and evaluation of thermal systems and principles from the operation and design of the most commonly used energy conversion devices.

Thereby, students learn to:

- be able to optimize energy supply systems by ensuring a good compromise among efficiency, cost of product(s) and environmental impact,
- be able to identify the inefficiencies of energy conversion systems and develop options for improvements,
- process creativity to optimize energy-conversion systems,
- have skills in preparing data and information for the design of such systems.

Students during a lab experiment infront with steam power plant at technical hall, Campus El Gouna.
Substance to the module covers diverse energy resources, discussing availability, supply, and prices of energy carriers. Thermodynamic and economic analysis of energy systems, starting with thermodynamic principles aiming to acquire skills in exergy based system evaluation and optimization (incl. Exergoeconomic and exergo-environmental analysis).

After completion of the module energy engineering, students should have a wide knowledge about modern methods of analysis and evaluation of thermal systems and principles from the operation and design of the most commonly used energy conversion devices as well as skills in engineering economics. Moreover students should be able to optimize an energy supply system by ensuring a good compromise among efficiency, cost of products and environmental impact. After learning exergy based analysis, students possess the ability to identify the sources of inefficiencies and costs in energy conversion systems, to develop options for improvements and to own the creativity to optimize energy-conversion systems and skills in preparing data.

Prof. Dr.-Ing. Prof. e.h. Dr. h.c. George Tsatsaronis, Institute for Energy Engineering, Technical University of Berlin

After completion of his Diploma in mechanical engineering at NTU Athens, Greece, Prof. George Tsatsaronis received both MBA, a Ph.D. in combustion, and a Doctor Habilitatus Degree in Thermoeconomics, at RWTH Aachen, Germany. Counting above forty years of experience and related scholastic background Prof. Tsatsaronis is an expert in the fields of exergy-based methods, combustion technology as well as the development, design, simulation and analysis of energy-conversion processes and the optimization of design and operation of energy systems. His contribution to the fundamentals of exergoeconomics is significant. Apart from publishing over 250 papers and co-editing 20 bound volumes, Prof. Tsatsaronis co-authored the book “Thermal Design and Optimization”, which is base to the modules “Energy Engineering I and II” and “Project Energy Systems”.

Advanced Information Modeling

The ability for an engineer specialized in Information Technologies applied to the challenges in the energy sector to describe systems and process information in form of models is of decisive importance. Thus Advanced Information Modeling is one of the compulsory models taught in this master program.

This module offers an advanced course in “Information Modeling” and “Modeling Methodology”. Participants will achieve detailed competences in modeling as well classical databases and information systems as well as highly heterogeneous distributed information systems. They will be enabled to integrate static (structure) and dynamic (processes and behavior) modeling approaches for these classes of information systems.

The competence of critically choosing (or even developing) an appropriate set of modeling techniques and the modeling methodology for complex information modeling tasks by understanding the foundations of modeling languages (semantics and metamodelling approaches) is the main qualification objective. Participants are enabled to use and modify advanced modeling constructs, applying (meta-) modeling methodology to model-based integration of software and data components.

1. Abstraction and Modularization in Information, Software and Business Process Modeling
2. Object-oriented Information Modeling
3. Models and Modeling Languages for Semi-structured Data
4. Metamodels / MOF-Hierarchy
5. Semantics of Modeling Languages
6. Combining Different Modeling Paradigms
7. (Modeling) Language Extensions via Metamodels and/or Math. Formalisms
8. Connecting Information and Business Process Modeling
9. Model Management, e.g. Model Transformation, Model Integration (matching/merging/...)
10. Business Applications of Model-Based Software & Data Integration
Information Technology for Energy

Key playing industry worldwide has gone through transition in order to compile, manage, and use information. Module Information Technology for Energy was designed only for this Master program in order to provide the students with a multi-disciplinary mindset to solve problem occurring in the energy sector with the creative and efficient use of IT.

The students:
- know the principles of implementing the information technologies to the energy sector,
- know the principles of organization, management, developing the infrastructure and optimization within energy sector,
- know the principles of distribution of primary and secondary energy carriers, and rational use of the final products,
- have skills in preparing data and informations for the implementing the information technologies to the energy sector,
- have the ability to independently solve tasks in the field of implementing the information technologies to the energy sector.

Content

This module will illustrate the principles of analyzing, designing, and implementing information systems in order to increase energy efficiency, cost- and environmental effectiveness of the energy conversion processes/plants, energy storage and consumption.

Another focus will be on organization, management, developing the infrastructure and optimization within energy sector including generation of electricity/heat from fossil and renewable sources, distribution of primary and secondary energy carriers, and rational use of the final products, taking into account issues of energy efficiency, cost and environmental effectiveness of these processes.

Prof. Dr. Tetyana Morozyuk,
Institute for Energy Engineering, Technical University of Berlin

Tetyana Morozyuk is professor at the Institute for Energy Engineering at the Technical University Berlin, Germany. She studied refrigeration engineering in the Odessa State Academy of Refrigeration, Ukraine, and received her Diploma in 1990. She received her Ph.D. in 1994 and a Doctor Habilitatus Degree in 2001, all in Ukraine. Professor Morozyuk has over twenty years teaching experience in the fields of refrigeration and energy engineering (development, design, simulation and analysis of energy conversion processes) and applied thermodynamics (exergy-based methods). She is the author or co-author of 7 books and more than 250 research publications, and has 10 patents. Professor Morozyuk is associated with several scientific organizations (ASME - USA and IIF/IIR – France) as well as many international energy-related conferences and recognized International Journals.

Modules: Refrigeration and Air conditioning, Energy Engineering, Project Energy Systems
Mastering the design and planning of energy systems is an asset that any energy engineer must grasp. The arrangement of a number of complex interrelated components needs to be carefully considered, simulated or tested and optimized. As well economic, ecologic and environmental aspects may not be neglected. There is no denying the fact that advanced knowledge of the means of information technology in this context is crucial. Concept realization, process synthesis, economic analysis, exergoeconomic analysis and iterative process improvement, are methods that need to be taught and applied in the module Project Systems Optimization.

The planning and design of energy supply systems for power, heat and cold systems forms the focus of this project. The analysis and evaluation under energetically, exergetical, economic and ecologic aspects will also form part of the project. The students will be separated into smaller project groups and cluster the specified problem. The size of the groups depends on the respective topic to begin with, the problem is outlined and possible solutions are discussed. The participants in the project organize themselves to solve sub-problems on the way to developing the overall solution.

Skills necessary attempted are: mathematical optimization methods, mathematical modelling, the optimization of the design of power plants, optimal unit commitment in power systems.

Students are responsible for their time management, reporting and results. The tutors may also teach several technological topics in addition. Finally, there is a written report and a final presentation. Students are also required to participate in a cross-disciplinary seminar.

Students will apply, deepen and extend their knowledge in the area of energy engineering and energy economics. Depending on the students’ previous knowledge, fundamentals will also be part of this module. The project-based work will enhance the students’ scientific and collaborative problem-solving skills. After participating in this module the students will be familiar with systematic mathematical methods to optimize the design and operation of energy conversion systems. They will be aware of problems, such as model accuracy, model reliability and computational effort.
Intercultural Communications and Project Management

Communication skills, team work in an intercultural context, working in international networks, conflict management, mediation, facilitation, presentation, as well as computer-mediated communication are key aspects in work life. Moreover, time management is of crucial importance. Hence, more and more companies ask for managerial and project coordination expertise in a new employee.

The aim of the course Intercultural Communications and Project Management is on the one hand to provide students with an awareness of cultural differences and to equip them with skills required for tackling problems of intercultural communication in a global setting, and on the other hand to introduce them with project management and its application in different situations.

As the study program takes place in Germany and Egypt, the cultural differences and similarities within the Western and the Arab World are of particular interest. Multiple aspects of communication and intercultural competencies will be provided. In addition, the following fields will be covered in form of theoretical inputs, role games, working groups and interactive exercises:

- Basic knowledge about culture, cultural dimensions, communication, diversity and intercultural competence. Reflected dealing with different cultural values, behavior, perceptions, working patterns, stereotypes and prejudices and conflicts resulting out of diversity. Develop basic competencies, interpersonal skills and strategies for successful inter-cultural and gender communication. Develop basic knowledge for establishing continuous dialogue with stakeholders from science, industry, NGOs as well as with customers, employees or the local population.

Within the Project Management taught in the module, students acquire knowledge of the law on the implementation of projects, particularly in the energy sector, from the perspective of clients and service providers. Knowledge about the management tasks, management techniques and leadership means written for the planning and execution of projects mediated by the lifecycle orientation will be discussed. Project organization, schedule management, cost management, quality management, project management tools will be explicated within case studies.

Students from TU Berlin Campus El Gouna during project work, lecture and presentation.
Master Thesis and Internship

The German higher education system is dominated by learning of self-management and organization along with an independent and systematic approach to scientific tasks. Thus students have the opportunity to choose among electives, locate the company for their two month industrial internship and independently select the subject of their projects and their Master's thesis topic, supervising institution and professors individually.

Internship (6 Credits)

The industrial internship should be completed during the summer vacation in Berlin and will last a minimum of six weeks. During the internship the students are able to gain an insight into the work flows in industry, planning companies, or servicing firms. There are several possibilities for completing an internship in Berlin and the students will be supported by the El Gouna team. Students must also, create an internship report on a weekly basis, describing their activities during their time in the company or organization.

Master`s Thesis (30 Credits)

The master’s thesis requires students to develop the knowledge they have acquired during their studies and to transfer it into a novel scientific energy engineering topic solved with Information Technology on the basis of their individual research. This relates to the development of innovative energy solutions for the challenges in the MENA region in the context of a practical or theoretical study of a self-selected topic in the field of energy conversion, efficiency, systems or infrastructure. The students are encouraged to carry out their own, individual research, preferably in the framework of a research project specified by their supervisor, or possibly in cooperation with an industrial, administrative or governmental organization in a global setting. To ensure the progress of their scientific work students will also receive support from research assistants. The master's thesis ends with the presentation of the research results to supervisors and fellow students.

First intake of students of TU Berlin Campus El Gouna after their Master thesis defense.
b. Energy Engineering Electives

Conversion Technologies for Renewable Energies

Refrigeration and Air Conditioning

Energy Engineering II

Integration of Renewable Energies

Components of Energy Conversion Systems

Photovoltaics

Energy Storage and Conversion

Energy for Buildings
Refrigeration and Air Conditioning

Complementary to increasing the efficiency of energy supply and introducing higher penetration of renewable energy sources, the reduction of energy demand is an even more relevant manner while aiming for a more sustainable energy system. Especially in countries of the MENA region and generally hot regions, the electricity required for air conditioning and refrigeration dominates the overall electricity consumption, resulting in power fadeouts on hot summer days as the power supply does not meet the demand.

The course Refrigeration and Air Conditioning firstly introduces principles of operation of compression refrigeration machines and principles from the design of the most commonly used types of components. Furthermore modern methods of analysis and evaluation of compression refrigeration machines are taught.

After completion of the module, students are able to choose an adequate tool for the optimization of a system. Moreover students should gain the creativity to design new tools for the optimization of processes, have skills in preparing data and information for the design of the system and have the ability to independently solve tasks in the field of thermal design of compression refrigeration machines starting with insulation, thermodynamic cycles, working fluids, main and additional components for single and multi-stage refrigeration machines. As well cascade refrigeration machines, special refrigeration machines and thermally driven refrigeration machines are part of the class.

For each topic the terminology, historical background, rational field of application as well as energy and exergy analyses, economic aspects, ways for improving or optimizing the machines, principles of control and automatic systems will be discussed.
Components of Energy Conversion Systems

So as for any energy system to run properly, each of the numerous interrelated components needs to function correctly. In order to supervise the design, installment and operation of a complex energy system, energy engineers need to be familiar with each component’s behavior and limitation, as even a malfunctioning water pump in the cooling system can cause system failure.

This module focuses in detail on the most important components of all kinds of energy conversion systems. These include pumps, compressors, turbines and heat rejection devices (cooling towers) as well as internal combustion engines, Stirling engines, Organic Rankine Cycles and Fuel Cells. The theoretical knowledge will be demonstrated on a practical basis in the technical hall with the various test rigs for the respective machines. In addition to this, fundamental measuring techniques for parameters, such as temperatures and pressures, are also presented on an experimental basis, along with the uncertainty, which is of the utmost importance for scientific work. With the calculation of state variables, the machines can be balanced by the students using the measured data.

The students shall know the basic physical phenomena which are used for mechanical energy conversion systems and they shall know associated methods of design, evaluation, and improvement of technical solutions. The students will be able to design and optimize components of the energy systems with regard to economic and ecologic aspects.
Integration of Renewable Energies

Dominated by environmental concerns, as in local pollution and global warming, limited economic fossil fuel resources, escalation of fossil fuel prices accompanied by price volatility and rapid increase in energy demand the power sector decided for a shift towards higher penetration of renewable energy production. Yet the drastic modification from conventional on-demand power generation based on fossil fuel to non-dispatchable strongly intermittent renewable energy generation renewable energy generation introduces a large range of considerable challenges and is only successful under careful consideration of technical feasibility, policy framework, environmental and social impact.

The module Integration of Renewable Energies teaches the most important systemic, ecologic and economic connections for the effective integration of renewable energies in electrical grids, supply systems and markets under the constraints of sustainability with respect to the different solutions. Furthermore, the students will be able to assess the information concerning energy potentials, demand scenarios, systems solutions and market strategies using scientific methods with regard to economic decisions.

The description of obstacles enables the students to create the conditions for a possible transition of the electricity industries to sustainable concepts and allows the assessment of respective actions. The lecture introduces different analytical methods and instruments which help to understand the complex interdependencies. The focus lays not on detailed technical design and engineering but on strategic assessment and implementation of learned context.
Energy for Buildings

The building sector make up above 60% of the global energy consumption. In particular in the MENA region a noteworthy part of this share can easily be reduce by simple indirect and direct measures, making the module Energy for Buildings essential to the Master of Energy engineering program.

This module focuses on energy systems in buildings in order to understand the complex energy flows and media required in the context of sustainable aspects in the MENA region to comply with human needs. In terms of the physiology of people with respect to thermal comfort and air quality, the measurement of meteorological data such as solar radiation, air temperature, humidity and winds are crucial in respect of comfort. The goal is to enable students to understand the different energy flows in a building and to use calculation methods for planning and constructions with respect to different building purposes. This also includes the design of thermal heat insulation and the suitable materials. This will be explained using the primary energy consumption for the heating and cooling system. Comparisons between the annual energy needs for heat/cold generation as well as losses of transfer and distribution are discussed. The course provides examples of classical and solar heat supply systems in terms of primary energy consumption for ventilation and air conditioning. It also includes theoretical exercises to develop the learned methods, as well as practical experiments in specially designed test rooms e.g. for visualizing air flows.
Environmental concerns, escalating and highly volatile fossil fuel prices and an ever-rising energy demand pushed the power sector towards an energy transition: from conventional fossil fuel based power generation towards low-emission renewable energy generation. Especially wind and solar power have recently experienced a significant boost in globally installed capacity. This module is aiming to introduce the students to the full range of renewable energy conversion technologies.

The generation, conversion and utilization of renewable energies form the focus of this module. The direct and indirect utilization of solar energy including photovoltaic panels, concentrating power plants and wind power plants is presented in its fundamental principle and technical resource assessment. The diverse exploitation possibilities of biomass and waste as an energy carrier with biochemical and thermochemical conversion technologies also content of the course, as well as hydropower plants and geothermal heat. Students will have the possibility of deepening their knowledge in practical laboratory experiments regarding fuel characterization and fluidized bed conversion. Students should subsequently be able to understand, evaluate and design conversion systems of various renewable energies sources.
Energy Storage and Conversion

Most renewable energy sources are neither capable to provide constant nor on-demand power generation. Energy storage and the production of alternative energy carrier such as Hydrogen are the most commonly discussed approaches to ensure a secure and stable energy supply dealing with the introduction of intermittent renewable energy generation.

The module Energy Storage and Conversion is split into two sections. An overview on diverse energy storage systems is content to the first set of lectures. The second part will specifically discuss electrochemical energy storage.

The overview on stationary electrical and thermal energy storage systems includes large scale technologies such as pumped hydro, compressed air, long and short term thermal energy storages, Power-to-gas-concepts, decentralized electric technologies like cell batteries (Lead Acid, Sodium Sulfur, Lithium Ion), Flow batteries (Vanadium, Zinc Bromide), flywheels and double layer capacitors. Each technology will be explained in terms of functionality and application cases, where necessary the underlying working principles are presented. Consequently, students will learn to perform a comparative analysis of different storage technologies and to define typical application cases in the context of system integration of intermittent renewable energies. Special attention will be paid to understand thermodynamic mechanisms in order to optimize selected storage technologies such as thermal storages in Compressed Air Energy Storage and thermal management of cell batteries.

In the second set of lectures and lab work, the students get familiar with basic concepts and experimental methods of Electrochemistry, Surface Catalysis, electrochemical energy conversion and storage, such as fuel cells, batteries, electrolyzes, photo electrochemical cells and others. The students will also be exposed to some additional concepts at the borderline of electrochemistry and catalysis and solid state physics, surface science, materials science. Participants are able to independently research and analyze topics related to electrochemistry, catalysis, electrochemical energy storage and conversion and will be given an opportunity to present their literature research to the course in form of a short slide presentation.
Photovoltaics

The harvest of energy emitted by the sun and convert it to electrical energy in only one step is not only brilliant but also has the largest range of applications. Photovoltaics is available and economically feasible at any scale and the most attractive renewable energy technology for off-grid application particularly in the MENA region. The module Photovoltaics introduces the students to the true scope of semiconductor technologies.

This module starts with the physical fundamentals for understanding the concept of semiconductors and function of this technology, as well as the respective raw materials. In addition to the physical understanding of the solar cells, new techniques such as thin layer cells are also explained and characterized. This includes material supply, component design, component characterization and integrated circuits.

After successful completion, students should be able to work effectively in the development of solar cells, solar modules and systems. As part of the module, students are expected to acquire a basic understanding particularly in the following areas of photovoltaics (PV): Electrical and physical properties and relationships, radiation of the sun, interaction between radiation and PV materials, preparation and properties of PV materials, as well as PV components, characterization of PV materials and PV components. Standard concepts as well as special concepts will be discussed. The course combines the transmission of knowledge (lecture) with the theoretical (exercise) and practical (laboratory) application.
c. IT, Economics and Law Electives

- Heterogeneous and Distributed Information Systems
- Economic Principles for Engineers
- International Contract and Competition Law
- Environmental Management
- Internship

- Fundamentals of Electrical Networks
- Energy Economics I
- Energy Economics II
- Internship
Heterogeneous and Distributed Information Systems

Due to increased complexity of energy database energy equilibrium must be systematically managed. Consequently as much energy information as possible must be processed in order to build up profound and numerical knowledge of energy consumption and supply. Energy databases are distributed and heterogeneous causing the management of multiple distributed and heterogeneous sources a key subject to the master program IT for Energy.

We show how individual database systems will retain their autonomy in spite of mutual information sharing. Dynamic handling of user requests on multiple database systems with high security and the utilities for the user to handle the global data are the key features of the proposed system. We discuss some special functional components and language constructs which can be easily incorporated in the existing systems to achieve these goals. The participants of this module will achieve deep conceptual, methodical, technical and practical knowledge in requirements analysis, design, architecture and development of heterogeneous and distributed information systems. This includes classical knowledge about federated databases and mediator-based information systems. Different paradigms of heterogeneous information infrastructures and their management and interoperability architecture will also be investigated. Modern model-based concepts for the development, integration and evolution of arbitrary information infrastructures, and –under this conceptual frame– model, meta model, and metadata management as well as semantic concepts will be discussed and brought into practical experience by some larger project-like group work.

1. Foundations/Terminology of HDIS (FDBS, FIS, MBIS)
2. Dimensions of HDIS: Distribution, Heterogeneity, Autonomy
3. Heterogeneous Data Models in HDIS: structured, semistructured, un-structured
4. Distributed Data Organization and Software Architectures of HDIS (FIS, P2P, CS)
5. Interoperability and Middleware Platforms for HDIS
6. Persistency Services
7. Metadata Standards and Management in HDIS
8. Model-based Development of HDIS
9. Applications from Industry and Public Services
Fundamentals of Electrical Networks

Nowadays the power network is facing a rapid transition, more and more highly fluctuating, non-dispatch-able, distributed and small capacity renewable energy generators, flexible loads and energy storage are introduced endangering the demand-supply-equilibrium essential to maintaining grid stability. For energy engineers it is of great essence to be aware of the complexity of electrical networks and their behavior.

In this module basic knowledge for operation of networks of electric power supply is taught to the students. This includes complex numbers, sources and load, nodal analysis, three-phase systems, load flow calculation, network control, modeling.

- Content taught within the module: Harmonic sizes: Representation of time functions by harmonic series, vector representation
- Load curves
- Switching processes in simple electrical networks: Switching on and off of DC voltages, circuit with R, L and C
- Source and load: voltage and current sources, controlled sources, replacement sources
- Analysis of networks: mesh analysis, node potential method
- Multi-pole networks: n poles, n gates, scattering parameters
- Four poles (two goals): Two-port network equations, equivalent circuits, frequency response of two gates,
- Transfer functions, Bode diagrams, pole/zero maps
Environmental Management

Any day-to-day action has environmental impact that needs to be measured and managed. Decent environmental management can be very beneficial, not only from a moral point of view to improve a business’ image or reputation but rather decreases risks, brings about cost savings and enables meeting stakeholder expectations and ensures submission of related environmental regulations.¹

Within this module the students shall gain applicable knowledge on the environmental policy instruments. The Environmental Management lecture further comprises instruments for environmental protection management with the focus on companies’ environmental protection. The majority of these tools is standardized in the ISO 14000 series. Besides, a short look is taken on environmental policy instruments directed to industry.

The core topics discussed in this class are:

1. Introduction to environmental protection and environmental management
2. Life Cycle Assessment and Footprints
3. Environmental costing, Life Cycle Costing
4. Environmental product development and labels
5. Environmental Management Systems and auditing
6. Environmental policy instruments

¹ Environmental Management System
Importance of Environmental Management
(Pearson)
Economic Principles for Engineers

For students coming from an engineering intensive backgrounds and no previous experience in economics, the basic economic principles are an asset in order to understand micro- and macroeconomics and business administration.

Within the module “Economic Principles for Engineers” the students shall learn a basic understanding of economic issues and contexts and become acquainted with the functioning of important economic institutions. Moreover the procurement of literature and other sources of information for processing and classifying this information in scientific and practical contexts is a major learning outcome of the module.

The students will carry out independently simple investing and financing bills and gain an overview about selected key terms and concepts of business administration, micro- and macroeconomics by an contractarian introduction to the nature of business. Thereby the focus is on the acting contractor or its production, investment and financing decisions.

To work out decision criteria and the most important restrictions, and the understanding and application of professional knowledge by use of case studies are major learning goals of “Economic Principles for Engineers”.

Main content of the module:

1. Market/Supply & Demand
2. Business forms
3. Balances & profit and loss account
4. Production decisions (Polypol/Monopol)
5. Investment decisions (static & dynamic processes)
6. Taxes
7. Financing
8. Risk and business valuation
Energy markets have complex structures and regulations determining prices and market behavior of key actor groups e.g. developers, investors, generators, shippers and customers. It is crucial for energy engineers to understand market behavior in order to be a successful player for instance while introducing new energy technologies to the market.

The courses Energy Economics I and II consider markets for different energy carriers along with markets for electricity and heat which have different properties and include both renewable and non-renewable sources. The key elements of this course include methodological issues, such as cost calculations including external costs, and energy modeling on the basis of energy balances and scenarios. A focus is also put on the market liberalization of the grid business and the related trading at energy exchanges and over the counter.

In addition to the supply side of energy markets, the demand side is also covered by analyzing energy efficiency measures and instruments. Understanding the particularities of energy markets is crucial for managers in the energy business, even if their key competence is energy or environmental engineering. In the first part of this module students gain a general understanding of methodological instruments for analyzing energy markets, secondly a practical insights into advanced energy markets by cooperating with companies and experts in industry is given.

Prof. Dr. rer. pol. Georg Erdmann,
Department of Energy Systems, Technical University of Berlin

Prof. Georg Erdmann is Professor for Energy Systems at the Department of Energy Technology at TU Berlin. Research area of Prof. Erdmann includes but not limited to energy economics containing energy market reform, market modeling and forecasting, energy trade and investment strategies along with financing and risk management. His field of study was Mathematics and Economics, and he is holding a PhD degree in Economics from Münster University. Prof. Erdmann was Post doc researcher and Assistant Professor at the Center for Economic Research, Swiss Federal Institute of Technology, Zürich (1982–1995). Moreover his research includes market admission of novel energy technologies comprising for instance electric vehicles, battery storage and fuel cells. He published several books and scientific articles.

Prof. Erdmann is the President of the Board, KSB Energie AG Berlin, envolved in energy trading services and among several other mandates, chair of the GEE German member institution of the International Association for Energy Economics (IAEE).

Modules: Energy Economics I and II, Economic Principles for Engineers
## Energy Economics II

Goal of the module Energy Economics II is for students to be able to define themselves as experts within the group and to the outside world. Accordingly they apply the treated theoretical approaches taught in Energy Economics I and II in their own initiative. The conveyed contents and skills create above average conditions for a successful career start in the energy economy sector and belong to the conditions which are necessary for future management responsibilities.

### Content Energy Economics I

1. Energy bilancing
2. Economic calculation with External costs
3. Fundamentals of energy trade
4. Markets for emission certificates
5. Markets for power generation
6. Markets for crude oil and natural gas
7. Markets for petroleum products
8. Transport and distribution of piped energy systems

### Content Energy Economics II

1. Determination of energy demand,
2. Energy prognosis and timetable forecasts,
3. Energy and development,
4. Energy efficiency,
5. Energy management,
6. Political influence to the developments at the energy market,
7. Long-term energy scenarios,
8. Innovation processes in the energy sector

## International Contract and Competition Law

After assignment of this module, students have a basic overview of the framework conditions of the energy law on the German and European level. They also know the legal basis for energy trading and consumer protection. Based on this, they understand various law related energy concepts. Special focus is also on the ecological energy transition and the resulting issues of energy security and affordable energy.

1. Fundamentals of German and European Energy law
2. Unbundling provisions, infrastructure regulation, concession contracts and municipal responsibility (energy concepts)
3. Energy security, affordable energy prices and ecological energy transition (EnWG, EEG, CHP Act, TEHG)
4. Energy trading and energy consumer protection law
V. What happens after the Masters? – Alumni Reports

Mohamed Magdeldin, Doctoral candidate at Aalto University, Finland

Mohamed Magdeldin, intake 2012

Mohamed Magdeldin is currently in pursuit of his Ph.D, in Energy Technology at Aalto University School of Engineering after graduating from TUB El-Gouna campus in 2015.

He joined the M.Sc. program earlier after obtaining a degree in Chemical Engineering from the University of Technology PETRONAS, Malaysia. During his enrollment and as a result of presenting a research paper on the development of Energy policy frameworks in Egypt, Mohamed received the best paper award at the 4th Desertec Energy Conference held in Rabat, Morocco in 2012.

As a partial fulfillment of the M.Sc. program, Mohamed joined Industrial Solar GmbH based in Freiburg, Germany for a two month internship period. The scope of work involved working closely with the engineering team on the development of the company’s solar direct steam generation pilot plant based on the Linear Fresnel technology.

Mohamed culminated the program with a Master thesis research titled: “The development of optimized conceptual plant designs for the supercritical water gasification of biomass process”. The thesis work was prepared and conducted at Aalto University in Finland, as part of the European mobility ERASMUS exchange program.

Mohamed’s current doctoral research is a continuation to the thesis project he started at TUB El-Gouna. According to Mohamed, the Master program enabled his personal and technical aptitude with “the necessary skill set to pursue a future career in the field of innovative energy technologies”. It also provided several opportunities to exchange knowledge and contribute within the global energy research community.
Karim Rizk, intake 2012

Karim Rizk is a former nuclear energy engineer from Alexandria with experience in project management and worked as research engineer at Bibliotheca Alexandria for a period of three years. Nowadays, Karim is employed by FRENELL GmbH a German company recently established resuming the work of the former company NOVATEC Solar GmbH that undertakes manufacture, supply and turnkey delivery of solar fields and thermal energy storage systems.

Karim was part of the first intake at Campus El Gouna, as a part of his master study in Energy Engineering Karim conducted his internship and his master thesis at NOVATEC in Karlsruhe, Germany. After performing market assessment on the MENA region and analyzing a the integration of “Direct-Molten-Salt-Based Integrated Solar Combined Cycle for Egypt’s Power Generation Market in 2020” at NOVATEC. Karim was offered a position as Business Development Engineer. Karim is currently engaged heavily in the Egyptian power generation market believing that Concentrated Solar power is Egypt’s future.

According to Karim, the Energy Engineering master program was a major shift from being an observant of the Egyptian power sector crisis into an actor that contributes to the solution of the energy crisis. “This shift would have never been possible without being taught and supervised by the eminent professors of the modules Energy Engineering, Integration of renewable energies and Energy Economics.”, Karim stated.

Moreover Karim shares the opinion, that TUB campus el gouna is a great example of interdisciplinary teaching in a multicultural environment, as “the topics you have out of class are unlimited and it opens the mind to new ideas and concepts from the four corners of the world”.

TUB Campus EL Gouna has a huge potential to be a leading Energy and water research institute, not only serving Egypt but the whole MENA region. Karim is always looking forward to support TUB campus el gouna to be one of the leading institutes in the MENA region.
Louay Hossam, Project Coordinator at Orascom Construction, Egypt

Louay Hossam, intake 2012

Louay Hossam was one of the first students of Campus El Gouna, starting his Master’s degree in 2012. With him being a Mechatronics undergraduate from Helwan University in Egypt, his present career in the energy sector is significantly determined by his performance in the campus’ master program Energy Engineering.

Apart from his Master thesis on “Exergy-based methods applied to Egyptian Concentrated Solar Power Plants” winning the best paper award, he was one of the students travelling to Morocco presenting the project output from the module - Integration of Renewable Energies - at the 4th Dii Desert Energy Conference 2013.

Since 2015, Louay is working as Project Coordinator at Orascom construction (OC) Ltd one of the biggest Egyptian companies with convincing regional presence.\(^2\) Being in the lead as global engineering and construction contractor predominantly concentrating on commercial and industrial infrastructure projects, Orascom construction took on two of the three planned 4.8 GW gas fired Combined-Cycle Power Plants.\(^3\)

Though his recent graduation, Louay was handed the responsibility to coordinate the construction of the largest power plant in the MENA region, ensuring a trouble-free cooperation of multiple large international companies.

Louay signified the Energy Engineering program at TU Berlin Campus El Gouna as “unique” and is proud to have graduated from “one of the most reputable technical universities worldwide”. The switch to the self-managerially dominated German education system he commended as a broad intellectual experience enhancing his personal endurance. In future he would like to continue to encourage scientific and commercial cooperation between Germany and Egypt, in addition to proceeding with his PhD Studies.

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\(^2\)http://www.dailynewsegypt.com/2015/03/28

\(^3\)http://www.orascom.com/
Mohamed Nabil, intake 2013

Mohamed Nabil graduated in 2011 from Helwan University with a bachelor’s degree in Energy Engineering. At the beginning of the summer term of 2015 Nabil went from being a Master’s student of the Energy Engineering program at TU Berlin Campus El Gouna to a part time energy engineer at toughTrough GmbH, a global acting solar company.

ToughTrough is a German enterprise, specialized in innovative light-weight solar application. Nabil not only had the chance to do his Master’s thesis with toughTrough but was also sent to Thailand to coordinate and supervise one of the company’s CSP projects.

According to Nabil’s narration the Energy Engineering program was a main contributor to his personal success story. Apart from the program being the motivation for him heading to Germany and learning the German language in the first place he especially complimented the push towards independent work and critical thinking in addition to the content taught. Moreover, he appreciated the focus on most critical challenges in the energy sector covering state of the art technologies for conventional and renewable energy sources.

Nabil made clear, that El Gouna’s - life as it should be - atmosphere is not as relaxing as it seems: “You will always be chased by deadlines, but the studying atmosphere is real fun.” Moreover he stated: “Although the campus is located in Egypt, you will always get the feeling that you are in one of the building extensions from Berlin. Starting from the great German professors (...)

All in all, the hard work was worth it and the energy engineering is very proud that Mohamed Nabil made it in the harshly competitive CSP business.

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4 http://www.toughtrough.com/
I. What’s in it for me? – Leisure

There is no denying the fact, that the Master programs at TU Berlin Campus El Gouna are very intense in means of time and place. Students travel almost every six month back and forth between El Gouna and Berlin with hardly any break. Yet this brings along as much as it costs, despite the limited spare time, in the touristic town El Gouna on the coast of the red sea, the few free time students spend with yoga, soccer tournaments, basketball, kyte surfing, beach volleyball, social gatherings and much more. It is hard not to find pleasure in a touristic town entitled: “live as it should be”.

Attracting five million visitors yearly, Berlin is the to go to city in Europe. Specially in the recent years the German capital experienced a wave of artists, designers and media professionals. Berlin is a very diverse and alive city with unique charm and an outstanding status for cultural vitality.
Apart from their private activities, students are provided with very diverse exposure. TU Berlin Campus El Gouna strives to provide a number of excursions and cultural activity in both Egypt and Germany. The annual visit of the Hannover Messe, the most significant industrial fair worldwide, became a tradition within the energy department.

Moreover, visits to different power plants such as: Reuter-West power plant, Oil fired power plant Hurghada, Wind Farm and PV power plants Germany and Egypt. Cultural activities are for instance visits of local museums, the freshers-day safari, visit of the German Reichstag, German and Arabic courses.

Field trip to PV power plant in Germany, excursion to Wind park in Hurghada, visit of the German Parliament, daytrip to the Hannover Messe.
II. Application and Admission

The application and admission to one of the Master programs offered at TU Berlin Campus El Gouna can be easily broken down in four steps: Preparation, Submission, Admission and Search for Scholarships. Before submitting you should make sure you gathered all the requested documents. Please check our website for the detailed list of requested documents. In case you are accepted for studies, you receive a preliminary letter of acceptance. In case you need a scholarship to provide for the study fees or living expenses, search for scholarships early on. As soon as you get the preliminary letter of acceptance applying you can easily apply for scholarships. Consequently, the earlier you obtain the preliminary letter of acceptance, the higher your chances to receive funding. Due to this issue, TU Berlin Campus El Gouna is opening three different deadlines through-out the year: Early, regular and late application.

Apply NOW... [www.campus-elgouna.tu-berlin.de/v_menu/admission_process/application/](http://www.campus-elgouna.tu-berlin.de/v_menu/admission_process/application/)
And be part of TU Berlin Campus El Gounas community